Warren H. Finlay

Concise Catalog of Deep-Sky Objects

Astrophysical Information for 550 Galaxies, Clusters and Nebulae

Second Edition

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In memory of Clare Patershuk
May her scattered photons grace the Universe forever

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About the Author

Dr. Warren H. Finlay is a Canadian citizen. He is an avid amateur astronomer and author of "The Concise Catalog of Deep-Sky Objects: Astrophysical Information for 500 Galaxies, Clusters and Nebulae," published by Springer in 2003. He has been a Contributing Editor of the bimonthly *Journal of the Royal Astronomical Society of Canada* and is the recipient of the Royal Astronomical Society of Canada's (RASC) Simon Newcomb Award for literary achievement, among several other RASC awards for dark sky preservation and astronomy education. He has traveled extensively in search of dark sky sites, and has logged thousands of deep sky objects with his telescope from all over the world. In his day job as a Professor of Mechanical Engineering at the University of Alberta, Warren has written two books, six chapters in other books, more than 140 archival journal papers, and 220 refereed conference publications – in addition to several hundred non-refereed conference publications. He is also an accomplished night sky photographer, with many of his photographs gracing astronomy magazines as well as art venues.

Chapter 1

Introduction

This book is intended to give a concise summary of some of the more interesting astrophysical facts that are known about objects commonly observed by amateur astronomers. Pondering this information while viewing an object in the field has added a new level to the author's enjoyment of deep-sky observing, and it is hoped this information will be similarly enjoyed by other amateur astronomers. The book is not intended to be read cover to cover, but rather is designed so that each object entry can be read individually one at a time and in no particular order, perhaps while at the eyepiece.

A total of 550 deep-sky objects are listed as separate entries in this book, in order of their NGC (New General Catalogue) number in the main section of the book, including all the Messier objects, the Herschel 400 objects, the Royal Astronomical Society of Canada's Finest 110 NGC objects plus 30 of the Royal Astronomical Society of Canada's Southern Hemisphere Splendours objects. Because NGC and IC numbers were originally assigned in approximate order of an object's location from west to east, objects that are well placed for viewing in the sky at a particular time of year occur within a few pages of each other.

For convenience, the Messier objects are repeated in a separate chapter in order of their Messier number. The separate chapter on the Messier objects includes astrophotos of them, taken by Canadian amateur astronomers. The only five objects from the IC (Index Catalogue) are listed in the last chapter of the book along with the Large Magellanic Cloud which does not have its own defining NGC or IC number.

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The following notes apply to the presentation of information for each object.

Object type: This is one of the following:

Open cluster – a close-knit collection of stars within the disk of our Galaxy that all formed from the same interstellar cloud in the past few billion years, usually containing fewer (usually many fewer) than a few thousand stars and often containing only a few tens of stars that are visible in an amateur telescope.

Globular cluster – a close-knit collection of stars, usually outside the disk of our Galaxy, that formed many billions of years ago and contains many tens of thousands (or even more than a million) stars.

Planetary nebula – this is a short-lived stage in the life of stars having masses not too different from the Sun. Near the end of the nuclear fusion stage of such a star, gas is expelled in winds from the dying star, with these winds sometimes expelling more gas in certain directions, and also interacting (e.g. with previously expelled gas, binary companions, planets or magnetic fields), making interesting patterns in the gas that we see as different shapes to planetary nebulae. The gas is ionized by ultraviolet radiation from the central star, making the gas visible when electrons recombine with ions.

Emission nebula – this is a region where an interstellar gas cloud has been ionized by young, hot stars near or in these clouds. The clouds are mostly made of ionized hydrogen, but small amounts of other ionized atoms, such as oxygen, also emit light (for example, doubly ionized oxygen, or OIII, emits light at a particular wavelength that is easier to see with a special OIII filter that only lets this wavelength through).

Reflection nebula – this is a region where light from stars is scattered off dust in an interstellar cloud.

Elliptical galaxy – as the name suggests, these are galaxies with the shape of an ellipsoid (although many are not far from being spherical in shape).

Lenticular galaxy – lenticular means "lens-shaped" and this is the shape of these galaxies i.e. they are shaped like a convex lens and have a disk in their central plane (but this disk lacks spiral arms). Some have a bar in the disk, and this is noted by the classification "barred lenticular galaxy."

Spiral galaxy – these are galaxies with a disk shape that contains spiral arms within it. Those with a bar in the disk are indicated as "barred spiral galaxy." A galaxy is said to be "early-type" if it is an elliptical or lenticular galaxy, or is a spiral galaxy with relatively tightly wound spiral arms and a large central bulge (making it an "early-type" spiral). "Late-type" spirals have less tightly wound arms and a very small bulge compared to an extended disk.

Irregular galaxy – these are galaxies with no obvious rotational symmetry.

Supernova remnant – the visible remains of a supernova.

Asterism – a pattern of physically unrelated stars on the sky.

R.A., Dec.: The right ascension (R.A.) and declination (Dec.) coordinates of the object (Equinox 2000). R.A. and Dec. are analogous to longitude and latitude but refer to the object's position in the sky. R.A. is different from longitude, however, since it is measured in hours and minutes instead of degrees like declination, with

1 h R.A. being 15° (so that 24 h R.A. makes 360°), while 1 min R.A. is 1/4° or 15′ angular measure. Note that 00 h 00.0 m R.A. runs through the east side of the Great Square of Pegasus.

Approximate date of transit at local midnight: This gives the approximate date on which the object is highest in the sky at midnight (and so is best positioned for viewing at midnight). The time of transit moves 2 h earlier every month. For this reason, an object will transit at 10 p.m. approximately 1 month later than the date given and will transit at 8 p.m. 2 months later than the date given. For example, the entry for the Crab Nebula (M 1) gives "transit at local midnight" as December 24. Thus, at midnight on Christmas Eve, the Crab Nebula will be approximately due south for northern temperate zone observers, but will be due south at 10 p.m. around January 24 and at 8 p.m. around February 24.

The dates given assume daylight saving time is in effect from the end of March through early November, unless otherwise specified. Because the dates of switchover from standard to daylight savings and back again vary each year as well as by location, these times may be incorrect for dates near the switchover date; correction for this is left to the reader. In addition, because the time of transit will depend on the observer's location within their time zone, variations by as much as 2 weeks from the date given can be expected (but are of little practical consequence).

Distance: Most astronomical distances are not known accurately, so that the distances listed here must be considered as approximate values. Most distances are accurate at best to 10 %, but inaccuracies of up to a factor of 2 do occur (for example with planetary nebulae, whose distances are notoriously inaccurate). For example, if an object is listed as being at a distance of 5,000 light years, then its distance is probably not known to an accuracy of better than ±500 light years in the best cases, but in the worst cases its distance may only be known to lie in the range 2,500–10,000 light years.

Age: The ages of most deep-sky objects are also not known to high accuracy, so that the values given are approximate values only. Inaccuracies are similar to those given under distance.

Apparent size: These are the approximate dimensions of the object in the sky as it would appear in a telescope. It should be noted that these dimensions will depend on the aperture of the telescope in many cases, since larger-diameter telescopes will often see larger dimensions for the object than smaller telescopes (since dimmer regions can be seen with larger telescopes). As a result, the given dimensions are approximate values. For reference, the apparent sizes of several commonly observed deep-sky objects are given in Table 1.1.

Magnitude: This is the total, integrated, visual magnitude of the object i.e. if all the visual light from the object were emitted from a point source (a star), this would be the magnitude of that point source. For diffuse objects it can be difficult to use total, integrated magnitudes to guess how bright the object would appear in the eyepiece. This is because what we see is the object's light spread out over the entire

Table 1.1 Apparent sizes of several commonly observed objects

Object	Apparent size
M45 (Pleiades)	≈2°
M42 (Orion Nebula)	≈1°
M81 (spiral galaxy in Ursa Major)	25′ × 12′
M11 (Wild Duck Cluster)	11′
M49 (brightest galaxy in Virgo cluster)	≈10′
M27 (Dumbbell Nebula)	6′
M57 (Ring Nebula)	≈1′
Separation of stars in the double star ε Lyrae (the "Double–Double")	2.3″, 2.6″

area of the object (the effect is similar to looking at a star in the eyepiece when the view is out of focus – the star appears much dimmer when out of focus even though the same amount of total light is reaching the eye from the star). The alternative is to use surface brightness, which has units of magnitude per unit area, but this requires knowing the area of the object and this has not been accurately measured for a number deep-sky objects. Thus, only the total, integrated visual magnitude is given. It should be noted that the visual magnitude of some objects is somewhat uncertain, and for these objects the magnitude is given as an integer.

Other Facts: Various interesting astrophysical facts about the object are given in the text following the above headings. Since a number of these refer to the relative location of objects within the Milky Way, a simplified schematic of the approximate basic dimensions of our Galaxy is shown in Fig. 1.1. Our Galaxy is thought to be a barred spiral galaxy. Most of the luminous matter in our Galaxy is contained in the central bulge and disk, the latter being about 6,000 light years in thickness and 100,000 light years in diameter. The bulge is a flattened spheroid with a major axis diameter of about 15,000 light years and minor axis of about 10,000 light years. At the center of the bulge lies what is thought to be a giant black hole with a mass of about 4 million Suns and a diameter that is no larger than that of our Solar System.

Unlike how it is shown in Fig. 1.1, the Galactic disk does not end abruptly at its edges. Rather, it trails off over some distance, making its exact dimensions somewhat difficult to define. Most of the disk revolves at the same speed (a little over 200 km/s). Our Sun lies in the disk close to the Galactic central plane at a distance somewhere around 27,000 light years from the center, as indicated in Fig. 1.1, and has a period of roughly 1/4 billion years in its orbit around the Galaxy. The disk consists mostly of young and intermediate age ("Population I") stars that are typically between 1 million and 10 billion years old. Although not shown in Fig. 1.1, the entire disk and bulge are embedded within a giant spherical region, termed the "halo," that contains extensive amounts of dark matter extending out to a diameter of several hundred thousand light years. Within the halo lie many of the Galaxy's globular clusters. In contrast to the disk, the halo consists of old ("Population II")

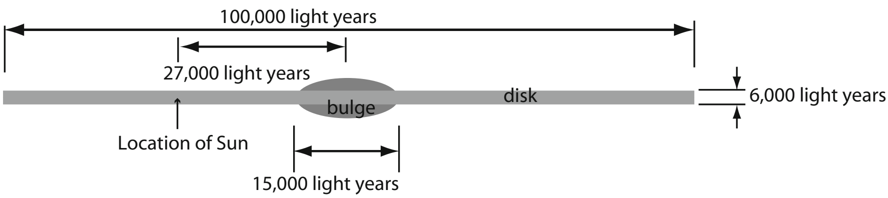

Fig. 1.1 Schematic diagram of our Galaxy as viewed from the side (edge-on), with the location of the Sun as indicated

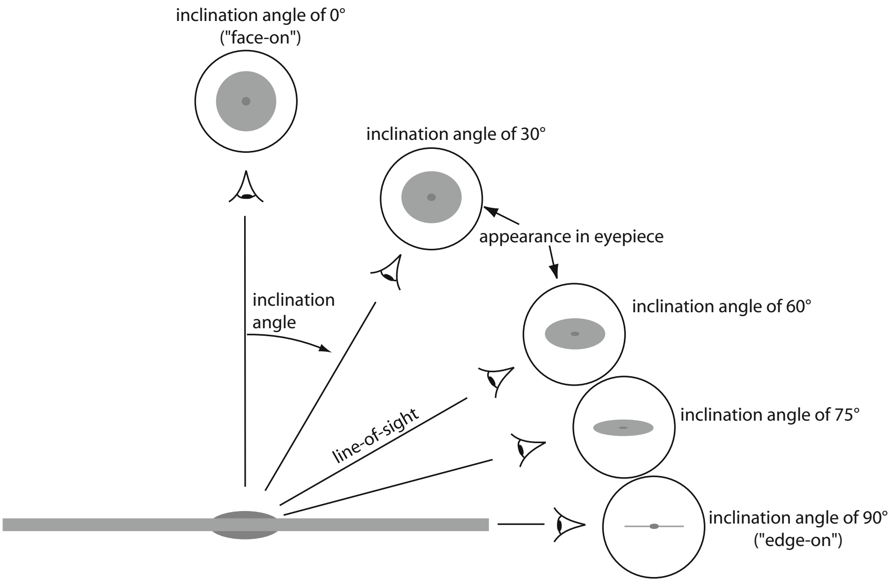

Fig. 1.2 The concept of inclination angle is illustrated for a disk galaxy, with the appearance in the eyepiece shown at various inclination angles

stars that are typically at least 10 billion years old. The total mass of the Milky Way (both dark and luminous matter) is somewhat uncertain but thought to be somewhat less than a trillion Suns, with luminous stars making up less than a few hundred billion Suns of this mass.

For a number of galaxies, an inclination angle is mentioned in the text. This is the angle subtended by our line-of-sight and an axis perpendicular to the galaxy's central plane, as shown in Fig. 1.2. The higher the inclination angle, the more flattened a disk galaxy appears to us, as shown in Fig. 1.2 for several inclination angles. The inclination angle is defined so that it is always between 0° and 90°, so that no distinction is made between views from "above" or "below" a galaxy's central plane. For disk galaxies, the inclination angle can be approximated as arccos (minor axis/major axis), where the minor and major axes dimensions are listed under the object's "Apparent size" entry.

Number convention: Throughout the book, billion indicates 10^9 and trillion indicates 10^{12}, which is their common usage in North America and not to be confused with the usage of these words in the UK and other parts of the world.

References: The information in this book was culled from several thousand archival journal papers, many of which were located using NASA's Astrophysics Data System. Additional sources of information included the following: NASA/IPAC Extragalactic Database (NED) which is operated by the Jet Propulsion Laboratory California Institute of Technology, under contract with the National Aeronautics and Space Administration; SIMBAD, Aladin Sky Atlas and VizieR operated by the Centre de Données astronomiques de Strasbourg; Stellarium open source planetarium software; the Revised New General Catalogue and Index Catalogue compilation of Wolfgang Steinicke; the Catalog of Parameters for Milky Way Globular Clusters, compiled by William E. Harris, McMaster University; the *Observer's Handbook*, edited by Rajiv Gupta, published yearly by the Royal Astronomical Society of Canada; and William Herschel's original articles (Phil. Trans. Royal Soc. London vol. 76:457–499, 1786; vol. 79:212–255, 1789; vol. 92:477–528, 1802).

Chapter 2

The Messier Objects

M1 (NGC 1952)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Taurus	Supernova remnant	05 h 34.5 m, +22° 01′	December 24
Distance	**Age**	**Apparent size**	**Magnitude**
6,500 light years	1,000 years (created by a supernova in A.D. 1054)	6′×4′	8.4

Nicknamed the "Crab Nebula," this is one of the most well-studied objects in the sky. At its center is a pulsar, which is a rotating neutron star (about 10 km in diameter with a mass about twice that of the Sun) with a strong magnetic field that emits a narrow beam of radio emission. The Crab pulsar rotates about 30 times a second (i.e., its period is 33 ms), with its beacon pointing at us once each rotation (like a very rapidly rotating lighthouse beam). It is slowly spinning down, so that when the pulsar first formed in A.D. 1054 it is thought to have rotated more than 50 times a second. Of more than 1,000 known radio pulsars, this is one of only six whose pulses are visible in optical wavelengths (with professional telescopes). Pulsars are the remains of a star that went supernova. For the Crab pulsar, the progenitor star is thought to have had a mass about ten times that of our Sun. The Crab Nebula constitutes the remnants of the material ejected by the supernova event of this star, with several solar masses worth of material being present in the luminous portion of the nebula. The filaments in the nebula are moving outward at over 1,000 km/s.

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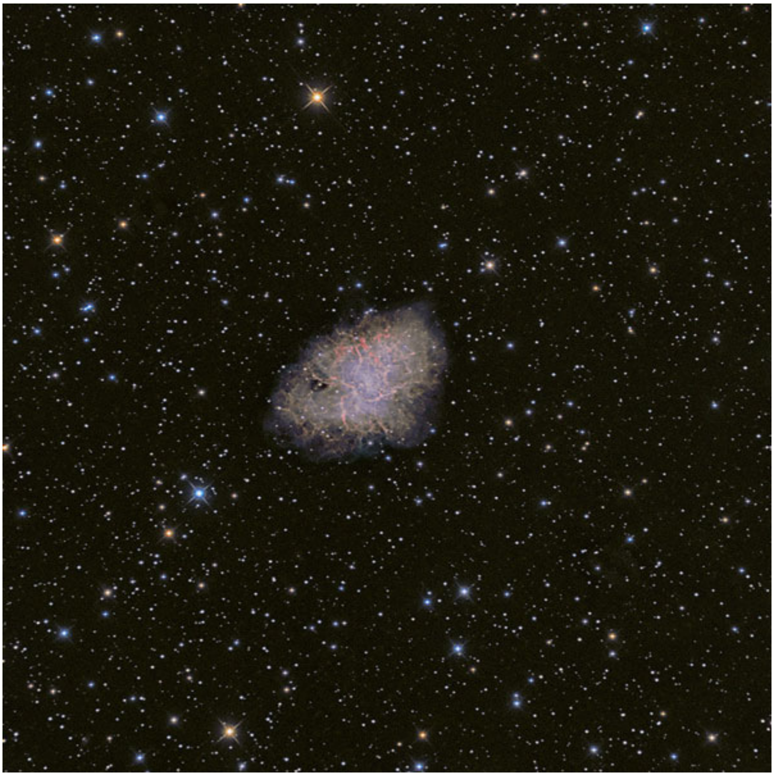

Fig. 2.1 Photo of M1; 9×15 min luminance, red, green, blue exposures with QSI540wsg camera, Astro-Tech 10″ f/8 Ritchey-Chrétien telescope on Celestron CGE Pro mount. North is up and east is to the left. (Copyright Dalton Wilson)

M2 (NGC 7089)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Aquarius</td><td>Globular cluster</td><td>21 h 33.5 m, −00° 49′</td><td>September 8</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>40,000 light years</td><td>10–14 billion years</td><td>16′</td><td>6.6</td></tr>
<tr><td colspan="4">The mass of this cluster is about 900,000 suns, but many of these stars are more massive than the Sun so that the total number of stars is about 150,000. Its size of 11.7′ gives it a diameter of about 130 light years. It lies in the halo of our galaxy. The halo is the region outside the spiral disk and bulge of our galaxy, extending out as a sphere with a radius of perhaps six times that of the spiral disk region and containing most of the galaxy's dark matter. M2 orbits the galaxy independently of the galactic disk on an inclined orbit that wanders out over 100,000 light years from the galactic center and then approaches within a few tens of thousands of light years of the galactic center, taking the better part of a billion years to complete one revolution around the galaxy. Its color magnitude diagram (CMD) has both a split sub-giant branch, where the two populations differ by a few tenths of magnitude, and a double red giant branch, where the two populations differ somewhat in color. These CMD features may reflect two sequential generations of star formation in this cluster.</td></tr>
</table>

Fig. 2.2 Photo of M2; 19×5 min exposures with Canon 40D camera, ISO 800, Astro-Tech 8″ f/4 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M3 (NGC 5272)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Globular cluster	13 h 42.2 m, + 28° 23′	May 11
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	18′	6.3

The mass here is about a half million suns. Its size of 18′ corresponds to a diameter of about 160 light years. It orbits the galaxy on a precessing elliptical path that is highly inclined with the plane of our galaxy and quite eccentric (minor axis to major axis ratio of 0:4). It takes about 300 million years to make one revolution of the galaxy, never straying farther than about 60,000 light years from the galactic center (we are about 27,000 light years from the galactic center, although we stay in the disk of our galaxy and M3 does not). M3 never approaches closer than about 10,000 light years from the galactic center, making it an inner halo cluster (so called since it doesn′t travel too far out in the halo – see M2 for the meaning of "halo"). It is considered intermediate in its richness of "metals" (elements heavier than helium), ranking just out of the top third in metallicity for globular clusters in our galaxy.

Fig. 2.3 Photo of M3; 9×10 min exposures with Canon 40D camera, ISO 800, Skywatcher Equinox 120 mm f/7.5 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M4 (NGC 6121)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Scorpius</td><td>Globular cluster</td><td>16 h 23.6 m,
−26° 31′</td><td>June 21</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>7,000 light years</td><td>10–14
billion years</td><td>36′</td><td>5.4</td></tr>
<tr><td colspan="4">This is the nearest globular cluster to us. Its size of 36′ corresponds to a diameter of about 70 light years. It has a mass of about 100,000 suns. It has two distinct stellar populations, which are thought to represent two different generations of stars that formed at different times in this cluster. The cluster lies toward the galactic center, within roughly 2,000 light years of the galactic central plane, so that interstellar material in the disk of our galaxy blocks out some of its light and makes it dimmer (by a few magnitudes) than it would otherwise appear. It follows an orbit that takes it in as close as 1,000 light years and out as far as 30,000 light years from the galactic center over a period of about 120 million years.</td></tr>
</table>

Fig. 2.4 Photo of M4; 3 × 10 min red, green, blue exposures with QSI540wsg camera, Skywatcher Equinox 120 mm f/7.5 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M5 (NGC 5904)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Serpens Caput	Globular cluster	15 h 18.6 m, +02° 05′	June 5
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	23′	5.7

This has a mass of about 600,000 suns and its diameter is about 160 light years. Like most globular clusters, it does not orbit our galaxy with the galactic disk, as we do. Instead it follows an orbit that takes it out as far as 180,000 light years from the galactic center and then back in as close as a few thousand light years, on a path highly inclined to the galactic disk, taking almost a billion years to make one revolution around our galaxy (compare to the quarter-billion years our Sun takes to make one galactic revolution). M5 currently sits about 20,000 light years from the galactic center, which is much closer than its average orbital distance, since it is about to reach its closest approach to the galactic center.

Fig. 2.5 Photo of M5; 8×5 min luminance, 6×5 min red, green and blue exposures with a ST-10XME camera, Takahashi FSQ 106 mm f/5 telescope on AP900GTO mount. (Copyright Stuart Heggie)

M6 (NGC 6405)

Constellation	**Object type**	**RA, Dec**	**Approx. transit date at local midnight**
Scorpius	Open cluster	17 h 40.3 m, −32° 15′	July 10
Distance	**Age**	**Apparent size**	**Magnitude**
1,600 light years	95 million years	33′	4.2

This is nicknamed the "Butterfly Cluster," due to the shape of its apparent outline. It contains several chemically peculiar stars ("CP2" stars – see NGC 2169 for explanation). It lies in the direction of the center of our galaxy, less than 20 light years below the galactic central plane. Its size of 33′ corresponds to a diameter of about 15 light years. Professional telescopic studies have counted over 300 stars belonging to this cluster (only a small fraction of which are visible in amateur telescopes).

Fig. 2.6 Photo of M6; 25 min exposure on chilled Kodak Ektachrome 400 with 8″ f/6 Newtonian telescope. North is up and east is to the left. (Copyright John Mirtle)

M7 (NGC 6475)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scorpius	Open cluster	17 h 53.8 m, −34° 48′	July 14
Distance	**Age**	**Apparent size**	**Magnitude**
1,000 light years	300 million years	75′	3.3

First mentioned by Ptolemy over 2,000 years ago, it has a diameter of about 20 light years. Professional telescopic studies find that nearly 100 % of the stars in M7 are binary stars, an inordinately high frequency of binaries compared to the galactic field (where >50 % of main-sequence stars are binaries). It has a mass of about 700 suns. Like all open clusters, a good number of the stars in the field of this cluster (called "field stars") do not belong to the cluster. Instead, they just happen to lie in the line-of-sight of the cluster but are actually much closer or farther away from us than the cluster. This "contamination" by field stars can be seen in Fig. 3.7 of Chapter 3. (See M39 for further discussion of this.)

Fig. 2.7 Photo of M7; 13×30 s exposures, ISO 1600, Canon Rebel XT 350D camera with 300 mm f/5 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M8 (NGC 6523)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Emission nebula	18 h 03.7 m, −24° 23′	July 16
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years		45′×30′	5.0

Nicknamed the "Lagoon Nebula," the open cluster NGC 6530, with more than a thousand member stars, is embedded within this nebula. The stars in this cluster formed from the nebula in the past couple million years. It contains many pre-main sequence stars that are still contracting and have not yet begun burning hydrogen. The nebula itself is a large ionized hydrogen (or HII) region, within which young O-and B-type stars associated with the cluster are thought to still be triggering star formation. M8 is actually only a small "blister" on the surface of a giant molecular gas cloud that lies behind M8. The nebula is ionized (and thus made visible) largely by just three stars (primarily 9 Sgr, but also the binary HD 165052, and the multiple star Herschel 36) as shown in Fig. 3.8 of Chapter 3. Herschel 36 may be a triple-star system, perhaps consisting of a close binary pair that orbits a primary star whose mass is similar to that of the orbiting binary pair and is >20 suns. It is responsible for ionizing the brightest part of the nebula, a 15″×30″ patch in the center of the nebula. This patch is called the "Hourglass." The Hourglass is on the back side of the nebula, right on the edge of the giant molecular cloud from which NGC 6530 formed.

Fig. 2.8 Photo of M8; 10×2 min exposures, ISO 1600, with Canon 60Da camera, 200 mm Skywatcher f/5 Newtonian reflector with a Paracorr coma corrector. (Copyright Blair MacDonald)

M9 (NGC 6333)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 19.2 m, −18° 31′	July 5
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	12′	7.8

The mass of this cluster is about 300,000 suns. Its size of 12′ gives it a diameter of about 90 light years. It belongs to the central bulge of our galaxy (i.e., the central, spherically shaped region within about 15,000 light years of the galactic center) and lies a few thousand light years nearly directly above the galactic center. This is a metal-poor bulge cluster (metal-poor meaning it has a low abundance of elements heavier than helium), being in the bottom 20th percentile for metallicity of Milky Way globular clusters.

Fig. 2.9 Photo of M9; 21 × 30 s exposures, ISO 1600, Canon Rebel XT 350D camera with 200 m f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M10 (NGC 6254)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	16 h 57.1 m, –04° 06′	June 30
Distance	**Age**	**Apparent size**	**Magnitude**
15,000 light years		20′	6.6

The mass here is 100,000–200,000 suns. The size of 20′ corresponds to a diameter of about 80 light years. This cluster stays within several thousand light years of the galactic central plane and has a velocity close to that of the material in the galactic disk. This is quite unusual for a moderately “metal-poor” cluster like this one (“metal-poor” meaning it has low amounts of elements heavier than helium), since stars in the galactic disk tend to have “metal” that was scattered by previous supernovae. Only a few percent of its stars are binaries, which is much lower than that seen on average in the Milky Way, but is expected given the high density of stars and resulting dynamical interactions between stars. About 120 blue stragglers are known in this cluster, which are stars that are paradoxically far more blue and luminous than expected, perhaps because of mass transfer between or coalescence of stars. (See NGC 6633).

Fig. 2.10 Photo of M10; 22×30 s exposures, ISO 1600, Canon Rebel XT 350D camera with 200 m f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M11 (NGC 6705)

Constellation	**Object type**	**RA, Dec**	**Approx. transit date at local midnight**
Scutum	Open cluster	18 h 51.1 m, −06° 16′	July 29
Distance	**Age**	**Apparent size**	**Magnitude**
6,000–7,000 light years	200 million years	11′	5.8
This is nicknamed the "Wild Duck Cluster" after the V-shaped outline (pointed east) that some of its brighter members make. Its mass is several thousand suns, with 500 members brighter than mag. 14. Its size of 14′ corresponds to a diameter of about 25 light years. A person in the middle would see a night sky with several hundred first mag. stars, each separated by <1 light year. This is nearly as dense as some globular clusters. A significant number of field stars are present as foreground/background stars. (See M39.)			

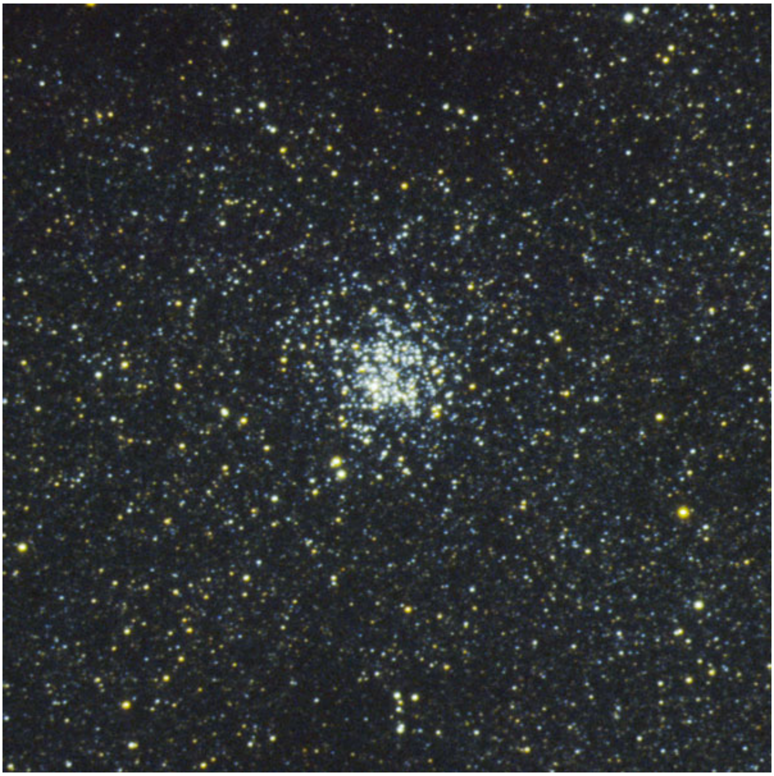

Fig. 2.11 Photo of M11; 20 min exposure on chilled Kodak Ektachrome 400 with 8″ f/6 Newtonian telescope. North is up and east is to the left. (Copyright John Mirtle)

M12 (NGC 6218)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	16 h 47.2 m, −01° 57′	June 27
Distance	**Age**	**Apparent size**	**Magnitude**
15,000 light years	10–14 billion years	16′	6.1

The size of 16′ here corresponds to a diameter of about 70 light years. Like M3 and M10, this is an inner halo cluster, so called since it doesn't travel too far out in the halo – see M2 for the meaning of "halo." M12 never strays farther than about 20,000 light years from the galactic center on an orbit inclined to the galactic central plane by 33° or so. M12 takes about 130 million years to complete one revolution around the galaxy, having just crossed the galactic central plane a few million years ago (lying 2,000 light years below it) on its way to a maximum excursion of 10,000–15,000 light years below the galactic plane. Its mass is about 100,000 suns, which is perhaps a fifth of its original mass, having been tidally stripped of stars by interactions with the Milky Way's gravitational potential over its lifetime, losing a mass of perhaps 5,000 suns each time it orbits our galaxy.

Fig. 2.12 Photo of M12; 22×30 s exposures, ISO 1600, Canon Rebel XT 350D camera with 200 m f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M13 (NGC 6205)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hercules	Globular cluster	16 h 41.7 m, +36° 28′	June 26
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	20′	5.8

This is nicknamed the "Hercules Cluster." Its 20′ size corresponds to a diameter of about 130 light years. It has a mass of about 500,000 suns. It orbits the galaxy independently of the material in the galactic disk on an inclined orbit that travels out to beyond 100,000 light years from the galactic center but approaches within 15,000 light years of the galactic center, taking a half billion or so years to complete one revolution.

Fig. 2.13 Photo of M13; 5×10 min luminance, 9×5 min red and green, 4×5 min blue exposures with Apogee U16M camera, Astrophysics 155 EDF 4″ f/7 telescope on Paramount ME mount. North is to the left. (Copyright Stuart Heggie)

M14 (NGC 6402)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 37.6 m, −03° 15′	July 10
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	11′	7.6

The mass of this cluster is about 1.2 million times that of our Sun. Its size of 6.7′ corresponds to a diameter of about 100 light years. It is located in the central bulge of our galaxy (i.e., the central, spherically shaped region) and is relatively lacking in elements heavier than helium (i.e., "metals"), so that it may have formed in one of the earliest star-forming periods of our galaxy (see NGC 6287). It lies about 8,000 light years above the galactic central plane about 13,000 light years from the galactic center. It was only the second globular cluster (after M80) to have a nova discovered in it. It may have an extragalactic origin and been accreted by the Milky Way.

Fig. 2.14 Photo of M14; 10 × 1.5 min luminance, red, green, blue exposures with Atik 460EXM camera, Celestron 14″ telescope with Hyperstar lens corrector. North is up and east is to the left. (Copyright Dalton Wilson)

M15 (NGC 7078)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pegasus	Globular cluster	21 h 30.0 m, +12° 10′	September 7
Distance	**Age**	**Apparent size**	**Magnitude**
34,000 light years	10–14 billion years	18′	6.3

The mass here is nearly a million suns. The size of 18′ corresponds to a diameter of about 180 light years. It is a halo cluster (see M2 for the meaning of "halo"), but never travels farther than about 45,000 light years from the galactic center on a path that is inclined by about 40° from the galactic disk. It revolves once around the galaxy every quarter billion years or so in a prograde orbit (like most globular clusters), meaning it revolves about the galaxy in the same direction as the galaxy's own rotation. The cluster is core collapsed (see NGC 6284 for explanation) and has one of the most concentrated centers (with more than 30 stars per square arc second in professional telescopes). M15 contains a planetary nebula (Pease 1, mag. 13), one of only four known globular clusters that share this distinction and the easiest planetary of the four to find in amateur telescopes (but recommended for a 12-in. or larger telescope, and requiring a detailed map of the field, optional nebula filter, and patience to discern Pease 1 among the myriad stars near it). M15 is the most metal-poor globular cluster in the Milky Way, meaning it has the least abundance of elements heavier than helium.

Fig. 2.15 Photo of M15; 10×3 min exposures with Canon 40D camera, ISO 800, Astro-Tech 8″ f/4 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M16 (NGC 6611)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Serpens Cauda</td><td>Open cluster with nebulosity</td><td>18 h 18.8 m, −13° 48′</td><td>July 20</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>6,000 light years</td><td>1–3 million years</td><td>8′</td><td>6.0</td></tr>
<tr><td colspan="4">The stellar mass of this open cluster is thought to be about 20,000 suns. The cluster’s size of 8′ corresponds to a diameter of about 14 light years. It is embedded in a gas cloud from which the cluster formed and in which star formation is still going on. Young, hot stars in the cluster are ionizing the surrounding hydrogen gas cloud (making it a so-called HII region), thereby making it fluoresce as the emission nebula IC 4703, which is nicknamed the “Eagle Nebula” or the “Star Queen Nebula” after the appearance of part of this nebula in professional telescopic images and photographs. This namesake region is well known from the Hubble Space Telescope’s “Pillars of Creation” photo of a 2′×2′ or so portion of it (which lies just SE of the open cluster’s most concentrated area). This photo shows three large pillars (looking like “elephant trunks” or hoodoos) aligned in a SE-NW direction. The pillars are regions of dark molecular gas and dust that are being “eroded” by intense radiation from stars to their NW. Stars in NGC 6611 are thought to progress in age from younger (1 million years) in the northwest to older (3 million years) in the southeast, possibly because star formation in this region was progressively triggered by an encounter starting in the southeast several million years ago with a giant molecular shell created earlier by supernovae explosions.</td></tr>
</table>

Fig. 2.16 Photo of M16; 7 × 10 min H-alpha exposures with Apogee U16M camera, Astrophysics 155 EDF 4″ f/7 telescope on Paramount ME mount. North is to the left. (Copyright Stuart Heggie)

M17 (NGC 6618)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Emission nebula + open cluster	18 h 20.8 m, −16° 10′	July 21
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	1 million years	20′ × 15′	6.0

The appearance of this nebula in amateur telescopes leads to its various nicknames ("Swan Nebula," "Omega Nebula," among others). Its size of 20′ corresponds to a diameter of about 40 light years. Like M8 and M16, the nebula fluoresces due to an embedded open cluster, in this case containing thousands of stars that formed from the nebula. However, the stars in the open cluster are so heavily obscured by intervening gas and dust that only five of them have magnitudes brighter than 14 (with only two brighter than magnitude 10), making its appearance as a true "cluster" of stars essentially nonexistent in the eyepiece of an amateur telescope. Professional telescopes find many pre-main sequence stars in this cluster that are only a few hundred thousand years old. These young stars are still collapsing and have not yet begun nuclear fusion. Ongoing star formation is thought to be occurring, triggered by already formed large bright O-type stars that are irradiating the molecular cloud from which they formed.

Fig. 2.17 Photo of M17; 3 × 20 min H-alpha exposures with SBIG STL11000 camera, Takahashi FSQ 106 mm f/5 telescope on AP900GTO mount. North is down. (Copyright Stuart Heggie)

M18 (NGC 6613)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Open cluster	18 h 20.0 m, −17° 06′	July 21
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	30 million years	7′	6.9
This sparse cluster has a diameter of about 10 light years and has not been well studied. It has a mass of perhaps a little less than a couple hundred suns.			

Fig. 2.18 Photo of M18; 14×30 s exposures, ISO 1600, Canon Rebel XT 350D camera with 200 m f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M19 (NGC 6273)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 02.6 m, –26″ 16′	July 1
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	17 ′	6.8
With a mass of about 1.2 million suns, this emits the 10th most visible light of all the globular clusters in our galaxy. It belongs to the central bulge of our galaxy (i.e., the central, spherically shaped region), lying a few thousand light years nearly directly above the galactic center. It is a metal-poor bulge cluster (meaning it has a low abundance of elements heavier than helium), being close to the bottom 20th percentile in metallicity for Milky Way globular clusters.			

Fig. 2.19 Photo of M19; 5×5 min exposures with QSI540wsg camera, Skywatcher Equinox 120 mm f/7.5 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M20 (NGC 6514)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Emission and reflection neb.	18 h 02.7 m, −22° 58′	July 16
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	300,000 years	20′	6.3

Light from very young stars that formed out of the surrounding gas ionize hydrogen in the nebula here, causing it to glow (making this a so-called HII region, although other elements are present, in particular oxygen, since the nebula benefits from a filter that lets in light from doubly ionized oxygen, i.e., OIII). This nebula is thought to be in a "pre-Orion-nebula" state, where young stars are violently ejecting matter, and protostars with jets are interacting with the nebula. The nebula is "lit up" mostly by the bright star in the middle of the nebula (HD 164492 or ADS 10991, mag. 7). ADS 10991 is a multiple star whose two brightest components have a separation of 10.6″ and position angle of 212°. It is found to consist of seven stars in professional telescopic studies. Dust grains are also present in the nebula (in the northern regions near the bright mag. 7.5 star there) that scatter the starlight, so that this nebula consists of both a reflection nebula (in the north) and an emission nebula (in the south). The nickname "Trifid Nebula" refers to the emission nebula and is derived from Latin (*trifidus,* meaning "split into three"), which refers to its three lobes that are separated by lanes of dust grains in the nebula that block its light from us. The entire nebula's size of 20′ corresponds to a diameter of about 30 light years.

Fig. 2.20 Photo of M20; 8×3 min red, 7×3 min green and blue exposures with SBIG XR-10XME camera, Takahashi FSQ 106 mm f/5 telescope. North is up and east is to the left. (Copyright John Mirtle)

M21 (NGC 6531)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Open cluster	18 h 04.2 m, −22″ 29′	July 16
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	5–10 million years	16′	5.9
This cluster lies very close to the galactic central plane (being a few tens of light years below it). It has a mass of perhaps 800 suns. Of the 1,500 or so open clusters in our galaxy this is one of many that have not been well studied by professional telescopes.			

Fig. 2.21 Photo of M21; 15×30 s exposures, ISO 1600, Canon Rebel XT 350D camera with 200 m f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M22 (NGC 6656)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 36.4 m, −23° 54′	July 25
Distance	**Age**	**Apparent size**	**Magnitude**
10,000 light years	10–14 billion years	32′	5.2

Its mass is a few hundred thousand suns. It is the third brightest globular cluster in our night sky, after 47 Tuc (NGC 104) and ω Centauri (NGC 5139). It is also the third closest globular cluster to us (after M4 and NGC 6397). Along with M15, this is one of only four globular clusters that contains a planetary nebula, labeled GJJC 1. However, at mag. 15 and lying near the core of the cluster, finding GJJC 1 in an amateur telescope is exceptionally challenging (the one in M15 is easier to find – see M15). M22 never strays too far from the galactic disk in its orbit, staying within about 15,000 light years of the galactic central plane between about 50,000 and 10,000 light years from the galactic center, orbiting the galaxy once every 200 million years or so. It has two distinct stellar populations with unusually different abundances of heavy elements, the origin of which remains uncertain but may either be simply two generations of stars as occurs in most globular clusters or, more unusually, the cluster may have an extragalactic origin.

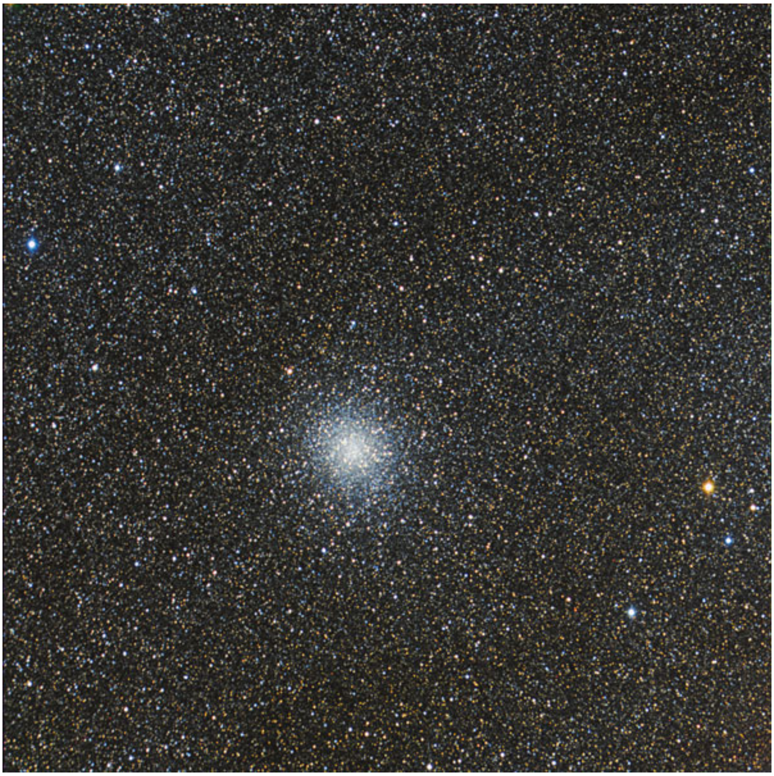

Fig. 2.22 Photo of M22; 3×1 min luminance, red, green, blue exposures with QSI540wsg camera, Celestron 14″ telescope with Hyperstar lens corrector. North is up and east is to the left. (Copyright Dalton Wilson)

M23 (NGC 6494)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Open cluster	17 h 57.1 m, −18° 59′	July 15
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years	300 million years	25′	5.5
The size of 25′ here corresponds to a diameter of about 15 light years. It has a mass of nearly 600 suns.			

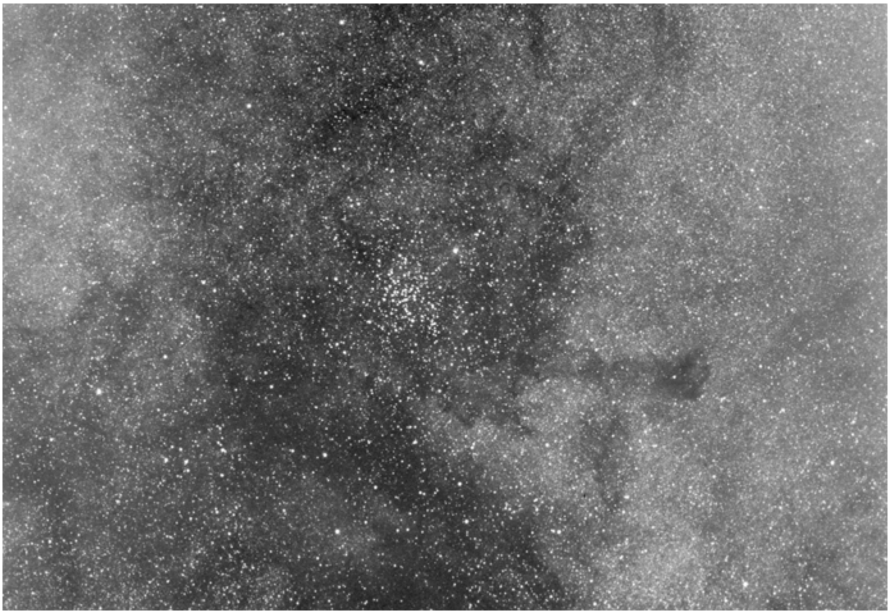

Fig. 2.23 Photo of M23; 5 min exposure on hypered Kodak Tech Pan with 8″ f/1.5 Schmidt camera. North is up and east is to the left. (Copyright John Mirtle)

M24 (IC 4715)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Star cloud	18 h 16.5 m, −18° 50′	July 15
Distance	**Age**	**Apparent size**	**Magnitude**
9,000–12,000 light years		1.6°×0.6°	4.6

This is a patch of the Milky Way seen through a hole in the foreground interstellar dust that obscures the surrounding sky, making the patch appear as a cluster to Messier even though it is not a true cluster. Nicknamed the “Small Sagittarius Star Cloud,” the open cluster NGC 6603 (mag. 11.1, 9,000–12,000 light years away, 100–200 million years old) lies within M24 (probably on the near side of the star cloud that makes up M24) and is sometimes incorrectly labeled as M24.

Fig. 2.24 Photo of M24 (IC4715); 15 min exposure on Kodak film with 8″ f/1.5 Schmidt camera. North is up and east is to the left. (Copyright John Mirtle)

M25 (IC 4725)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Sagittarius</td><td>Open cluster</td><td>18 h 31.8 m, −19° 07′</td><td>July 24</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>2,000 light years</td><td>70–100 million years</td><td>26′</td><td>4.6</td></tr>
<tr><td colspan="4">This has a diameter of about 15 light years and has a mass of over 1,000 suns. It contains one Cepheid variable star (U Sgr, mag. 6.4 – see NGC 7790 for an explanation of Cepheid variables). It also contains six known Be stars (see M47 for explanation of Be stars).</td></tr>
</table>

Fig. 2.25 Photo of M25 (IC 4725); 2×10 min luminance, red, green, blue exposures with QSI540wsg camera, Skywatcher 80 mm telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M26 (NGC 6694)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scutum	Open cluster	18 h 45.3 m, −09° 23′	July 27
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	100–200 million years	10′	8.0
This has a diameter of about 15 light years. It lies about 250 light years below the galactic central plane, which happens to be about the furthest extent our Sun travels from the galactic central plane (although the Sun currently sits within about 100 light years above the galactic central plane). In professional telescopes it has a mass of 300–400 suns.			

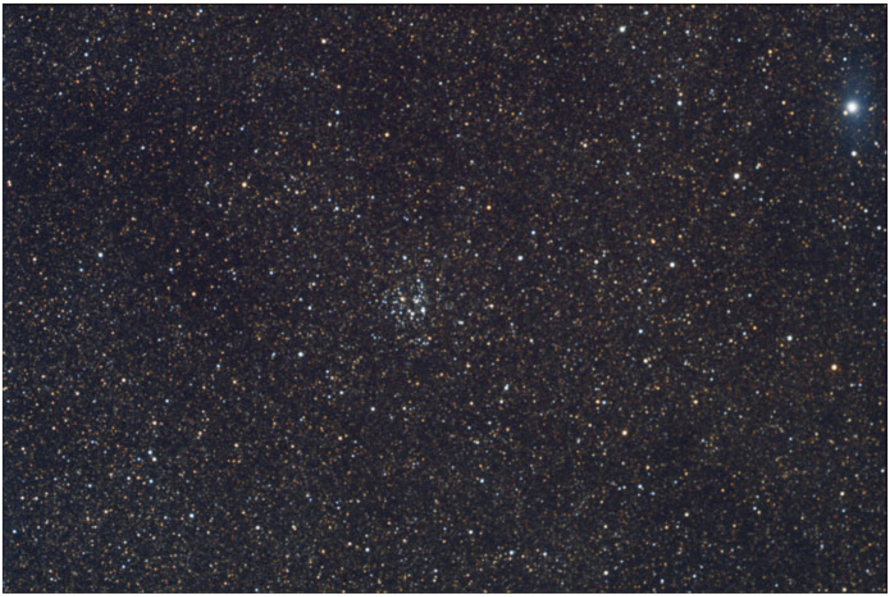

Fig. 2.26 Photo of M26; 3×5 min red, green, blue exposures with SBIG ST-8XE camera, Takahashi FSQ 106 mm f/5 telescope. North is up and east is to the left. (Copyright John Mirtle)

M27 (NGC 6853)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Vulpecula	Planetary nebula	19 h 59.6 m, +22° 43′	August 15
Distance	**Age**	**Apparent size**	**Magnitude**
1,000 light years		5.8′	7.3

This is nicknamed the "Dumbbell Nebula," although a partially eaten apple might be a better description of its actual appearance in amateur telescopes. Planetary nebulae begin when an aging giant star gives off a large amount of gas in a "superwind" (traveling at 10 km/s, emitting 10^{-4} solar masses/year). Once the core of the old star is eventually exposed, a hot, fast wind (1,000 km/s, emitting 10^{-9} solar masses/year) slams into the previously emitted gas. This may explain the complex shapes of some planetary nebulae, but the presence of companion stars and magnetic fields may also play a role in some cases. The nebula is ionized by short wavelength, non-visible radiation from the central star and re-emits this radiation in visible wavelengths. The central star (mag. 13.8) lies at the narrowest part of the "bowtie" shape and has a temperature of about 110,000 K. The nebula is several thousand years old and still expanding (at several tens of km/s). In professional telescopes M27 is found to have an elliptical halo surrounding the main nebula, which itself is elliptical, and also contains an internal elliptical shell, so that the structure of this nebula consists of nested shells.

Fig. 2.27 Photo of M27; 51×15 min H-alpha, 12×10 min red, 4×10 min green, 3×10 min blue exposures with Apogee U16M camera, Planewave 12.5″ f/8 telescope on Paramount ME mount. North is to the right. (Copyright Stuart Heggie)

M28 (NGC 6626)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 24.5 m, −24° 52′	July 22
Distance	**Age**	**Apparent size**	**Magnitude**
20,000 light years		13′	6.9

The mass here is about 300,000 suns. Like M10 (NGC 6254), this cluster spends its time within a few thousand light years of the galactic central plane. This is quite unusual for a "metal-poor" cluster like this one (meaning it has low amounts of elements heavier than helium), since stars in the galactic disk tend to have "metal" that was scattered by previous supernovae. The origin of this cluster is thus uncertain. Its elliptical orbit takes it in as close as 2,000 light years (at perigalacticon) and out as far as 20,000 light years (at apogalacticon) from the galactic center, with an orbital period of about 50 million years. It is currently near apogalacticon. Interactions with the Milky Way's gravitational pull have resulted in mass loss and perhaps two tidal tails, one of which may be due to its last passage about 4 million years ago through the galactic central plane.

Fig. 2.28 Photo of M28; 8×4 min exposures with Canon 40D camera, ISO 800, Celestron 14″ telescope with Hyperstar lens corrector. North is up and east is to the left. (Copyright Dalton Wilson)

M29 (NGC 6913)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Cygnus</td><td>Open cluster</td><td>20 h 23.9 m, +38° 32′</td><td>August 21</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>3,000 light years</td><td>A few million years</td><td>10′</td><td>6.6</td></tr>
<tr><td colspan="4">This has a diameter of less than 10 light years. It is heavily obscured by foreground dust that is very patchy (dimming some stars in the cluster by up to five magnitudes, but hardly dimming others). In professional telescopes this cluster is found to contain several hundred stars and a mass close to 1,000 suns.</td></tr>
</table>

Fig. 2.29 Photo of M29; 2×5 min red and green, 2×11 min blue exposures with SBIG ST-8 camera, Vixen 8″ f/9 telescope. North is up and east is to the left. (Copyright John Mirtle)

M30 (NGC 7099)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Capricornus	Globular cluster	21 h 40.4 m, −23° 11′	September 9
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	12′	6.9

This has a mass of about 100,000–200,000 suns. It orbits the galaxy on a retrograde orbit that is inclined to the galactic disk (by 50°), taking about 160 million years to complete one revolution around the galaxy, never straying farther than about 30,000 light years from the galactic center, but never approaching closer than about 10,000 light years to the galactic center. The core of this cluster has “collapsed” (see NGC 6284), making its central region like a swarm of angry bees suddenly placed into a small container. Its size corresponds to a diameter of about 90 light years. It contains a high concentration of “blue straggler” stars. These are stars that are paradoxically far more blue and luminous than expected, perhaps because of mass transfer between or coalescence of stars (see NGC 6633), with almost 50 such stars known in this cluster.

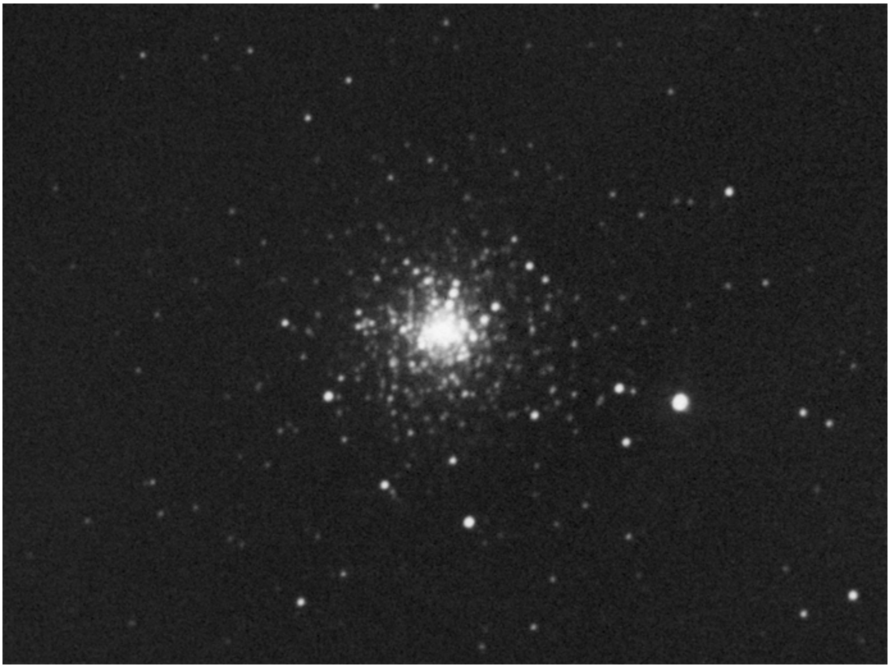

Fig. 2.30 Photo of M30; 20 min exposure on hypered Kodak Tech Pan film, with 8″ f/6 telescope. North is up and east is to the left. (Copyright John Mirtle)

M31 (NGC 224)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Andromeda</td><td>Spiral galaxy</td><td>00 h 42.7 m, +41° 16′</td><td>October 26</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>2.5 million light years</td><td></td><td>3.2°×1.0°</td><td>3.5</td></tr>
<tr><td colspan="4">Nicknamed the “Andromeda Galaxy,” this is the nearest large galaxy to us and is the most luminous member of our Local Group of galaxies that contains about 40 galaxies in a radius of a few million light years. M31 is thought to have about the same mass as our galaxy. An apparent disk diameter of 3.2° corresponds to a diameter of 140,000 light years, although the diameter visible in telescopes is larger than this (and depends on the aperture and observing conditions). Professional telescopes show it has perhaps as many as 28 dwarf satellite galaxies, including NGC 205 (M110), which is prominent in amateur telescopes. Nearby M32 may be experiencing its first tidal encounter with M31, while M33 is thought to have had a close encounter with M31 a few billion years ago. M31 is rich in globular clusters for a spiral galaxy, with nearly 250 counted in professional telescopes. The brightest of these globular clusters can be observed in amateur telescopes. Some of them are thought to have come from dwarf galaxies that M31 accreted in past merger events. Professional telescopes find M31 has a double nucleus containing a black hole with a mass of about 50 million suns, the largest black hole in our Local Group of galaxies. The two nuclei are separated by 0.5″ and are thought to be part of an eccentric nuclear disk. The nucleus also contains a young blue star cluster with a mass of a few thousand suns that formed a couple of hundred million years ago. The galaxy is a LINER (“low-ionization nuclear emission region” – see M81/NGC 3031 for explanation). It is expected to collide with the Milky Way in a few billion years.</td></tr>
</table>

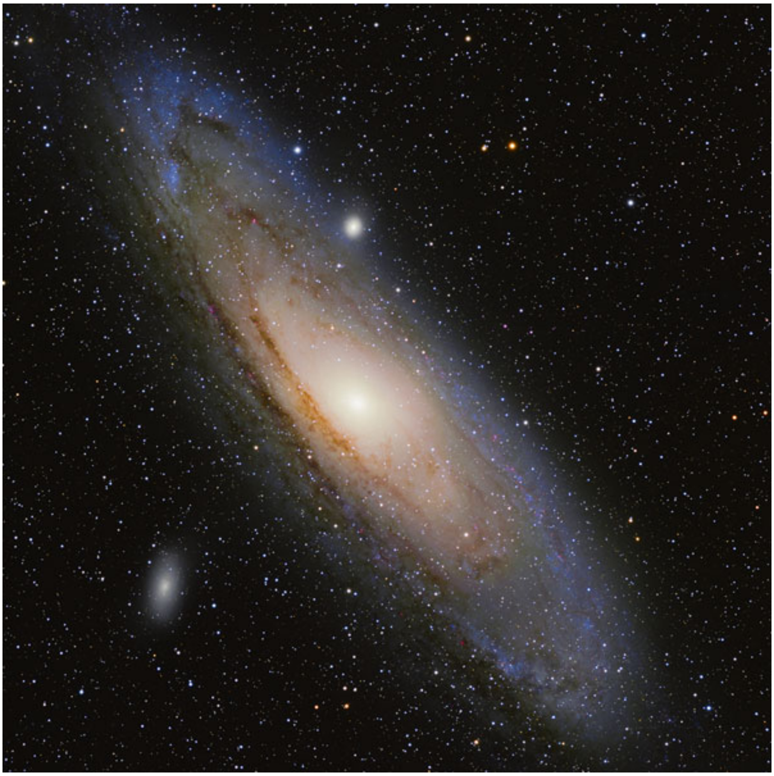

Fig. 2.31 Photo of M31; 17×10 min luminance, 10×10 min red, green and blue exposures with Apogee U16M camera, Astrophysics 155 EDF 4″ f/7 telescope on Paramount ME mount. North is down. (Copyright Stuart Heggie)

M32 (NGC 221)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Andromeda	Elliptical galaxy	00 h 42.7 m, +40° 52′	October 26
Distance	**Age**	**Apparent size**	**Magnitude**
2.5 million light years		8.5′ × 6.5′	8.1

This is a dwarf satellite galaxy of M31 and is M31's closest companion. M32 is a very unusual galaxy, referred to as a "compact elliptical" galaxy, having an inordinately bright and compact central core. Fewer than ten compact elliptical galaxies are known to exist within a distance of 300 million light years of our galaxy. Its origin remains uncertain, but one hypothesis suggests it was once a spiral galaxy that was stripped down to its bulge a few billion years ago by intense tidal interaction with M31. Alternatively, it may simply be a low-mass classical elliptical galaxy that happened by or else formed close to M31. Its stars are mostly older than a few billion years. A black hole with a mass of several million suns is thought to be present in the center of M32. M32 has an optical diameter of about 7,000 light years.

Fig. 2.32 Photo of M32; 2 × 10 min red, green, blue exposures with QSI540wsg camera, Celestron 14″ C14 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M33 (NGC 598)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Triangulum</td><td>Spiral galaxy</td><td>01 h 33.9 m, +30° 39′</td><td>October 24 (Standard Time)</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>2.7 million light years</td><td></td><td>68.7′×41.6′</td><td>5.5</td></tr>
<tr><td colspan="4">This is the third most luminous galaxy in our Local Group (which contains about 40 galaxies in a radius of a few million light years) after M31 and the Milky Way. It has an optical diameter of about 60,000 light years (about half that of the Milky Way), which is about average for a spiral galaxy. Its luminous mass is about 10 billion suns. It rotates clockwise from our viewpoint with a period of about 200 million years. The size of its central supermassive black hole (if one exists) is less than a couple of thousand solar masses. NGC 604, the largest known ionized hydrogen region (1,500 light years in diameter) and second most massive in our Local Group (after 30 Doradus), belongs to this galaxy and is visible as a knot in large amateur telescopes near the NNE edge; its stars are only a few million years old and in total have a mass of a few hundred thousand suns, with star formation still ongoing. M33 is thought to have had a close encounter with M31 a few billion years ago. It has about a tenth the mass of M31 and may be a satellite of M31, although M33 may have a dwarf spheroidal satellite galaxy of its own, labeled And XXII.</td></tr>
</table>

Fig. 2.33 Photo of M33; 9×5 min exposure ISO 1600, Canon 60Da camera, 200 mm Skywatcher f/5 Newtonian reflector with a Paracorr coma corrector. (Copyright Blair MacDonald)

M34 (NGC 1039)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Open cluster	02 h 42.1 m, +42° 46′	November 10
Distance	**Age**	**Apparent size**	**Magnitude**
1,500 light years	200 million years	25′	5.2

This has a diameter of about 10 light years and was discovered in the middle of the seventeenth century by Giovanni Batista Hodierna. Its stars rotate at rates that are midway between those in the younger Pleiades cluster (100 million years old – see M45) and the older Hyades cluster (600 million years old). This is thought to be the result of rotational braking, whose effect on rotation rates becomes more pronounced with age. Such braking is believed to be due to angular momentum loss via magnetic coupling to the chromosphere (i.e., the star's atmosphere outside the bright photosphere). In professional telescopes, approximately 60 % of the 700 or so stars with magnitudes of between 14 and 24 in this region are cluster stars (the rest are field stars).

Fig. 2.34 Photo of M34; 2×10 min red, green, and blue exposures with SBIG ST-8XE camera, Takahashi FSQ 106 mm f/7 telescope. North is up and east is to the left. (Copyright John Mirtle)

M35 (NGC 2168)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Gemini	Open cluster	06 h 09.0 m, +24° 21′	January 2
Distance	**Age**	**Apparent size**	**Magnitude**
2,000–3,000 light years	100–200 million years	25′	5.1
This lies almost directly in the galactic anti-center direction (i.e., directly outward from us in the opposite direction from the center of the galaxy), about 100 light years above the galactic central plane. The open cluster NGC 2158 (see NGC 2158) lies only 24′ SW, but is not near M35 in space (NGC 2158 is roughly 10,000 light years farther away). The total mass of M35 is several thousand suns.			

Fig. 2.35 Photo of M35; 10×30 s exposures, ISO 1600, Canon Rebel XT 350D camera, 200 mm f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M36 (NGC 1960)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Auriga</td><td>Open cluster</td><td>05 h 36.3 m, +34° 08′</td><td>December 25</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>4,000 light years</td><td>20 million years</td><td>10′</td><td>6.0</td></tr>
<tr><td colspan="4">It is estimated to contain nearly 1,700 stars with masses between 0.1 and 7 times that of the Sun, although many of these are low mass stars, so that it contains less than 500 stars with mass 0.5–7 times the Sun. Although it is quite a young cluster, it is old enough that most of its stars have had time to lose their youthful circumstellar disks (that formed when the stars collapsed from the surrounding gas and dust – see NGC 2362). Its neighbors M37 (3° 45′ ESE) and M38 (2° 16′ NW) lie within 1,000 light years of M36.</td></tr>
</table>

Fig. 2.36 Photo of M36; 5×6 min exposures with Canon 40D camera, ISO 800, Skywatcher Equinox 120 mm f/7.5 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M37 (NGC 2099)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Auriga	Open cluster	05 h 52.3 m, +32° 33′	December 29
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	400–500 million years	15′	5.6
This has a diameter of about 20 light years. It lies close to M38 and M36 (see M36/NGC 1960). It is a rich cluster, with nearly 5,000 stars considered to be members in professional telescopic studies. No planets have yet been detected among its member stars, despite observations of nearly a third of its stars.			

Fig. 2.37 Photo of M37; 8×2 min exposures with Canon 40D camera, ISO 800, Skywatcher Equinox 120 mm f/7.5 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M38 (NGC 1912)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Auriga	Open cluster	05 h 28.7 m, +35° 51′	December 23
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	300 million years	15′	6.4
This has a diameter of about 20 light years and lies about 55 light years above the galactic plane. It contains more than 600 stars in professional telescopes. Physically it is close to M37 and M36 (see M36). NGC 1907, 32′ SSW, was once thought to perhaps be a coevolved twin to NGC 1907, but the two clusters are separated by more than 1,000 light years and are now thought to have had different birth environments and locations.			

Fig. 2.38 Photo of M38; 2×6 min red, green, blue exposures with QSI540wsg camera, Celestron 14″ telescope with Hyperstar lens corrector. North is up and east is to the left. (Copyright Dalton Wilson)

M39 (NGC 7092)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Open cluster	21 h 31.7 m, +48° 25′	September 7
Distance	**Age**	**Apparent size**	**Magnitude**
1,000 light years	300–400 million years	31′	4.6

This has a diameter of about 10 light years and a mass of a few hundred suns. This cluster lies in a rich field that is "contaminated" with field stars (i.e., stars that happen to lie along the same line-of-sight but which are foreground or background stars) from the Milky Way. This "contamination" worsens the fainter the stars that are being considered. For example, about 80–90 % of the mag. 8–10 stars are true cluster members, but only about 20 % of the mag. 11 stars in this cluster are actual cluster members (the rest being field stars), while fewer than 10 % of the mag. 12 stars are true cluster members. Distinguishing field stars from true open cluster members requires professional telescopic studies, but the fact that one is seeing a mix of field stars and true cluster members should be borne in mind when viewing an open cluster through the eyepiece.

Fig. 2.39 Photo of M39; 3×5 min red and green, 3×6 min flue exposures with SBIG ST-8XE camera, Takahashi FSQ 106 mm f/7 telescope. North is up and east is to the left. (Copyright John Mirtle)

M40

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Two stars	12 h 22.4 m, +58° 05′	April 21
Distance	**Age**	**Apparent size**	**Magnitude**
			8

This is simply two stars (mag. 9.7 and 10.1, separation 52″, position angle 81°, i.e., the two stars lie along a nearly E-W line), also known as Winnecke 4. The two stars are not believed to be orbiting each other, i.e., this is not a binary star. The brighter star lies about 500 light years away while the dimmer one lies about 2,000 light years away. Messier included this entry when looking for a nebula reported by Hevelius in this region.

Fig. 2.40 Photo of M40; 7×20 s exposures, ISO1600, Canon Rebel XT 350D camera, 300 mm f/5 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M41 (NGC 2287)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canis Major	Open cluster	06 h 46.0 m, −20° 46′	January 11
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years	200–300 million years	39′	4.5

This has a diameter of about 20 light years. A large percentage (perhaps as high as 80 %) of its stars are binary stars. Open clusters are beasts of the galactic disk and are stripped of their stars over time by gravitational interaction with material in the disk as they jostle about it while rotating with it. For an open cluster in our vicinity of the galaxy, like this one, typical lifetimes are thought to be a little over half a billion years, so that this cluster is approaching middle age. The cluster has about 70 members with magnitudes brighter than 12, although our view of the cluster to this magnitude is "contaminated" by about as many field stars as cluster members (see M39).

Fig. 2.41 Photo of M41; 2×6 min red, green, blue exposures with Canon 40D camera, ISO 800, Skywatcher Equinox 120 mm f/7.5 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M42 (NGC 1976)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Emission and reflection nebula	05 h 35.3 m, –05° 23′	December 24
Distance	**Age**	**Apparent size**	**Magnitude**
1,400 light years		1°	4.0

Nicknamed the "Orion Nebula," this is the apparently brightest and one of the closest ionized hydrogen star-forming regions (or HII regions) in our sky. It is lit up by the stars in a very young cluster (less than a few million years old and referred to as the Orion Nebula Cluster) containing about 3,500 stars situated in the heart of the nebula. However, many of the stars in this cluster are obscured by material in the nebula. Light from these stars is both scattered off dust, particularly in the outer regions of the nebula, and re-emitted by gas, particularly in the inner regions, making this both a reflection and emission nebula. Four stars in the cluster form a quadrangle (with sides of about 10″–20″) called the "Trapezium" and are all part of the multiple star system θ^1 Orionis. Professional telescopic studies indicate θ^1 Orionis contains at least 14 stars, only six of which can be seen, including the four in the Trapezium, under good seeing conditions in moderate amateur telescopes. θ^1 Orionis is in fact a wide double star with θ^2 Orionis (itself a triple star, so that θ Orionis consists of at least 17 stars!). The brightest (and most southern) star in the Trapezium quadrangle (θ^1 Orionis C) is largely responsible for the ionization of the nebula. M42 is actually only a small "blister" on the near side of a much larger cloud of gas and dust (the Orion A complex) that has a mass of about 100,000 suns. The Orion A complex is itself part of an even larger group of giant molecular gas clouds (the Orion-Monoceros complex) that extend 30° in a SE-NW direction and sit about 500 light years below the galactic central plane. Formation of the Orion-Monoceros complex may have been triggered by a giant bubble blown out of the galactic plane by the open cluster Collinder 121. The 1° apparent dimension of M42 corresponds to a diameter of a little more than 20 light years.

Fig. 2.42 Photo of M42; 10×4 min exposures for outer region and 20×20 s exposures for core, ISO 800 with Canon EOS 350D camera, 200 mm Skywatcher f/5 telescope. (Copyright Blair MacDonald)

M43 (NGC 1982)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Emission nebula	05 h 35.5 m, −05° 16′	December 24
Distance	**Age**	**Apparent size**	**Magnitude**
1,400 light years		20′	9.0

This is part of the same gas and dust cloud as M42 (the Orion A complex), lying just NE of M42, separated from M42 by a wall of dust between the two. M43 has relatively little dust, so its light is largely from gas emission (it is an ionized hydrogen, i.e., HII, region). The nebula is visible because it is ionized by the bright variable star NU Orionis (i.e., HD 37061, mag. 6.9) in its center. Professional telescopic studies find planet-forming ("protoplanetary") disks are present around several stars in M43 (as well as in M42), some of which contain water-ice.

Fig. 2.43 Photo of M43 (lower portion of photo, below M42); 8×5 min red, green, blue exposures, SBIG STL11000 camera, Guan Sheng Optics 8″ Ritchey-Chretien telescope. North is down. (Copyright Stuart Heggie)

M44 (NGC 2632)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cancer	Open cluster	08 h 40.6 m, +19° 40′	February 9
Distance	**Age**	**Apparent size**	**Magnitude**
600 light years	600 million years	1.2°	3.1

This is nicknamed the “Beehive Cluster” or “Praesepe” (which means “manger” in Latin, its common-use anglicized pronunciation being pree-SEE-pee). It contains perhaps 1,100 members. In professional telescopes its tidal diameter is 7°. It is one of only a few open clusters thought to have stars harboring planets, in this case two Jupiter-mass planets in low radius orbits (“hot Jupiters”) having orbital periods of a few days. M44 and the Hyades (60° W) may be part of a single, moving group, although M44 is thought to be perhaps 50 million years younger than the Hyades.

Fig. 2.44 Photo of M44, 4×5 min red, green and blue exposures, Apogee U16M camera, Astrophysics 155 EDF 4″ f/7 telescope on Paramount ME mount. North is to the left. (Copyright Stuart Heggie)

M45

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Taurus	Open cluster	03 h 47.0 m, +24° 07′	November 27
Distance	**Age**	**Apparent size**	**Magnitude**
400 light years	100 million years	1.8°	1.2

Nicknamed the "Pleiades" (pronounced PLEE-ah-deez) or the "Seven Sisters" (although only six stars are visible with the naked eye in light polluted skies), this cluster has a mass of about 900 suns. The Orion Nebula cluster (see M42) is believed to be similar to what M45 was like when it was a few hundred thousand years old. The nebulosity around its stars that is apparent in photographs is thought to be foreground dust and is not material from the original giant molecular cloud that birthed the Pleiades.

Fig. 2.45 Photo of M45; 15×5 min luminance, 12×10 min red, green and blue exposures, Apogee U16M camera, Astrophysics 155 EDF 4″ f/7 telescope on Paramount ME mount. North is up. (Copyright Stuart Heggie)

M46 (NGC 2437)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	07 h 41.8 m, −14° 49′	January 25
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	200 million years	20′	6.1

This has a mass of approximately 1,000 suns. It lies about 400 light years above the galactic central plane at a distance of about 30,000 light years from the galactic center. Although NGC 2438 lies on the NE edge of the open cluster M46 (see M46/NGC 2437), their differing relative velocities and the young age of M46 together suggest that NGC 2438 is not part of M46, despite them lying at a similar distance.

Fig. 2.46 Photo of M46 (*left*) and M47 (*right*); 9 min exposure on 120 format Kodak Ektachrome 400, 6″ f/4.5 Newtonian telescope. NGC 2423 (see NGC 2423) is also visible (*middle right*), above M47. North is up and east is to the left. (Copyright John Mirtle)

M47 (NGC 2422)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	07 h 36.6 m, −14° 29′	January 24
Distance	**Age**	**Apparent size**	**Magnitude**
1,600 light years	100 million years	25′	4.4

This has a mass of a few hundred suns. Interstellar dust between us and the stars in this cluster cause its stars to appear dimmer by only a few tenths of a magnitude, which is much less than the average two magnitudes of dimming for every kiloparsec (3,260 light years) that is typical when light travels in the central plane of our galaxy. Several Be stars are known in this cluster, the brightest of which is HD 60856 at mag. 8 and is readily visible in amateur telescopes (see Fig. 3.6 of Chapter 3). Be stars are B-type stars that are peculiar because of hydrogen Balmer emission lines in their spectra, due to atomic transitions in material expelled by high rotational velocities into a circumstellar disk in the equatorial plane of the star.

See Fig. 2.46

M48 (NGC 2548)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hydra	Open cluster	08 h 13.7 m, −05° 45′	February 2
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years	400 million years	1°	5.8

Of 750 stars brighter than mag. 15.0 in this region, about 300 are thought to be cluster members. It lies about 28,000 light years from the center of our galaxy and nearly 700 light years above the galactic central plane. Its current position is close to its maximum excursion of 800 light years from this plane, having crossed it perhaps ten times in its lifetime, while making a little less than two revolutions about the galactic center. It has a diameter of about 30 light years. Messier's discovery and subsequent listing of this object resulted in an error in its quoted position, so that its location in some old star charts (before T. F. Morris' correction of this error in 1959) is incorrect.

Fig. 2.48 Photo of M48; 10 min exposure on 120 format Kodak Ektachrome 400, 6″ f/4.5 Newtonian telescope. North is up and east is to the left. (Copyright John Mirtle)

M49 (NGC 4472)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 29.8 m, +08° 00′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		10.2′×8.3′	8.3

This is a giant elliptical galaxy and the brightest member of the Virgo galaxy cluster, which is the nearest galaxy cluster to us. The Virgo galaxy cluster may contain nearly 2,000 galaxies, which are bunched into several subclusters with M87 and M49 being principal members of the two main subclusters. M49 lies perhaps a few million light years closer than M87. Occupying a roughly rectangular shape in the sky (8° E-W×16° N-S), the major concentration of the Virgo cluster extends several tens of millions of light years around the cluster center near M87 (but, for simplicity, all its members are listed herein as being at the same distance). M49 is thought to be falling toward the center of the Virgo cluster at about 1,000 km/s. Much of the mass in the Virgo cluster is dark matter, with the total mass of the Virgo cluster being many hundreds of trillions of solar masses. The Virgo cluster lies at the center of the Virgo supercluster, an even larger gathering of galaxies with a diameter of about 100 million light years that includes our own Local Group. M49 contains about 6,000 globular clusters, which are mostly old (10 billion years). The center of M49 is thought to contain a supermassive black hole with a mass of about half a billion suns. The stellar mass of M49 is perhaps 200 billion suns, but its total mass (including dark matter in its halo) is more than a trillion suns. Its optical diameter is about 150,000 light years.

Fig. 2.49 Photo of M49; 4×10 min luminance, red, green and blue exposures with QSI583wsg camera, Astro-Tech 8″ f/4 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M50 (NGC 2323)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster	07 h 02.7 m, −08° 23′	January 15
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	130 million years	15′	5.9
This contains about 2,000 stars brighter than mag. 23, which is about half the number of stars in this region (the other half are field stars). Its apparent diameter corresponds to about 14 light years. The interstellar gas and dust in the disk of our galaxy is not uniformly distributed at light year length scales, but instead is clumped into patches with typical masses of a few hundred suns. Open clusters are thought to form from such interstellar clouds of gas and dust.			

Fig. 2.50 Photo of M50; 8.5 min exposure on 120 format Ektachrome 400, 6″ f/4.5 Newtonian telescope. North is up and east is to the left. (Copyright John Mirtle)

M51 (NGC 5194)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Spiral galaxy	13 h 29.9 m, +47° 12′	May 8
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		11.2′×6.9′	8.1

This is nicknamed the "Whirlpool Galaxy." It is a grand-design spiral, meaning that it has two symmetrically placed spiral arms that extend over most its visible disk in professional telescopic images. What appears as a bridge connecting M51 to its nearby companion galaxy NGC 5195 (4′ NNE – see NGC 5195) is actually an optical illusion. A spiral arm of M51 is superimposed on NGC 5195 with NGC 5195 actually lying on the far side of M51 (by perhaps half a million light years), although the two galaxies have had perhaps two recent close encounters in the past (see NGC 5195). These gravitational interactions with NGC 5195 are thought to have triggered star formation in M51, with two peaks in star cluster formation occurring a few hundred million years ago, in addition to a recent peak a few million years ago. Almost 20,000 ionized hydrogen (HII) star-forming regions have been identified in M51, with diameters averaging about 30 light years and having masses up to several thousand suns. A number of these HII regions can be seen as bright knots in amateur telescopes. M51 is a Seyfert galaxy (see NGC 3372 for explanation) and has an optical diameter of about 80,000 light years. It is part of the M51 galaxy group of perhaps nine gravitationally bound galaxies.

Fig. 2.51 Photo of M51; 12 × 10 min luminance, 3 × 10 min red, green and blue exposures with Apogee U16M camera, Astrophysics 155 EDF 4″ f/7 telescope on Paramount ME mount. North is to the left. (Copyright Stuart Heggie)

M52 (NGC 7654)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	23 h 24.8 m, +61° 36′	October 6
Distance	**Age**	**Apparent size**	**Magnitude**
4,000–5,000 light years	100 million years	16′	6.9
This is a relatively rich cluster. At magnitudes brighter than 15.0, there is nearly one star for every square arc second of sky in its densest parts (although about one in ten of these is a field star and not a cluster member – see M39). To magnitude 14.5, a total of about 130 stars belong to the cluster (with only about 30 field stars "contaminating" the cluster), with these cluster members having masses about two to five times that of our Sun. To magnitude 19.5, over 6,000 stars belong to the cluster (with about the same number of field stars present), with most of these dimmer cluster members having masses near that of our Sun. The stars in this cluster appear to have a much larger spread of ages (tens of millions of years) than most open clusters (where the stars are typically only a few million years apart in age). Gas and dust between us and the cluster dim the stars in this cluster considerably (by a few magnitudes).			

Fig. 2.52 Photo of M52; 5×5 min exposures with Canon EOS 350D camera, 1600 ISO, Meade 8″ f/4 Schmidt Newtonian telescope. M52 is on the *bottom* and NGC 7635 (see NGC 7635) can be seen in the *mid-upper right*. (Copyright Blair MacDonald)

M53 (NGC 5024)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Coma Berenices</td><td>Globular cluster</td><td>13 h 12.9 m, +18° 10′</td><td>May 4</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>60,000 light years</td><td>10–14 billion years</td><td>13′</td><td>7.7</td></tr>
<tr><td colspan="4">The mass here is about 0.5 million suns. It lies nearly directly "above" us from the galactic central plane in the halo of our galaxy (see M2/NGC 7089 for the meaning of "halo"). Its orbit keeps it out in the halo, with a period of close to a billion years. It follows a path that takes it well over 100,000 light years from the galactic center and never closer than about 35,000 light years to the galactic center. Its orbit is highly inclined (by about 60°) to the disk of our galaxy. M53's apparent size corresponds to a diameter of about 230 light years. The nearby globular cluster NGC 5053 (1° ESE) lies nearly directly "below" M53 in three-dimensional space, being 1,600 light years closer to us (in a direction nearly perpendicular to the disk of our galaxy).</td></tr>
</table>

Fig. 2.53 Photo of M53; 3 × 10 min red, 4 × 10 min green, 4 × 10 min blue exposures with SBIG ST-8XE camera, Takahashi FSQ 106 mm f/5 telescope on AP900GTO mount. M53 is *upper right* while NGC 5053 (see NGC 5053) is at *lower left*. North is up and east is to the left. (Copyright John Mirtle)

M54 (NGC 6715)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 55.1 m, −30° 29′	July 30
Distance	**Age**	**Apparent size**	**Magnitude**
85,000 light years	10–14 billion years	12′	7.7

This globular cluster is not part of our galaxy, but instead belongs to a nearby satellite galaxy (which goes by the cumbersome name "Sagittarius Dwarf Elliptical Galaxy"), embedded in its nucleus. This companion galaxy is in the process of being gravitationally disrupted by our galaxy. Models predict that it, along with M54, will collide with the disk of our galaxy in several tens of millions of years, having had a past such collision about 200 million years ago. M54 is the second most massive known Milky Way globular cluster (after ω Centauri/NGC 5139) with a mass of about 1.5 million suns (which is about 1/40 the mass of the galaxy it belongs to). Its size of 12′ corresponds to a diameter of about 300 light years.

Fig. 2.54 Photo of M54; 23×30 s exposure with Canon Rebel XT 350D camera, ISO 1600, 200 mm f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M55 (NGC 6809)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	19 h 40.0 m, −30° 58′	August 10
Distance	**Age**	**Apparent size**	**Magnitude**
18,000 light years	10–14 billion years	19.0′	6.3

This has a mass of about 100,000–200,000 suns and a diameter of about 100 light years. It takes a little over 100 million years or so to complete an orbit about our galaxy, always staying within about 25,000 light years of the galactic center but swinging within a few thousand light years, all in a path that is highly inclined to the disk of our galaxy. It contains 65 identified "blue stragglers" (see NGC 6633), which are stars that are paradoxically far more blue and luminous than expected, perhaps because of mass transfer between or coalescence of stars. It is metal poor, being near the bottom 10th percentile for metallicity of Milky Way globular clusters.

Fig. 2.55 Photo of M55; 24×30 s exposure with Canon Rebel XT 350D camera, ISO 1600, 200 mm f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M56 (NGC 6779)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Lyra	Globular cluster	19 h 16.6 m, +30° 11′	August 4
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	8.8′	8.4
This has a mass of about 200,000 suns and a diameter of about 80 light years. Although its orbit is roughly circular and lies nearly in the galactic disk (inclined by only about 15° to the central plane), like almost all globular clusters in our galaxy, it does not orbit with the disk material at a constant radius from the galactic center. Instead its path is thought to take it out as far as about 50,000 light years away from the galactic center and within a few thousand light years of the galactic center, although it takes about the same amount of time to complete an orbit as our Sun does (i.e., about a quarter of a billion years). It is a metal-poor halo cluster, meaning it contains lower amounts of compounds heavier than helium (i.e., "metals"), being near the bottom 10th percentile in metallicity of Milky Way globular clusters.			

Fig. 2.56 Photo of M56; 17×10 min exposure with Canon 40D camera, ISO 800, Skywatcher Equinox 120 mm f/7.5 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M57 (NGC 6720)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Lyra	Planetary nebula	18 h 53.6 m, +33° 02′	July 29
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years		3.0′×2.4′	8.8

This is nicknamed the "Ring Nebula," It is thought to have been created a few thousand years ago when an old star blew off its outer layers. In professional telescopes the nebula extends out to nearly 4′ in diameter (with its outer halo 5,000 times dimmer in surface brightness than the ring). Its three-dimensional structure is thought to consist of an ellipsoidal shell (like the skin of an airship/dirigible as in the Hindenburg or the Goodyear blimp) that we are looking at nearly end-on. This shell is thought to be encircled at its midsection (half-way along the "dirigible") by a torus of material so that the ring we see is merely a donut of denser material at the mid-section of the ellipsoidal shell. The denseness of the ring is thought to be a relic of the preferential ejection of mass by the central star in its equatorial plane (in a "superwind" – see M27). The shell is expanding outward at a few tens of km/s. Invisible (UV) radiation from the hot central star ionizes the atoms in the shell, and electrons recombining with these ionized atoms cause optical photons to be emitted that make the nebula visible to us.

Fig. 2.57 Photo of M57; 90 min exposure from urban light polluted setting with Canon 60Da camera, ISO 1600, 200 mm Skywatcher f/5 reflector telescope. (Copyright Blair MacDonald)

M58 (NGC 4579)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 37.7 m, +11° 49′	April 25
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		6.0′ × 4.8′	9.6

This is part of the Virgo galaxy cluster (see M49/NGC 4472). M58 has a mass of about 300 million suns. It is a LINER galaxy (see M81) in which emission from the nucleus is thought to occur due to accretion of matter onto a supermassive central black hole with a mass of about 50 million suns. It has a nuclear ring with a diameter less than 1,000 light years. Its optical diameter is about 100,000 light years.

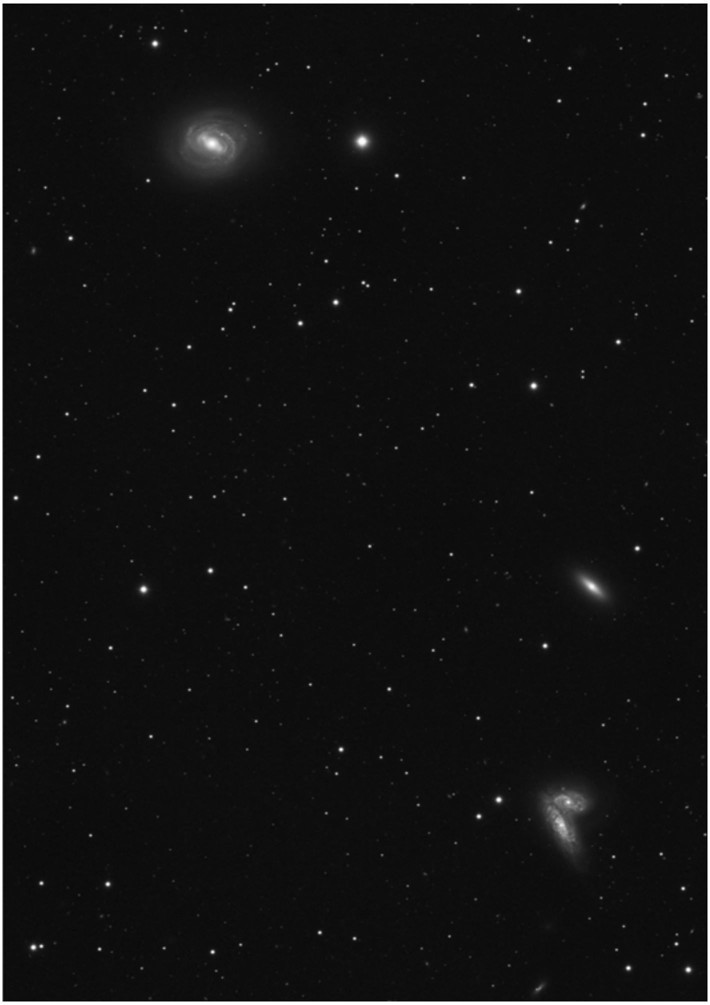

Fig. 2.58 Photo of M58; 15 × 10 min exposure with SBIG STF-8300M camera, Astrophysics AP130EDT f/8.35 telescope. M58 is at *upper left*, NGC 4567/4568 (see NGC 4567) is at *lower right*, while NGC 4564 is in the *middle right*. North is up and east is to the left. (Copyright John Mirtle)

M59 (NGC 4621)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 42.0 m, +11° 39′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		5.4′×3.7′	9.7

This is part of the Virgo galaxy cluster (see M49/NGC 4472). The inner core of this galaxy is unusual because it is thought to be counter-rotating from the rest of the galaxy as well as having a different chemical makeup from, and being younger than, the rest of the galaxy, perhaps due to dynamics driven by a bar, or else by a past accretion event. This inner core has a diameter of several hundred light years and apparent size of about an arc second. Professional telescopes find M59 has a disk that emits about 16 % of the light from this galaxy. M59 also has a circumnuclear disk (diameter of 5″–7″) in professional telescopic studies. The center of this galaxy is believed to contain a supermassive black hole (with a mass of about 300 million suns). M59 contains about 2,000 globular clusters.

Fig. 2.59 Photo of M59 (*middle, right*), with M60 and its nearby companion NGC 4647 (*middle, left*); 40 min exposure on hypered Kodak Tech Pan, 8″ f/6 telescope. North is up and east is to the left. (Copyright John Mirtle)

M60 (NGC 4649)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 43.7 m, +11° 33′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		7.6′×6.2′	8.8
This is a giant elliptical galaxy. It is part of the Virgo galaxy cluster (see M49/NGC 4472). M60 is thought to contain a supermassive central black hole (with a mass of perhaps 4.5 billion suns). Its nearby companion galaxy NGC 4647 (barred spiral galaxy, 2.5′ NW, mag. 11.4) is possibly a few million light years away from M60, and not thought to have interacted significantly with M60 yet. M60 contains perhaps 15,000 globular clusters (about 100 times as many as in our galaxy).			

See Fig. 2.59

M61 (NGC 4303)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 21.9 m, +04° 28′	April 21
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		6.5′×5.8′	9.3
This has a total mass of about 70 billion suns. It has an active galactic nucleus containing a central supermassive black hole with a mass of a few millions suns. Its nucleus also contains a few million year-old starburst cluster with a mass of about 100,000 suns and has a massive circumnuclear star-forming disk (with a diameter of about 10″ and a mass of about 50 million suns) that itself has a bar and spiral structure. This galaxy has a diameter of about 100,000 light years. It is part of the Virgo cluster (see M49/NGC 4472) and is a grand-design spiral, meaning that it has two symmetrically placed spiral arms that in professional telescopic images extend over most its visible disk. Many giant, ionized hydrogen (star-forming) regions are present along its spiral arms, giving the arms an uneven brightness along their length in large amateur telescopes. The total star-formation rate in this galaxy is probably 1–2 solar masses/year (which is similar to that occurring in our galaxy, but our galaxy is more than ten times as massive). It is probably interacting with nearby NGC 4303A (10′ NE, mag. 13) and NGC 4292 (12′ NW, mag. 12.2).			

Fig. 2.61 Photo of M61; 10×5 min exposures with Canon 40D camera, ISO 800, Celestron 14″ telescope with Hyperstar lens corrector. North is up and east is to the left. (Copyright Dalton Wilson)

M62 (NGC 6266)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 01.2 m, –30° 07′	July 1
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	15′	6.4

This has a mass of almost a million suns. Its size of 15′ corresponds to a diameter of about 110 light years. It lies on the edge of the galactic disk, in the direction of the galactic center from us and is a “bulge cluster” (meaning it spends its time orbiting within the central 15,000-light year diameter bulge of our galaxy). It is one of only a few Milky Way globular clusters that might host a black hole, in this case with an intermediate mass of at most a couple thousand suns. The core of M62 is thought to be “collapsed.” (See NGC 6284 for explanation.)

Fig. 2.62 Photo of M62; 20 min exposure on hypered Kodak Tech Pan film, 8″ f/6 telescope. North is up and east is to the left. (Copyright John Mirtle)

M63 (NGC 5055)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Spiral galaxy	13 h 15.8 m, +42° 02′	May 4
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		12.6′ × 7.2′	8.5

Nicknamed the "Sunflower Galaxy," this is part of a gravitationally bound group of perhaps nine galaxies that includes M51 (NGC 5194) and NGC 5023 (spiral galaxy, mag. 12.1, 2° NNW). M63 is a so-called "flocculent" spiral galaxy, meaning that it lacks any obvious azimuthally symmetric spiral arm pattern (see NGC 3521 for further explanation). It has a mass of a couple hundred billion suns and is a "low-ionization nuclear emission region" galaxy (or "LINER" – see M81/NGC 3031 for an explanation). It has an optical diameter of a little over 90,000 light years. Beyond its optically visible regions the galaxy consists of a neutral hydrogen (HI) disk (not visible in amateur telescopes) that is "warped" so that the far outer edge of its HI disk lies in a plane that is skewed by perhaps about 20° from the rest of the galaxy. Warps occur in the HI distribution of most galaxies that have significant HI extending beyond their optical disks, perhaps because of misalignment, relative to the disk, of the angular momentum of accreted material. Professional telescopes also find a giant loop extending out 14′ on the eastern side of this galaxy, which is thought to be a stellar tidal stream created by the accretion, within the past few billion years ago, of a dwarf galaxy with a mass of a few hundred thousand suns.

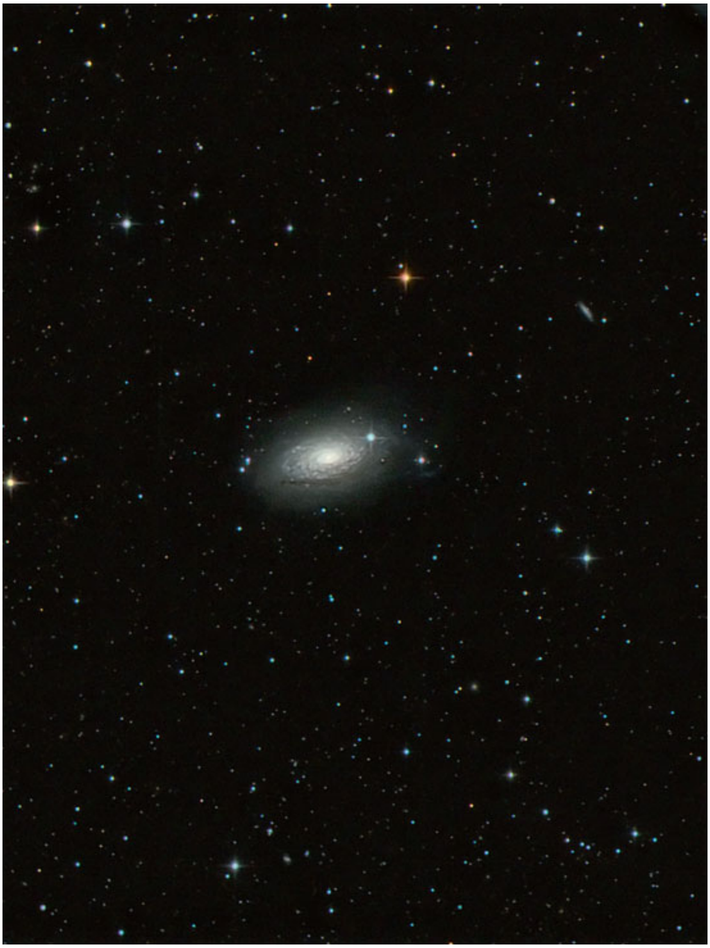

Fig. 2.63 Photo of M63; 5×5 min red, green, blue exposures with QSI583wsg, Astro-Tech 8″ f/4 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M64 (NGC 4826)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Spiral galaxy	12 h 56.7 m, +21° 41′	April 30
Distance	**Age**	**Apparent size**	**Magnitude**
15 million light years		10.0′ × 5.4′	8.5

This is nicknamed the "Black-Eye Galaxy" because of a dark arc-shaped dust region on its NE side, which is a challenge to discern in amateur telescopes. It has an optical diameter of about 50,000 light years. The nucleus of this galaxy is chemically different from the rest of the galaxy (and is said to be "chemically decoupled"). In addition, the gas in the outer disk (radii > about 1′ and containing 100 million solar masses) counter-rotates from rest of the galaxy, including the stars (which all rotate the same way). This highly unusual situation may have its origin in the past accretion of a gas-rich dwarf satellite galaxy. The dust that gives the galaxy its "black eye" rotates with the stars. M64 is thought to be a LINER galaxy driven by a starburst in its nucleus (see M81/NGC 3031 for an explanation).

Fig. 2.64 Photo of M64; 8×2 min exposures with Canon Rebel XT 350D camera, ISO 1600, 300 mm f/5 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M65 (NGC 3623)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred spiral galaxy	11 h 18.9 m, +13° 05′	April 5
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		9.8′×2.9′	9.2
M65 is nearly edge-on with its rotation axis inclined by 71° from our line-of-sight. It has an optical diameter of about 100,000 light years. It is part of a gravitationally bound group of galaxies that includes NGC 3593 (1° SW), as well as nearby M66 (see M66/NGC 3627) and NGC 3628 (see NGC 3628) with which it forms the "Leo Triplet." Its stars are unusually similar in age (0.7–0.9 billion years) across its central bulge and disk regions, perhaps because of central bulge star formation induced by past interaction with its fellow Leo triplets.			

Fig. 2.65 Photo of M65 (*upper right*), M66 (*lower right*), and NGC 3628 (*left*, see NGC 3628); 24×5 min exposures with Canon 60Da camera, ISO 1600, 200 mm Skywatcher f/5 Newtonian reflector with a Televue Paracorr coma corrector. (Copyright Blair MacDonald)

M66 (NGC 3627)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred spiral galaxy	11 h 20.3 m, +12° 59′	April 5
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		9.1′×4.1′	8.9

M66 is part of the "Leo Triplet" that includes nearby M65 (see M65/NGC 3623) and NGC 3628, which form a gravitationally bound group of four galaxies (the fourth member being nearby NGC 3593), and which are part of the Leo I galaxy group (see M96/NGC 3368). Professional telescopes find a quarter million light year (40′) long plume of stars and gas extending to the east of NGC 3628, with a mass of hundreds of millions of suns, that is thought to be the result of an interaction with M66 nearly a billion years ago. Distortions in the disk and arms within M66 itself may be the result of a dwarf galaxy careening in from the SE and colliding with M66 within the past few tens of millions of years. M66 has an optical diameter of about 90,000 light years and has an active galactic nucleus (AGN) of either LINER (see M81/NGC 3031) or Seyfert type (where a supermassive object in this galaxy's center accumulates nearby material and produces strong emission). It has an 12′′ long inner bar nested inside its large-scale 1.4′ long outer bar, with a 45° angle between the two bars.

See Fig. 2.65

M67 (NGC 2682)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cancer	Open cluster	08 h 51.3 m, +11° 48′	February 11
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	4 billion years	25′	6.9

This is one of the oldest open clusters known. Indeed, most open clusters disassociate within a few hundred million years of their formation. M67's large initial mass and distance from the galactic center have allowed it to reach its old age, although it is thought to have lost more than three quarters of its original stellar mass, and it is reaching its end of life as a bound cluster. As clusters age, mass segregation of stars (see NGC 2506) results in star mass decreasing with radial distance from the cluster center, and M67 is no exception. Professional telescopes find 1,400 members (down to magnitude 23) in this cluster. Its size of 30′ corresponds to a diameter of about 20 light years.

Fig. 2.67 Photo of M67; 30 min exposure on hypered Kodak Tech Pan film, 8″ f/6 telescope. North is up and east is to the left. (Copyright Blair MacDonald)

M68 (NGC 4590)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hydra	Globular cluster	12 h 39.5 m, −26° 45′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
34,000 light years	10–14 billion years	11′	7.3

This has a mass of a few hundred thousand suns. Its size of 11′ corresponds to a diameter of over 100 light years. Like most globular clusters, it does not orbit our galaxy with the galactic disk as we do. Instead it follows an orbit that takes it out as far as about 170,000 light years from the galactic center and then back in as close as about 30,000 light years on an elliptical path (with eccentricity 0.5) inclined to the galactic disk (by about 30°), taking about a half billion years to make one revolution around our galaxy. It is very "metal poor" (meaning it is sparse in elements heavier than helium), being among the 25 most metal-poor globular clusters in our galaxy.

Fig. 2.68 Photo of M68; 9×5 min exposures with Canon 40D camera, ISO 800, Skywatcher Equinox 120 mm f/7.5 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M69 (NGC 6637)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 31.4 m, −32° 21′	July 24
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	7.1′	8.3

This lies almost directly below the galactic center (about 5,000 light years below the galactic central plane), about 3,000 light years on the other side of the galactic center from us. It has a mass of about 300,000 suns, and its size corresponds to a diameter of about 60 light years. It is thought to be a “bulge cluster” (meaning it spends its time orbiting around the central, ball-like, 15,000 light year diameter bulge of our galaxy). It is a “metal-rich” cluster (meaning it contains significant amounts of elements heavier than helium). About a quarter of the globular clusters in our galaxy are considered metal-rich, and NGC 6637 is just within the top 25th percentile for metallicity of Milky Way globular clusters.

Fig. 2.69 Photo of M69; 24 × 30 s exposures with Canon Rebel XT 350D camera, ISO 1600, 200 mm f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M70 (NGC 6681)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Sagittarius</td><td>Globular cluster</td><td>18 h 43.2 m, −32° 17′</td><td>July 27</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>30,000 light years</td><td>10–14 billion years</td><td>8.0′</td><td>7.8</td></tr>
<tr><td colspan="4">This has a mass of about 200,000 suns and a diameter of about 70 light years. Like its neighbor M69, this is thought to be a “bulge cluster” (meaning it spends its time orbiting around the bulge of our galaxy – see M69/NGC 6637). Its core is thought to have “collapsed,” the result of an instability that causes the stars in its core to confine themselves to an unusually small region (see NGC 6284).</td></tr>
</table>

Fig. 2.70 Photo of M70; 20×30 s exposures with Canon Rebel XT 350D camera, ISO 1600, 200 mm f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M71 (NGC 6838)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagitta	Globular cluster	19 h 53.8 m, +18° 47′	August 14
Distance	**Age**	**Apparent size**	**Magnitude**
13,000 light years	10–14 billion years	7.2′	8.4

This is the eighth closest globular cluster to us. With a mass of only a few tens of thousands of suns and a diameter of a little over 25 light years, this is a sparse globular cluster. It has an elliptical shape with an aspect ratio (minor to major axis ratio) of about 0.7, its flattened shape possibly caused by its recent passage through the galactic central plane about 16 million years ago. Its orbit is highly elliptical (with a minor to major axis ratio of 0.2), and it takes about 160 million years to complete one orbit around our galaxy, never straying far from the galactic disk.

Fig. 2.71 Photo of M71; 22×30 s exposures with Canon Rebel XT 350D camera, ISO 1600, 200 mm f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M72 (NGC 6981)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aquarius	Globular cluster	20 h 53.5 m, −12° 32′	August 30
Distance	**Age**	**Apparent size**	**Magnitude**
55,000 light years	10–14 billion years	6.6′	9.2
This has a mass of about 200,000 suns and a diameter of about 100 light years. It lies in the halo of our galaxy. (See M2 for the meaning of "halo.") It rotates about our galaxy in a retrograde direction (i.e., opposite to the Sun's motion around the galaxy), which has led to the suggestion that it was adopted in a merger with another galaxy.			

Fig. 2.72 Photo of M72; 25×30 s exposures with Canon Rebel XT 350D camera, ISO 1600, 200 mm f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M73 (NGC 6994)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aquarius	Asterism	20 h 58.9 m, −12° 38′	August 31
Distance	**Age**	**Apparent size**	**Magnitude**
		1.4′	8.9
The four stars at this location are not a cluster but are simply an asterism (i.e., a pattern of physically unrelated stars in the sky).			

Fig. 2.73 Photo of M73; 7×30 s exposures with Canon Rebel XT 350D camera, ISO 1600, 200 mm f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M74 (NGC 628)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pisces	Spiral galaxy	01 h 36.7 m, +15° 47′	October 25 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		10.5′×9.5′	9.1

This has a mass of about 330 billion suns and an optical diameter of about 80,000 light years. It is nearly face-on (its inclination angle, which is the angle between its axis of rotation and our line-of-sight, is less than 10°). Hundreds of ionized hydrogen (HII) star-forming regions (like M42) have been identified in this galaxy in professional telescopes, some of which can be seen as bright knots in large amateur telescopes. In addition, within its inner 0.5′ is a circumnuclear ring of star formation. All told, these star-forming regions produce several new stars per year. M74 is thought to be part of a gravitationally bound group of perhaps six galaxies that includes NGC 660 (2° 38′ SE) as well as several dimmer galaxies (the brightest of which, at mag. 13, are UGC 1195, 22′ NNW of NGC 660 and UGC 1200, 29′ S of NGC 660), although it has not interacted with any galaxies for more than a billion years. Professional telescopic studies show that beyond its optically visible disk is an extended ring of atomic hydrogen reaching out to more than twice its optical diameter. This extended ring is warped, perhaps as the result of two high velocity clouds that are accreting onto the disk.

Fig. 2.74 Photo of M74; 3×15 min luminance, red, green, blue exposures with QSI540wsg camera, Astro-Tech 10″ f/8 Ritchey-Chrétien telescope on Celestron CGE Pro mount. North is up and East is to the left. (Copyright Dalton Wilson)

M75 (NGC 6864)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	20 h 06.1 m, −21° 55′	August 17
Distance	**Age**	**Apparent size**	**Magnitude**
70,000 light years	10–14 billion years	6.8′	8.6
This has a mass of about half a million suns and a diameter of about 140 light years. Its horizontal branch (HB), composed of stars immediately following their red giant stage, has two gaps in it, giving three HB populations that differ in temperature. It lies on the other side of the galaxy from us, well below the galactic central plane (by about 30,000 light years).			

Fig. 2.75 Photo of M75; 22×30 s exposures with Canon Rebel XT 350D camera, ISO 1600, 200 mm f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M76 (NGC 650/651)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Planetary nebula	01 h 42.3 m, +51° 34′	October 27 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	6,000 years	3.1′	10.1
This is nicknamed the "Little Dumbbell Nebula." Although different parts are expanding at different rates, typical expansion velocities are a few tens of km/s. It has a diameter of about 3 light years. The two lobes of the "bowtie" shape are each three-dimensional expanding bubbles, inclined at about 75° from our line-of-sight with the NW lobe pointing toward us.			

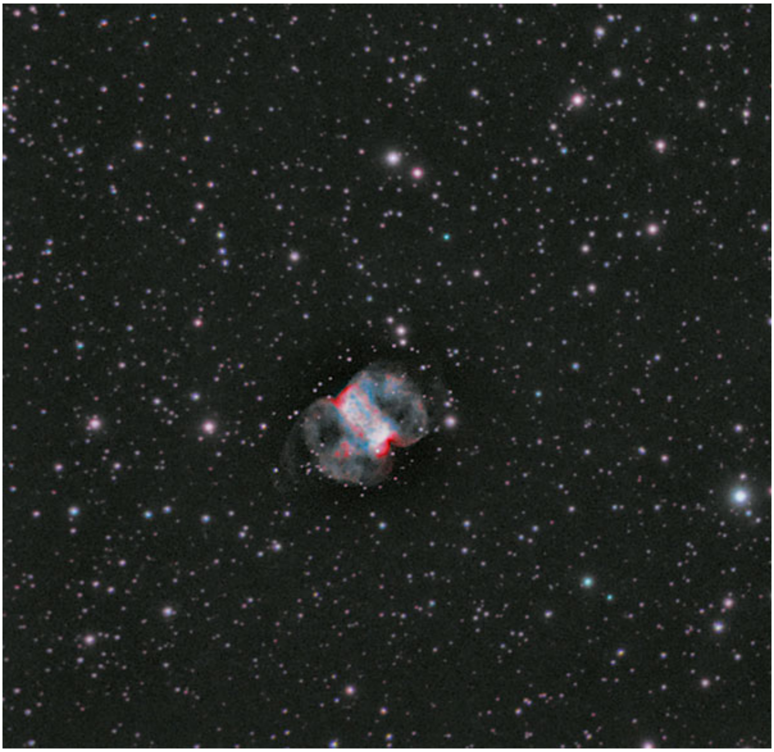

Fig. 2.76 Photo of M76; 9×4 min luminance, red, green, blue exposures with QSI540wsg camera, Celestron C14 telescope on Celestron CGE Pro mount. North is up and east is to the left. (Copyright Dalton Wilson)

M77 (NGC 1068)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Spiral galaxy	02 h 42.7 m, −00° 01′	November 11
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		7.1′×6.0′	8.9

This is a well-known Seyfert galaxy, in which emission from the nucleus is thought to occur due to accretion of matter onto a massive central black hole (which is thought to have a mass of about 20 million suns in this galaxy). The galaxy's inner region is complex. It has a 4″ diameter circumnuclear disk containing 300 million year old stars throughout, but with a ring of 30 million year old stars. Its nucleus also has a bar of stars (0.5′ in length) from which emanate two tightly wound spiral arms (0.5′ in radius) that nearly form a ring, in which intense star formation is occurring. M77 also contains water-vapor "masers" in its central region. Maser stands for "microwave amplification by stimulated emission of radiation," the physics of which is the microwave equivalent of a laser, except that lasers are usually designed to produce a beam, while astronomical masers yield emission that radiates from a roughly spherical region. M77 is part of a gravitationally bound group of perhaps 11 galaxies that includes NGC 1055 (30′ NNW), NGC 1073 (1° 25′ N), as well as the much dimmer, mag. 13, UGC 2275 and UGC 2302. M77 has an optical diameter of about 100,000 light years.

Fig. 2.77 Photo of M77; 3×15 min luminance, red, green, blue exposures with QSI540wsg camera, Astro-Tech 10″ f/8 Ritchey-Chrétien telescope on Celestron CGE Pro mount. North is up and east is to the left. (Copyright Dalton Wilson)

M78 (NGC 2068)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Reflection nebula	05 h 46.8 m, +00° 05′	November 11
Distance	**Age**	**Apparent size**	**Magnitude**
1,400 light years		8′	8

M78 is a star-forming region. Its size of 8′ corresponds to a diameter of a few light years. It is illuminated by the triple star labeled HD 38563. M78 is part of the giant molecular cloud Orion B, also known as LDN (Lynds Dark Nebula) 1630, that has a size of about 8° in professional telescopic studies (that also includes the fellow star-forming regions NGC 2071, NGC 2023 and NGC 2024) and is part of the much larger Orion-Monoceros complex (see M42).

Fig. 2.78 Photo of M78; 18×5 min luminance, 6×5 min red, green and blue exposures with a ST-10XME camera, Takahashi FSQ 106 mm f/5 telescope on AP900GTO mount. North is up. (Copyright Stuart Heggie)

M79 (NGC 1904)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Lepus	Globular cluster	05 h 24.2 m, −24° 31′	December 22
Distance	**Age**	**Apparent size**	**Magnitude**
40,000 light years	10–14 billion years	9.6′	7.7

This has a mass of about 300,000 suns and a diameter of a little over 100 light years. It may contain a central intermediate mass black hole, with a mass of 3,000 suns. Like most globular clusters, it does not orbit our galaxy with the galactic disk as we do. Instead it follows an orbit that takes it out as far as 90,000 light years from the galactic center and then back in as close as about 5,000 light years, on a path inclined to the galactic disk (by about 45°), taking about 400 million years to make one orbit around our galaxy. It has been hypothesized that NGC 1904, along with NGC 1851, NGC 2298 and NGC 2808, were once part of the now accreted Canis Major dwarf galaxy.

Fig. 2.79 Photo of M79; 13 × 15 s exposures with Canon Rebel XT 350D camera, ISO 1600, 200 mm f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M80 (NGC 6093)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scorpius	Globular cluster	16 h 17.0 m, −22° 58′	June 21
Distance	**Age**	**Apparent size**	**Magnitude**
33,000 light years	10–14 billion years	10′	7.3

This has a mass of about 300,000 suns and a diameter of about 100 light years. It was the first globular cluster to have a nova discovered in it. M80 is a bulge cluster (meaning it orbits inside the central bulge of our galaxy – see M9/NGC 6333) and has one of the shortest orbital periods of the globular clusters in our galaxy. Indeed, it only takes about 70 million years to complete one revolution about the galaxy, in an orbit that is highly inclined to the galactic central plane.

Fig. 2.80 Photo of M80; 21 × 30 s exposures with Canon Rebel XT 350D camera, ISO 1600, 200 mm f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M81 (NGC 3031)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	09 h 55.6 m, +69° 04′	February 28
Distance	**Age**	**Apparent size**	**Magnitude**
12 million light years		24.9′ × 11.5′	7.0

M81 is a LINER (low-ionization nuclear emission region) galaxy, which is a low-luminosity class of "active galactic nuclei" (AGN). The mechanism for LINERs varies, but in some galaxies it may be due to a supermassive black hole in the nucleus that is accreting gas and stars, resulting in photoionization of surrounding gas. (Indeed, some suggest that LINER galaxies represent an evolutionary stage between quasars and ordinary galaxies.) Alternatively, some LINERs may instead be caused by intense star-formation activity in the nucleus (a "starburst"). M81 is thought to be in the former class (a LINER whose emission is associated with a central black hole), with its supermassive black hole estimated to contain perhaps 70 million solar masses. About one-third of all galaxies are LINERs. M81 is the namesake member of the M81 group of about 30 gravitationally bound galaxies that includes NGC 2403 (14° W), NGC 2976 (1° 23′ SW), IC 2574 (3° E), NGC 4236 (12° E), in addition to nearby M82/NGC 3034 and NGC 3077, with which M81 has had strong past interactions (see NGC 3077 and M82/NGC 3034). M81 has an optical diameter of about 90,000 light years and a mass roughly similar to the Milky Way. To date, 144 globular clusters have been identified in M81.

Fig. 2.81 Photo of M81 (*left*), M82 (*right*); 20×5 min exposures with Canon 60Da camera, ISO 1600, 200 mm Skywatcher f/5 Newtonian reflector with a Televue Paracorr coma corrector. (Copyright Blair MacDonald)

M82 (NGC 3034)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	09 h 55.9 m, +69° 41′	February 28
Distance	**Age**	**Apparent size**	**Magnitude**
13 million light years		11.2′×4.3′	8.6

This is the prototypical starburst galaxy (in which intense star formation is occurring in its central region). Indeed, about ten new stars are formed every year in the center of this galaxy (within a radius of about 0.5′ of this galaxy's center), which is several times the rate at which stars form in the entire Milky Way. Supernovae occur in this starburst region about once a decade (which is several times the rate for the entire Milky Way). These supernovae blow material out of the center of this galaxy in a superwind (moving at speeds up to more than 1,000 km/s) that forms two jets perpendicular to the plane of the galaxy. These jets (which pick up material on their way out, possibly by turbulent shear layer mixing and by evaporating nearby gas in the galaxy), are believed to be slamming into gas outside the galaxy's disk. This gas is thought to be left over from earlier gravitational interactions with nearby M81. Material in the superwind jets is thought to be moving faster than the escape velocity of the galaxy and so will become intergalactic material. M82 is part of the M81 group of gravitationally bound galaxies (see M81/NGC 3031) and is thought to have had strong interactions with M81 over the last several hundred million years that have triggered the starburst in M82. Associated with the bright star-forming regions, over 1,000 "super star clusters" are known in M82, containing several hundred thousand suns each. The optical diameter of M82 is about 40,000 light years and its mass is roughly 10 billion suns.

See Fig. 2.81

M83 (NGC 5236)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Hydra</td><td>Barred Spiral galaxy</td><td>13 h 37.0 m, −29° 52′</td><td>May 11</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>15 million light years</td><td></td><td>12.9′ × 11.5′</td><td>7.5</td></tr>
<tr><td colspan="4">This is a grand-design spiral, meaning that it has two symmetrically placed spiral arms that extend over most its visible disk in professional telescopic images. It is also a starburst galaxy (meaning it has intense star formation occurring – see M82/NGC 3034) with the star formation concentrated in a half-ringlet occupying the region 3″–7″ from the galaxy center that contains hundreds of star clusters. About 30 of these star clusters have masses of more than 20,000 suns and are less than 10 million years old. An extremely massive star cluster, with a mass of about 10 million suns, formed about 100 million years ago from a previous starburst and lies just a few arc seconds away from the kinematical center of this galaxy, giving the galaxy the appearance of a double nucleus in professional telescopes. M83 is part of a gravitationally bound group of galaxies that includes nearby NGC 5264 (1° E) and NGC 5253 (1° 53′ SSE), the latter having its closest approach to M83 1 or 2 billion years ago. M83 has an optical diameter of about 60,000 light years and is nearly face-on (with an inclination angle of 24° i.e., it rotates about an axis that is inclined from our line-of-sight by 24°). It contains more than 1,000 massive Wolf-Rayet stars (see NGC 2403 for an explanation).</td></tr>
</table>

Fig. 2.83 Photo of M83; 60 min exposure on hypered Kodak Tech Pan film, 8″ f/6 telescope. North is up and east is to the left. (Copyright John Mirtle)

M84 (NGC 4374)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 25.1 m, +12° 53′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		6.5′ × 5.6′	9.2

This is part of the Virgo galaxy cluster (see M49/NGC 4472) and a physically close companion to M86. M84 lies at one end of the "Markarian Chain" of galaxies that lies along a "chain" NE of M84 and includes eight galaxies: M84 (NGC 4374), M86 (NGC 4406), NGC 4435, NGC 4438, NGC 4461, NGC 4458, NGC 4473 and NGC 4477. These galaxies are moving like a rigid chain thrown away from Earth at several hundred km/s with the chain tumbling so that the west side of the chain (M84) is actually moving toward us while the east side (NGC 4477) is moving doubly fast away from us. The nucleus of M84 is an AGN ("active galactic nucleus"), in which energetic emission is caused by accretion onto a massive central object, which for M84 is thought to be a black hole with a mass of around a billion suns. This AGN powers the two jets and associated lobes that are evident in the nuclear region (the inner few arc seconds) in professional telescopes at radio wavelengths, the radio waves being due to synchrotron emission of high-speed electrons gyrating wildly in a magnetic field. This galaxy contains about 1,800 globular clusters.

Fig. 2.84 Photo of M84 (*right*) with M86 (*middle right*) along with several dimmer galaxies that are also part of the Markarian Chain. 3×20 min luminance, 2×20 min green, 2×20 min blue exposures with SBIG ST-8XE camera, Takahashi FSQ 106 mm f/5 telescope. North is up and east is to the left. (Copyright John Mirtle)

M85 (NGC 4382)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Elliptical galaxy	12 h 25.4 m, +18° 11′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		7.1′×5.5′	9.1

M85 is at the northern edge of the Virgo galaxy cluster (see M49/NGC 4472) and is a close physical companion to NGC 4394 (7′ ENE). It is viewed nearly face-on and is unusual for an elliptical galaxy because it contains young stars (i.e., less than a few billion years old) in its inner regions, which may have arisen from a past merger with another galaxy or because of interaction with nearby NGC 4394. It is thought to have an eccentric stellar disk in its nucleus, which gives it the appearance of a double nucleus (with 0.25″ separation) in professional telescopes.

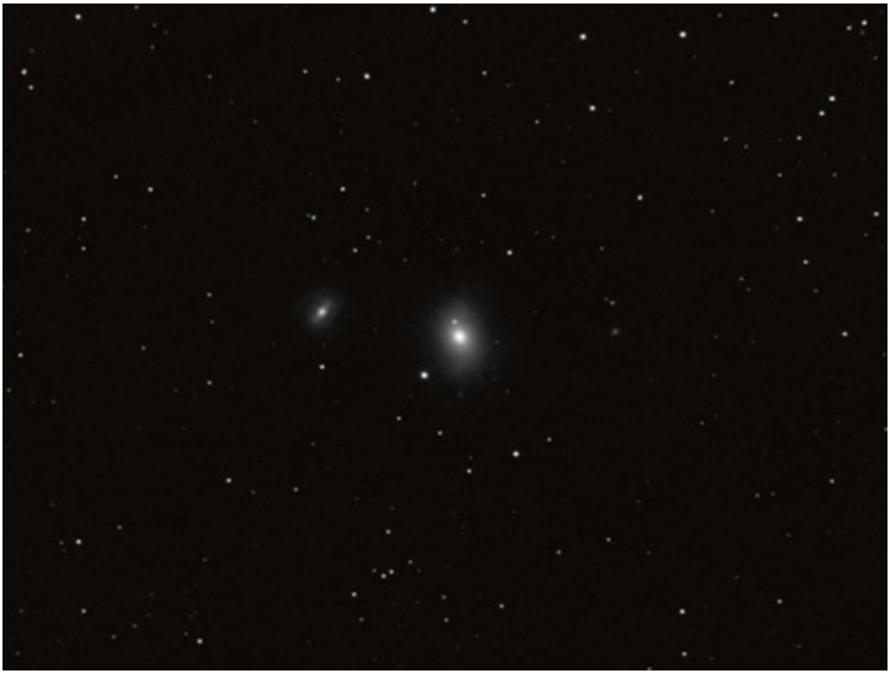

Fig. 2.85 Photo of M85 and the dimmer, nearby NGC 4394; 40 min exposure on hypered Kodak Tech Pan film, 8 f/6 telescope. North is up and east is to the left. (Copyright John Mirtle)

M86 (NGC 4406)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 26.2 m, +12° 57′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		8.9′×5.8′	8.9

It is part of the Virgo galaxy cluster (see M49/NGC 4472) and may anchor one of three subgroups in this cluster, the other two larger subgroups being associated with M87 (NGC 4486) and M49 (NGC 4472). Along with its close physical companion M84, it is part of the "Markarian Chain" of galaxies (see M84/NGC 4374). M86 is moving rapidly toward us compared to the rest of the Virgo cluster, resulting in M86 having a high speed (over 1,000 km/s) relative to the material between galaxies in the cluster (the "intracluster medium"). This galaxy's high-speed supersonic movement through the intracluster medium is thought to have caused gas to be stripped from the galaxy (so-called "ram-pressure stripping"), resulting in a tail of gas extending out from this galaxy more than a million light years and having a mass of about a billion suns. Professional telescopes have found several thousand globular clusters in this galaxy. It is thought to have undergone a collision with NGC 4438 (see NGC 4438) in the past.

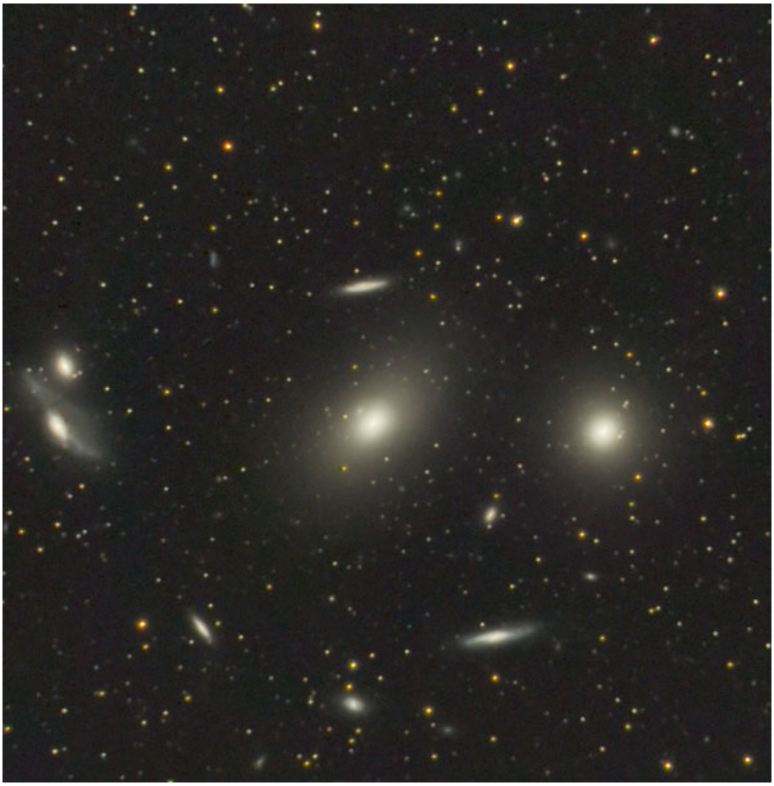

Fig. 2.86 Photo of M86 (*center*) with M84 (*left*) along with several dimmer galaxies that are also part of the Markarian Chain. 2×15 min red, green, and blue exposures with QSI540wsg camera, Skywatcher Equinox 120 mm f/7.5 telescope. North is up and east is to the left. (Copyright Dalton Wilson)

M87 (NGC 4486)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 30.8 m, +12° 23′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		8.3′×6.6′	8.6

Lying near the center of the Virgo galaxy cluster (see M49/NGC 4472), this is a heavyweight in the world of galaxies. Its mass is several trillion solar masses (although more than 90 % of this is dark matter, with less than a trillion suns due to stellar mass). This is many hundreds of times more massive than the average galaxy. M87 lies at the heart of the largest of the two major subclusters within the Virgo cluster (the other being associated with M49/NGC 4472), while a third smaller clump may be associated with M86/NGC 4406. The M87 clump of the Virgo cluster has a mass of several hundred trillion suns. The center of M87 is thought to contain a supermassive black hole with a mass of several billion suns. This black hole is believed to be what drives the active galactic nucleus (in which energetic emission is caused by accretion onto the massive central black hole) that gives rise to the optically one-sided jet in M87. This jet is the major part of the radio source known as Virgo A, the radio waves being due to synchrotron emission of high-speed electrons gyrating wildly in a magnetic field. It extends for thousands of light years (its brightest parts extending out about 25″), with material in the jet traveling at significant fractions of the speed of light. M87 has one of the largest numbers of globular clusters of any galaxy, with more than perhaps 16,000 (compare to the Milky Way's 150 or so). The optical diameter of M87 is about 130,000 light years (which is more than twice the diameter of the average galaxy), but it extends out several times this distance in professional telescopic studies.

Fig. 2.87 Photo of M87; 60 min exposure on hypered Kodak Tech Pan, 8″ f/6 telescope. North is up and east is to the left. (Copyright John Mirtle)

M88 (NGC 4501)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Spiral galaxy	12 h 32.0 m, +14° 25′	April 24
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		6.8′ × 3.7′	9.4

M88 is part of the Virgo galaxy cluster (see M49/NGC 4472) and is a Seyfert galaxy (where a black hole in this galaxy's center, in this case with a mass of 80 billion suns, accumulates nearby gas, resulting in strong emission from the nucleus). It has an optical diameter of about 110,000 light years. The nucleus of this galaxy (within a radius of about 4″) has a different chemical makeup than the rest of the galaxy. The galaxy is a "flocculent" spiral, meaning that it lacks any obvious azimuthally symmetric spiral arm pattern (see NGC 3521). It is traveling through the Virgo cluster's intracluster medium, which causes "ram pressure" compression of its western side and removal of its atomic hydrogen gas.

Fig. 2.88 Photo of M88; 45 min exposure on hypered Kodak Tech Pan film, 8″ f/6 telescope. North is up and east is to the left. (Copyright John Mirtle)

M89 (NGC 4552)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 35.7 m, +12° 33′	April 24
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		3.5′ × 3.5′	9.9

This is part of the Virgo galaxy cluster (see M49/NGC 4472). A supermassive object in this galaxy's center (thought to be a black hole with a mass of many hundreds of millions of suns) accumulates nearby gas resulting in emission from the nucleus as a LINER ("low-ionization nuclear emission region" – see M81/NGC 3031) galaxy. The galaxy's supersonic motion relative to the Virgo intracluster medium has resulted in ram pressure stripping of gas from this galaxy. A recent nuclear outburst, perhaps in the past couple million years, is thought to have produced a powerful shock wave that is causing X-ray emission in two ring-shaped regions within the center of this galaxy, with diameters of a few thousand light years. It contains 1,400 globular clusters within a radius of 10′ from its center. It has a complex structure of plumes, tails and shells in its outer regions that may be remnants from one or more past galaxy mergers or accretions.

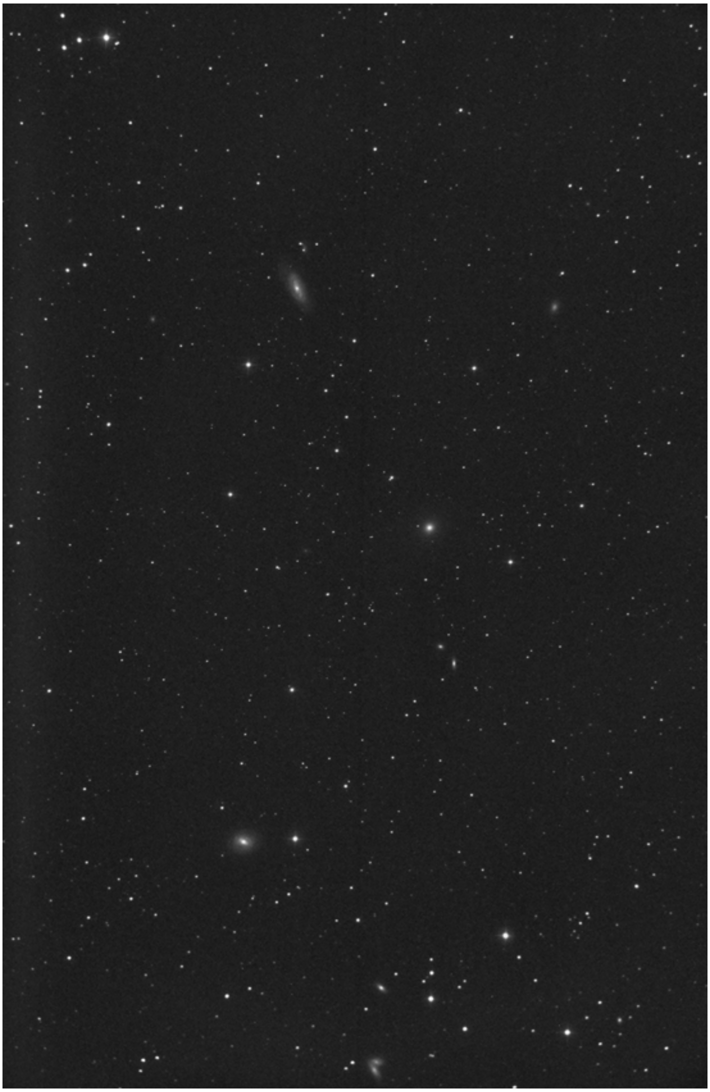

Fig. 2.89 Photo of M89 (*upper middle*), M90 (*middle right* and like a bright fuzzy star), M58 (*lower middle left*), as well as NGC 4567/4568 (*bottom middle* – see NGC 4567); 45 min exposure on hypered Kodak Tech Pan film, 6″ f/5.5 telescope. North is up and east is to the left. (Copyright John Mirtle)

M90 (NGC 4569)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 36.8 m, +13° 10′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		9.5′×4.4′	9.5

This is part of the Virgo cluster (see M49/NGC 4472). It is a LINER galaxy ("low-ionization nuclear emission region" – see M81/NGC 3031), but its nuclear emission is thought to be dominated by intense star formation and supernovae (i.e., a starburst, see M82/NGC 3034), rather than by accretion onto a central black hole. About two new stars form every year in this galaxy (about the same as form yearly in the Milky Way). The galaxy rotates about an axis that is inclined to our line-of-sight by about 64° with the western edge of the galaxy closest to us. Although the galaxy IC 3583 (6′ NNW) is nearby in the sky and is also a Virgo cluster member, the two are not thought to be interacting strongly. Because of M90's high speed relative to the Virgo cluster (over 1,000 km/s, which is locally supersonic), it is thought to have lost 90 % of its atomic hydrogen (HI) gas to "ram-pressure stripping" (see M91/NGC 4548) that peaked about 300 million years ago.

See Fig. 2.89.

M91 (NGC 4548)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 35.4 m, +14° 30′	April 24
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		5.2′×4.2′	10.1

This galaxy is part of the M87 clump of the Virgo galaxy cluster (see M49/NGC 4472). It is a LINER galaxy (see M81/NGC 3031). Like many spirals in galaxy clusters, this galaxy has much less atomic hydrogen gas than average for spirals in general. This is thought to be caused by stripping of this gas (so-called "ram-pressure stripping") from the galaxy due to the galaxy's motion relative to the material between galaxies in the cluster (the "intracluster medium"). Most of this galaxy rotates at about 250 km/s about an axis inclined to our line-of-sight by about 35°. It has a low star formation rate for a spiral galaxy. Stars in its nucleus have much higher "metal" content, meaning they are abundant in elements heavier than hydrogen and helium, than the rest of this galaxy.

Fig. 2.91 Photo of M91 (*upper middle*) and NGC 4571 (*lower left*); 50 min exposure on hypered Kodak Tech Pan film, 8″ f/6 telescope. North is up and east is to the left. (Copyright John Mirtle)

M92 (NGC 6341)

Constellation	**Object type**	**RA, Dec**	**Approx. transit date at local midnight**
Hercules	Globular cluster	17 h 17.1 m +43° 08′	July 6
Distance	**Age**	**Apparent size**	**Magnitude**
27,000 light years	10–14 billion years	12′	6.4

This is one of the oldest globular clusters known and is the second most metal-poor Milky Way globular cluster, after M15/NGC 7078. It has a mass of about 200,000–300,000 suns. Its size of 12′ corresponds to a diameter of about 100 light years. It orbits the galaxy on a path that is somewhat inclined to the disk (by a little more than 20°) that takes it a maximum of about 25,000 light years away from the galactic central plane, traveling between typically a few thousand and 40,000 light years from the galactic center. It completes one revolution around the galaxy about once every 200 million years.

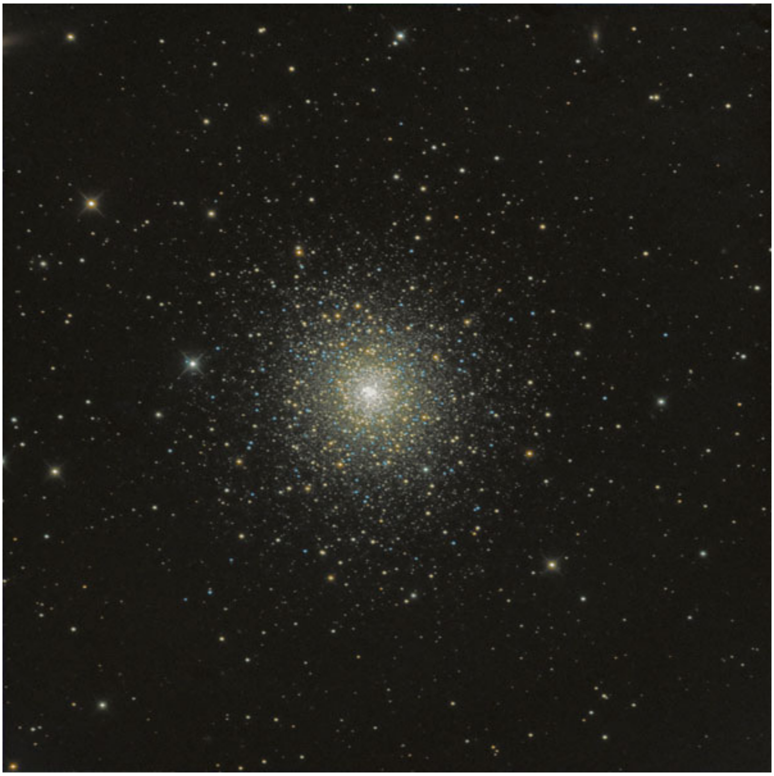

Fig. 2.92 Photo of M92; 6×10 min luminance, red, green, blue exposures with QSI540wsg camera, Astro-Tech 10″ f/8 Ritchey-Chrétien telescope on Celestron CGE Pro mount. North is up and east is to the left. (Copyright Dalton Wilson)

M93 (NGC 2447)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	07 h 44.5 m, −23° 51′	January 26
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	400 million years	10′	6.2

This lies just above the galactic central plane (by a few light years) a couple of thousand light years farther from the galactic center than we are. It has a diameter of about 10 light years and a mass of about 700 suns.

Fig. 2.93 Photo of M93; 8.5 min exposure on 120 format Ektachrome 200 film, 6″ f/4.5 telescope. North is up and east is to the left. (Copyright John Mirtle)

M94 (NGC 4736)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Canes Venatici</td><td>Barred spiral galaxy</td><td>12 h 50.9 m, +41° 07′</td><td>April 29</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>15 million light years</td><td></td><td>14.4′ × 12.1′</td><td>8.1</td></tr>
<tr><td colspan="4">This has a mass of perhaps 30–40 billion suns, an optical diameter of about 70,000 light years, and contains a central black hole with a mass of about 7 million suns. Professional telescopes find M94 has an inner ring (between 35″ and 48″ in radius) that is undergoing intense star formation (i.e., it is a “starburst” ring) and is the result of ring-bar dynamics. Star formation is also occurring in its outer disk. About one new star is formed every year in M94. Most of the galaxy rotates at approximately 150 km/s about an axis inclined to our line-of-sight by about 40°. M94 is a LINER galaxy (see M81/NGC 3031) and is part of the M94 group (also called the Canes Venatici I galaxy group) of perhaps 40 gravitationally associated galaxies. A counter-rotating component found in this galaxy may be the result of a past merger event.</td></tr>
</table>

Fig. 2.94 Photo of M94; 30 min exposure, 16″ f/4.5 telescope. North is up and east is to the left. (Copyright John Mirtle)

M95 (NGC 3351)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred spiral galaxy	10 h 44.0 m, +11° 42′	March 27
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		7.4′×5.0′	9.8

This is part of the M96 (NGC 3368) galaxy group – see M96/NGC 3368. It is a nuclear starburst galaxy. Indeed, professional telescopes find that M95 has an inner ring (7″ in radius) containing ionized hydrogen (HII) star-forming regions each with millions of suns divided among several clusters and being the result of orbital resonant interactions with this galaxy's bar, which itself is about 1.6′ long. M95 has an optical diameter of about 80,000 light years.

Fig. 2.95 Photo of M95 (*left*) and M96 (*right*); 30 min exposure, 16″ f/4.5 telescope. (Copyright John Mirtle)

M96 (NGC 3368)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Leo</td><td>Barred spiral galaxy</td><td>10 h 46.8 m, +11° 49′</td><td>March 28</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>35 million light years</td><td></td><td>7.8′ × 5.2′</td><td>9.3</td></tr>
<tr><td colspan="4">The nucleus of this galaxy harbors a black hole with a mass of about 7.5 million suns, and a nuclear bar with a radius of 5″. It is thought to also have a separate outer bar with length of 1′, as well as an inner disk with a diameter of about 0.5′. It is the namesake member of the M96 (NGC 3368) group of about a dozen galaxies that includes NGC 3299, NGC 3351 (M95), NGC 3377 (see NGC 3377), M105 (NGC 3379), NGC 3384 (see NGC 3384), NGC 3412 (see NGC 3412), and NGC 3489 (see NGC 3489). This group is part of the larger Leo I group that includes M65 and M66. M96 has an optical diameter of about 80,000 light years and is a LINER galaxy (see M81/NGC 3031).</td></tr>
</table>

See Fig. 2.95

M97 (NGC 3587)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Planetary nebula	11 h 14.8 m, +55° 01′	April 4
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years		3.8′	9.9

This is nicknamed the “Owl Nebula” because it resembles two owl’s eyes in a round disk when viewed at high power in large amateur telescopes. The nebula is expanding at a few tens of km/s and has a mass of perhaps a couple tenths that of our Sun (not including the central star, whose mass is about two-thirds that of the Sun and is a challenging object in amateur telescopes). In professional telescopic studies the three-dimensional structure of this nebula is complex, although the “owl’s eyes” are thought to be a bipolar (“hourglass”) cavity (inclined from our line-of-sight by about 30°) that is inside three separate elliptical shells. The inner shell of the three gives rise to the round outer shape visible in amateur telescopes.

Fig. 2.97 Photo of M97 (*upper left*) and M108 (*lower right*); 24 × 10 min luminance, 13 × 10 min red, 4 × 10 min green and blue exposures with Apogee U16M camera, Astrophysics 155 EDF 4″ f/7 telescope on Paramount ME mount. North is to the right. (Copyright Stuart Heggie)

M98 (NGC 4192)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 13.8 m, +14° 54′	April 20
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		9.8′×2.8′	10.1

M98 is part of the Virgo galaxy cluster (see M49/NGC 4472), near its western edge and thought to be lying toward the front of this cluster. It has a mass of about 200 billion suns and an optical diameter of about 150,000 light years. It is nearly edge-on (with its axis of rotation inclined by about 80° from our line-of-sight). It has emission from its nucleus (perhaps from a LINER that is powered by both a star-burst and accretion onto a massive central object – see M81/NGC 3031).

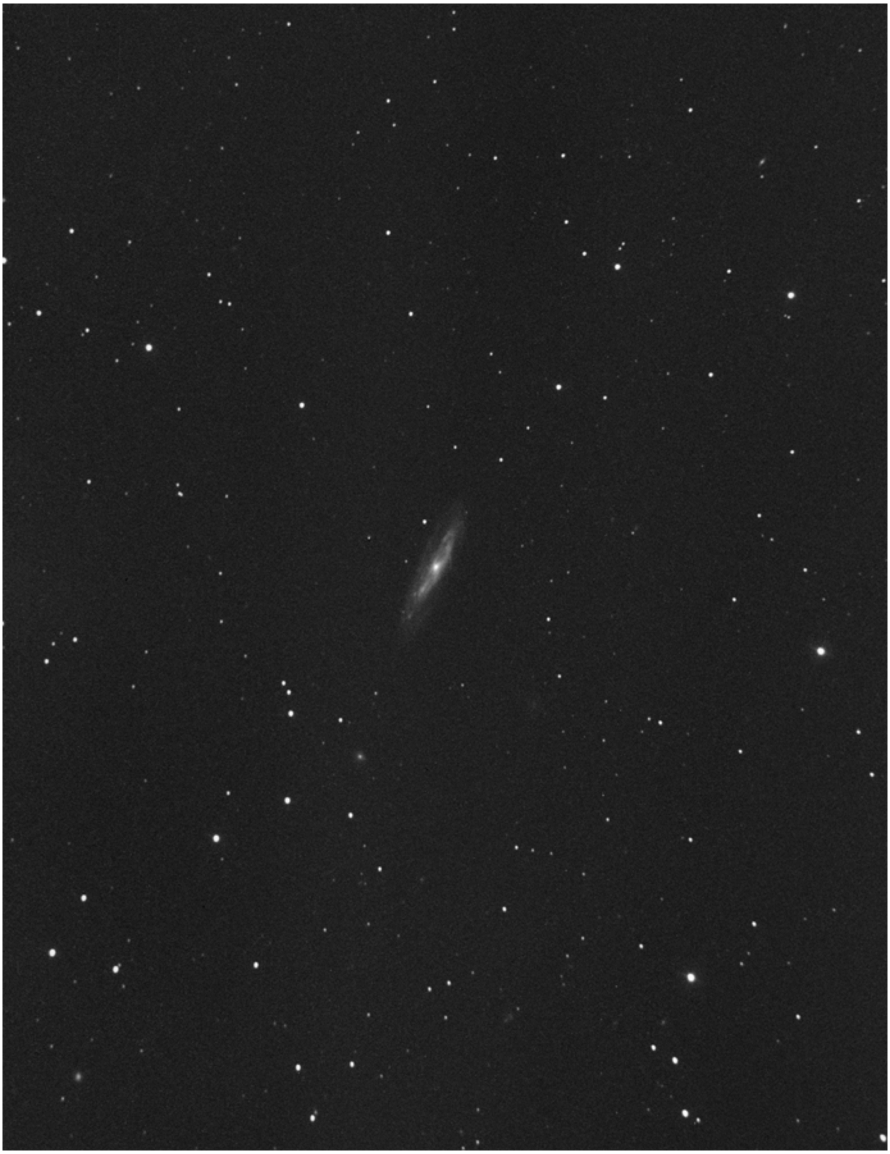

Fig. 2.98 Photo of M98; 60 min exposure on hypered Kodak Tech Pan film, 8″ f/6 telescope. North is up and east is to the left. (Copyright John Mirtle)

M99 (NGC 4254)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Spiral galaxy	12 h 18.8 m, +14° 25′	April 21
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		5.3′×4.6′	9.7

This is one of several galaxies whose nickname is the "Pinwheel Galaxy" (due to its multiple spiral arms evident in professional telescopic images). It is part of the Virgo galaxy cluster (see M49/NGC 4472) and may be a new entry to this cluster. It has a mass of a little under 200 billion suns and an optical diameter of about 90,000 light years. Vigorous star formation is occurring throughout this galaxy. In professional telescopes, one of this galaxy's spiral arms is much more pronounced, possibly caused by a close encounter with a massive galaxy, perhaps NGC 4162 (0.5° NNE, spiral galaxy, mag. 12.0), a few hundred million years ago. A huge cloud of neutral hydrogen (HI) with a mass of about 200 million suns lies about half a million light years from NGC 4254 and has been hypothesized to be tidal debris from a previous high velocity encounter with M98 (see NGC 4192/M98) a little less than a billion years ago.

Fig. 2.99 Photo of M99; 18×1 min exposures with Canon Rebel XT 350D camera, ISO 1600, 300 mm f/5 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M100 (NGC 4321)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 22.9 m, +15° 49′	April 22
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		7.5′×6.1′	9.3

This is part of the Virgo galaxy cluster (see M49/NGC 4472), being the brightest and largest spiral galaxy in the Virgo cluster. It is a “grand-design spiral,” meaning that it has two symmetrically placed spiral arms that extend over most of its visible disk in professional telescopic images. Resonance associated with the bar and the “Lindblad resonances” (where the speed of density waves resonantly amplifies oscillations in the orbits of matter in the disk) are thought to be triggering a ring of star formation (a “starburst”) in the central region of M100. This ring has a radius of 7.5″–20″ and its stars vary in age progressively around the ring from less than 10 million years old to several hundred million years old, formed in a succession of a few intense periodic star formation episodes. M100 has a mass of about 200 billion suns and an optical diameter of about 120,000 light years.

Fig. 2.100 Photo of M100 from a light polluted urban site; 12×5 min exposures, Canon 350D camera, ISO 200, Meade Schmidt Newtonian 8″ f/4 telescope. North is up and east is to the left. (Copyright Blair MacDonald)

M101 (NGC 5457)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	14 h 03.2 m, +54° 21′	May 17
Distance	**Age**	**Apparent size**	**Magnitude**
20–25 million light years		28.8′×26.9′	7.5

This galaxy is nearly face-on. It has a diameter of almost 200,000 light years. Many ionized hydrogen (HII) star-forming regions are present in M101, some of which can be seen as bright knots in amateur telescopes. Several of these knots have their own NGC numbers, e.g. NGC 5461, 5462, 5471, the latter of which is a hundred times larger and brighter than any HII region in our galaxy. Some of these supersized HII regions have masses of tens of millions of suns (e.g., NGC 5461 and 5471), and although they appear as a single knot in amateur telescopes, they are made up of many individual giant molecular clouds (GMCs) that have masses of several hundred thousands of suns (similar to the masses of GMCs in our galaxy). M101 is the namesake member of the M101 group of gravitationally bound galaxies that includes NGC 5474 (44′ SSE), NGC 5585 (3° 21′ NE), NGC 5204 (6° NW), NGC 5477 (22′ ENE) and Holmberg IV (UGC 8837, 1° 19′ WSW). Tidal interactions with several group members in the past few hundred million years (perhaps including NGC 5477, NGC 5474 and Holmberg IV) are thought to have distorted M101. These interactions may have induced the formation of some of the HII regions, e.g., NGC 5471.

Fig. 2.101 Photo of M101; 34×10 min luminance, 5×10 min red, 8×10 min green and blue exposures with Apogee U16M camera, Astrophysics 155 EDF 4″ f/7 telescope on Paramount ME mount. North is to the left. (Copyright Stuart Heggie)

M102 (NGC 5866)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Draco	Lenticular galaxy	15 h 06.5 m, +55° 46′	June 2
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		6.5′×3.1′	9.9

This is a lenticular galaxy (given the label S0 in classification schemes), meaning it has a disk and central bulge like a spiral galaxy but lacks the spiral arms. Lenticulars usually contain very little gas, dust or young stars, consisting almost entirely of old stars. It contains about 340 globular clusters. This galaxy is sometimes called the "Spindle Galaxy," although NGC 3115 also has this nickname. It is nearly edge-on (inclination angle of 86°, meaning it rotates about an axis that is inclined at 86° from our line-of-sight) with about 60 % of its light coming from its bulge and 40 % from its disk. It has an optical diameter of 80,000 light years (the diameter of our galaxy is about 100,000 light years). It is the namesake member of the NGC 5866 group of perhaps five galaxies that includes nearby NGC 5907 and NGC 5879, which are within several million light years of NGC 5866. Messier's original M102 is believed to be a duplicate entry of M101 (NGC 5457) rather than being NGC 5866, but in order to have 110 different objects in the Messier list, many amateur astronomers informally attach the label M102 to NGC 5866.

Fig. 2.102 Photo of M102; 3×2 min exposures with Canon XT 350D camera, ISO 1600, 300 mm f/5 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M103 (NGC 581)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	01 h 33.4 m, +60° 39′	October 24 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	20 million years	6.0′	7.4
Of 228 stars with magnitude 14.5 and brighter that have been examined in professional telescopic studies in the cluster region, 77 are known to be actual cluster members, the rest being field stars (see M39/NGC 7092 for further discussion). The brightest star in the cluster region (a double star, Struve 131, mag. 7.3 and 10.5 with separation 13.8″ along a SE-NW direction) is not a cluster member but is a field star (in the foreground). M103's size of 6′ corresponds to a diameter of about 15 light years.			

Fig. 2.103 Photo of M103; 20×30 s exposures with Canon XT 350D camera, ISO 1600, 200 mm f/6 telescope. North is up and east is to the left. (Copyright Tenho Tuomi)

M104 (NGC 4594)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Spiral galaxy	12 h 40.0 m, −11° 37′	April 25
Distance	**Age**	**Apparent size**	**Magnitude**
30 million light years		8.6′×4.2′	8.3

This is nicknamed the "Sombrero Galaxy." Its well-known dust lane, which actually has a ring shape (like Saturn's rings), contains a mass of about 16 million suns of dust grains that are submicron in size. The dust lane may owe its existence to the gravitational interaction of a now-defunct bar with the interstellar medium. The disk in this galaxy is about a quarter as massive as this galaxy's large spheroidal bulge (whereas in our galaxy the disk has a mass of about seven times that of the bulge). This galaxy has a stellar mass of about a quarter of a trillion suns. It harbors a central black hole with a mass of many hundreds of millions of suns, onto which a few percent of a solar mass is accreted every year. It is a LINER (see M81/NGC 3031) galaxy, is nearly edge-on (inclination angle of 84°) and contains nearly 2,000 globular clusters. An ultra-compact dwarf galaxy similar to a globular cluster, but with a mass of about 30 million suns, orbits M104.

Fig. 2.104 Photo of M104; 10×3 min exposures with Canon EOS 350D camera, ISO 800, Meade Schmidt Newtonian 8″ f/4 telescope. North is up and east is to the left. (Copyright Blair MacDonald)

M105 (NGC 3379)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Elliptical galaxy	10 h 47.8 m, +12° 35′	March 28
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		5.3′ × 4.8′	9.5

This is part of the M96 (NGC 3368) group of galaxies (see M96/NGC 3368). It has a stellar mass of about 100 billion suns, but its total mass including dark matter is about ten times this value. Its nucleus contains a supermassive black hole with a mass of perhaps as much as 400 million suns. Nearly 300 globular clusters are thought to orbit this galaxy, which is about twice as many as the Milky Way. NGC 3384 is nearby (see NGC 3384), as is the dimmer NGC 3389 (spiral galaxy, 10′ ESE, mag. 11.8, with a mass similar to M105). However, NGC 3389 is actually a background object and is instead about twice as far away and part of the NGC 3338 group of galaxies that includes NGC 3338, NGC 3389 and NGC 3346.

Fig. 2.105 Photo of M105 (*right*) and its companion NGC 3384 (*middle* – see NGC 3384), along with the background galaxy NGC 3389 (*below* and *left*); 4×15 min red, green, and blue exposures with QSI540wsg camera, Astro-Tech 10″ f/8 Ritchey-Chrétien telescope on Celestron CGE Pro mount. North is up and east is to the left. (Copyright Dalton Wilson)

M106 (NGC 4258)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 19.0 m, +47° 18′	April 20
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		18.6′ × 7.2′	8.3

This is a Seyfert galaxy (see NGC 3227) and is thought to harbor a central black hole with a mass of about 40 million suns that is accreting much less than one solar mass per year. This galaxy has bipolar nuclear jets, driven by the central black hole. These jets are thought to emanate from the nucleus at about a 30° angle from the plane of the disk and interact with material in the disk that appear as "anomalous arms" in professional telescopic studies. The nucleus of this galaxy also contains water masers (see NGC 3079) contained in a thin warped disk with diameter of only 10 light years. This galaxy has an optical diameter of about 130,000 light years. It is at the north end of the NGC 4258 (M106) group of about 15 gravitationally bound galaxies that includes NGC 4144 (1° 45′ WSW), NGC 4242 (1° 42′ S), NGC 4460 (3° SE), NGC 4490 (6° SSE – see NGC 4490), NGC 4485 (6° SSE – see NGC 4485), NGC 4618 (7° SE – see NGC 4618), NGC 4625 (7° SE) and possibly NGC 4248 (14′ WNW).

Fig. 2.106 Photo of M106; 9×10 min luminance, 3×10 min red, green and blue exposures with Apogee U16M camera, Astrophysics 155 EDF 4″ f/7 telescope on Paramount ME mount. Several other moderately dim galaxies can also be seen in the photo, including NGC 4217 (*lower right*), NGC 4346 (*lower left*), and NGC 4220 (*far upper right*) which are all mag. 11.3. The dimmer NGC 4238 (mag. 12.4) is at 2 o'clock to M106 and just to the *right* of that is the very dim NGC 4232 (mag. 13.7) with star-like NGC 4231 (mag. 13.6) *right above* it. North is up. (Copyright Stuart Heggie)

M107 (NGC 6171)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	16 h 32.5 m, −13° 03′	June 23
Distance	**Age**	**Apparent size**	**Magnitude**
20,000 light years	10–14 billion years	13′	7.8

This has a mass of about 100,000 suns and a diameter of about 80 light years. It is a bulge cluster (i.e., it orbits in the central ball-like bulge of our galaxy) with a period of about 100 million years. Its orbital path is inclined by about 45° to the galactic disk and is a very flattened ellipse. It was not noted by Messier, but instead is a recent (1947) addition to the Messier catalog suggested by H. S. Hogg.

Fig. 2.107 Photo of M107. North is up and east is to the left. 23×30 s exposures with Canon XT 350D camera, ISO 1600, 200 mm f/6 telescope. (Copyright Tenho Tuomi)

M108 (NGC 3556)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	11 h 11.5 m, +55° 40′	April 3
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		8.6′×2.4′	9.9

Professional telescopic studies find that this galaxy has two giant loops of atomic hydrogen gas, one at the east and one at the west end. These loops have diameters of 10,000–20,000 light years, have masses around 50 million suns and are expanding outward but parallel to the disk of the galaxy at 40–50 km/s. They are thought to have originated about 50 million years ago. The loops may be the result of the rapid expansion of material shot outward from an active galactic nucleus, with the jets "flaring" into shells as they reach the less dense outer regions of the galaxy. The nuclear activity has since largely subsided. The galaxy is nearly edge-on (having an inclination angle of about 75°, meaning that it rotates about an axis inclined at 75° from our line-of-sight) and has an optical diameter of about 100,000 light years. It is thought to have nearly 300 globular clusters. Its stellar mass is estimated to be a little over 100 billion suns, and its nucleus harbors a supermassive black hole with a mass of 20–30 million suns.

Fig. 2.108 Photo of M108; 5×10 min luminance, 5×20 min red, green, and blue exposures with QSI540wsg camera, Astro-Tech 10″ f/8 Ritchey-Chrétien telescope on Celestron CGE Pro mount. North is up and east is to the left. (Copyright Dalton Wilson)

M109 (NGC 3992)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	11 h 57.6 m, +55° 22′	April 15
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		7.5′×4.4′	9.8

This has a mass of about 250 billion suns and a diameter of about 130,000 light years. It is part of the Ursa Major galaxy cluster which contains nearly 300 galaxies, one of only three major galaxy clusters within 150 million light years of us (the others being the Virgo cluster and the Fornax cluster). The Ursa Major cluster contains about 1/30 the mass of the Virgo cluster and is part of the Virgo supercluster (see see M49/NGC 4472). The Ursa Major cluster is an unusual cluster in that it consists almost entirely of late-type galaxies (e.g., Sc and SBc and later galaxies in Hubble's galaxy classification scheme; Sc and SBc spirals are "late-type" spirals that have prominent, loosely wound spiral arms and only a very small central bulge relative to an extended disk). In contrast, most galaxy clusters consist of "early-type" galaxies (i.e., elliptical and lenticular, and early-type spirals, the latter having relatively tightly wound spiral arms and a large central bulge). Indeed, three-quarters of the Virgo cluster galaxies are early-type. M109 is the namesake member of the M109/NGC 3992 galaxy group of about 30 gravitationally bound galaxies that is a subgroup of the Ursa Major cluster.

Fig. 2.109 Photo of M109; 4 × 10 min red, green, and blue exposures with QSI540wsg camera, Celestron 14″ C14 telescope on Celestron CGE Pro mount. North is up and east is to the left. (Copyright Dalton Wilson)

M110 (NGC 205)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Andromeda	Elliptical galaxy	00 h 40.4 m, +41° 41′	October 26
Distance	**Age**	**Apparent size**	**Magnitude**
2.6 million light years		20′ × 12′	7.9

This is a dwarf galaxy about 15,000 light years in optical diameter, and having a mass of perhaps 100 million suns. It is in our Local Group and close to M31. The mass of interstellar gas in this galaxy, a million suns' worth, is restricted essentially to its inner 1′ diameter core and is much less than expected theoretically. The galaxy underwent a burst of star formation for a few hundred million years, ending less than a hundred million years ago, which created the young blue star cluster with mass of a few hundred thousand suns that professional telescopes find in its 1′ diameter central region.

Fig. 2.110 Photo of M110; 3×12 min luminance, red, green and blue exposures, with QSI540wsg camera, Celestron 14″ C14 telescope on Celestron CGE Pro mount. North is up and east is to the left. (Copyright Dalton Wilson)

Chapter 3

NGC (New General Catalogue) Objects

NGC 40

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cepheus	Planetary nebula	00 h 13.0 m, +72° 31′	October 19
Distance	**Age**	**Apparent size**	**Magnitude**
3,000–4,000 light years	4,000–6,000 years	1.2′	12.3

This has an actual diameter of about 1/2 light year. It may have a toroidal structure with two lobes opening off the toroid and the rotational axis of symmetry inclined at an angle of about 20° from our line of sight. The bright central star (mag. 11.5) has a mass of about 0.6 suns, temperature of about 50,000 K and is a Wolf-Rayet star. Wolf-Rayet stars are relatively rare, with less than 600 known in our galaxy; about 10 % of the central stars in planetary nebulae are Wolf-Rayet stars. Wolf-Rayet stars are very hot (around 100,000 K), ejecting mass at a high-speed (~1,000 km/s) and in the last evolutionary stages of their life. Wolf-Rayet stars in planetary nebulae typically have smaller masses than our Sun that originated from stars with masses <8 suns and are a different breed than their far more massive (many times the Sun's mass) Wolf-Rayet cousins that populate star-forming regions (see NGC 2403).

W.H. Finlay, *Concise Catalog of Deep-Sky Objects: Astrophysical Information for 550 Galaxies, Clusters and Nebulae*, The Patrick Moore Practical Astronomy Series, DOI 10.1007/978-3-319-03170-5_3, © Springer International Publishing Switzerland 2014

NGC 55

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sculptor	Barred spiral galaxy	00 h 14.9 m, −39° 12′	October 18
Distance	**Age**	**Apparent size**	**Magnitude**
7 million light years		31.2′×5.9′	7.8

The apparent optical major axis here corresponds to 62,000 light years. It is thought to be a foreground member of the Sculptor galaxy group, which contains about 30 galaxies. It is a dwarf Magellanic barred spiral galaxy, with only one spiral arm, like the Large Magellanic Cloud (see Large Magellanic Cloud). The stars outside the bright disk may have come from separate past merging events. It is a starburst galaxy (see M82) with the nuclear region burst probably being very young (<2 million years old) and intense enough to trigger star formation in HII regions away from the central plane. In professional telescopes, it has a spectacular variety of chimneys, loops, and bubbles that extend out thousands of light years from the disk, concentrated near two large central HII complexes. It is asymmetrical, with about 3/8 of this object extending off the NW side of its nuclear region and 5/8 off the SE side.

NGC 104

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Tucana	Globular cluster	00 h 24.1 m, −72° 05′	October 21
Distance	**Age**	**Apparent size**	**Magnitude**
15,000 light years	10–14 billion years	31′	4.0

Also referred to as 47 Tucanae, the outer regions here are thought to consist of older stars, with more recently formed helium-enhanced stars in the core. It is one of the most massive Milky Way globulars, containing somewhat less than a million solar masses. It is thought to have been nearly twice as massive when it first formed. It is the 11th nearest globular cluster. It contains about 300 neutron stars among its nearly 2 million stars. Professional telescopic studies do not find planets in this cluster, probably because the low metallicity of the cluster's stars is not conducive to large planet formation. It rotates about itself with a period on the order of 200,000 years. It is the second brightest globular in our night sky (after Omega Centauri/NGC 5139). It is thought to have crossed the galactic disk about 50 million years ago.

NGC 129

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	00 h 30.0 m, +60° 31′	October 23
Distance	**Age**	**Apparent size**	**Magnitude**
5,000–7,000 light years	80 million years	12′	6.5

This has an diameter of about 40 light years, making it a relatively large open cluster in actual size. Nearly 400 stars have been counted as members of this cluster in professional telescopic studies. The Cepheid variable DL Cas can be seen as an 8.9 mag. star that is the northern of three bright mag. 9 members that form a triangle (with 3′ long sides) near the center cluster. (See NGC 7790 for a brief explanation of Cepheid variable stars.) DL Cas has a mass of 5.6 suns, a radius nearly 70 times that of our Sun, and is a spectroscopic binary.

NGC 136

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	00 h 31.5 m, +61° 31′	October 24
Distance	**Age**	**Apparent size**	**Magnitude**
17,000 light years	250 million years	1.5′	11.5

This has a diameter of about 7 light years and was discovered in 1788 by William Herschel.

NGC 157

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Barred spiral galaxy	00 h 34.8 m, −08° 24′	October 25
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		3.5′ × 2.4′	10.4

This is a "grand-design" spiral, meaning that it has two symmetrically placed spiral arms that extend over most its visible disk in professional telescopic images. It has an outer slow-rotating gas disk (with rotational velocity near 125 km/s). This outer disk surrounds a more rapidly spinning inner disk, which is 2′ in diameter and "warped" so that the inner region lies in a plane that is inclined by about 10° from the outer disk. The galaxy rotates about an axis that is inclined to our line-of-sight by approximately 50°.

NGC 185

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Elliptical galaxy	00 h 39. 0 m, +48° 20′	October 26
Distance	**Age**	**Apparent size**	**Magnitude**
2 million light years		8.0′ × 10.4′	9.3

This is a dwarf galaxy (6,000 light years in optical diameter) in our Local Group that orbits M31 with a period of about 6 billion years and an orbital radius of about a half million light years. Despite its small actual size, its closeness to us gives it a relatively large size. Like all dwarf elliptical galaxies, NGC 185 was thought to consist only of very old (Population II) stars. However, star formation in this galaxy appears to have occurred as recently as a few hundred million years ago, but only in a central region of apparent diameter 1′. Outside this region the stars are >1 billion years old. It contains a mass of several thousand suns of dust and several hundred thousand suns of gas. Its total mass is a couple hundred million suns.

NGC 205 (M110)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Andromeda	Elliptical galaxy	00 h 40. 4 m, +41° 41′	October 26
Distance	**Age**	**Apparent size**	**Magnitude**
2.6 million light years		20′ × 12′	7.9

This is a dwarf galaxy about 15,000 light years in optical diameter and having a mass of perhaps 100 million suns. It is in our Local Group and close to M31. The mass of interstellar gas in this galaxy, a million Suns' worth, is restricted essentially to its inner 1′ diameter core, which is much less than expected theoretically. It underwent a burst of star formation for a few hundred million years, ending less than 100 million years ago, which created the young blue star cluster with a mass of a few hundred thousand suns that professional telescopes find in its 1′ diameter central region.

NGC 221 (M32)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Andromeda	Elliptical galaxy	00 h 42.7 m, +40° 52′	October 26
Distance	**Age**	**Apparent size**	**Magnitude**
2.5 million light years		8.5′ × 6.5′	8.1

This is a dwarf satellite galaxy of M31 and is M31's closest companion. M32 is a very unusual galaxy, referred to as a "compact elliptical" galaxy, having an inordinately bright and compact central core. Fewer than ten compact elliptical galaxies are known to exist within a distance of 300 million light years of our galaxy. Its origin remains uncertain, but one hypothesis suggests it was once a spiral galaxy that was stripped down to its bulge a few billion years ago by intense tidal interaction with M31. Alternatively, it may simply be a low-mass classical elliptical galaxy that happened by or else formed close to M31. Its stars are mostly older than a few billion years. A black hole with a mass of several million suns is thought to be present in the center of M32. M32 has an optical diameter of about 7,000 light years.

NGC 224 (M31)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Andromeda	Spiral galaxy	00 h 42.7 m, $+41^\circ\ 16'$	October 26
Distance	**Age**	**Apparent size**	**Magnitude**
2.5 million light years		$3.2^\circ \times 1.0^\circ$	3.5

Nicknamed the "Andromeda Galaxy," this is the nearest large galaxy and is the most luminous member of our Local Group of galaxies that contains about 40 galaxies in a radius of a few million light years. M31 is thought to have about the same mass as our galaxy. An apparent disk diameter of 3.2° corresponds to a diameter of 140,000 light years, although the diameter visible in telescopes is larger than this (and depends on the aperture and observing conditions). Professional telescopes show it has perhaps as many as 28 dwarf satellite galaxies, including NGC 205 (M110), which is prominent in amateur telescopes. Nearby M32 may be experiencing its first tidal encounter with M31, while M33 is thought to have had a close encounter with M31 a few billion years ago. M31 is rich in globular clusters for a spiral galaxy, with nearly 250 counted in professional telescopes. The brightest of these globular clusters can be observed in amateur telescopes. Some of them are thought to have come from dwarf galaxies that M31 accreted in past merger events. Professional telescopes find M31 has a double nucleus containing a black hole with a mass of about 50 million suns, the largest black hole in our Local Group of galaxies. The two nuclei are separated by $0.5''$ and are thought to be part of an eccentric nuclear disk. The nucleus also contains a young blue star cluster with a mass of a few thousand suns that formed a couple hundred million years ago. The galaxy is a LINER ("low-ionization nuclear emission region" – see M81/NGC 3031 for an explanation). It is expected to collide with the Milky Way in a few billion years.

NGC 225

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	00 h 43.6 m, +61° 46′	October 27 (Daylight Savings Time)
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years		15′	7.0
About 30 stars are counted by professional telescopic studies in this cluster, but it has a mass of about 70 suns. It was discovered in 1784 by Caroline Herschel (William Herschel's sister) and is sometimes called the Sailboat Cluster. The age of this cluster is found by some to be about 120 million years, but others find pre-main sequence stars in the cluster and suggest a very young cluster age of just a few million years.			

NGC 246

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Planetary nebula	00 h 47.1 m, −11° 52′	October 28
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years		4.1′	10.9
Professional telescopes show that the central star (see Fig. 3.1) is actually a binary system with a separation of 3.8″ and position angle of 130° (central star mag. 11.9, companion star mag. 14.3), with an orbital period of roughly 70,000 years. The central star mass is rather high (0.8 suns), suggesting the progenitor star had a mass about six times that of our Sun. The central star is very hot (well over 100,000 K) and is a PG 1159 star, meaning it is ending its status as a planetary nebula central star and becoming a white dwarf.			

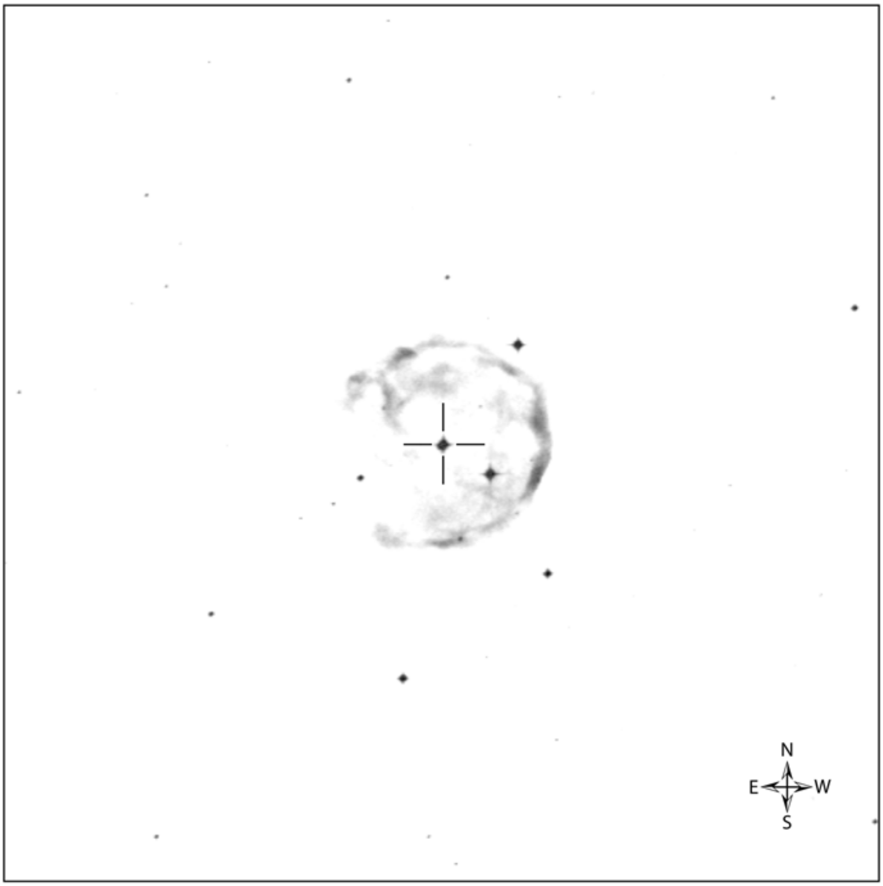

Fig. 3.1 The *cross-hairs* indicate the central star of the planetary nebula NGC 246. The area shown is 15′×15′. (From the Digitized Sky Survey, Space Telescope Science Institute, based on photographic data of the National Geographic Society-Palomar Observatory Sky Survey, or POSS I.)

NGC 247

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Barred spiral galaxy	00 h 47.1 m, −20° 46′	October 28
Distance	**Age**	**Apparent size**	**Magnitude**
8 million light years		19.2′×5.5′	8.9

This is considered a dwarf spiral galaxy. Such galaxies have a much larger fraction of their mass in the halo compared to normal spirals, as well as having disk rotation velocities that increase outward throughout the disk (in contrast to normal spirals, where most of the disk rotates at the same velocity). Star formation has occurred in the central regions of this galaxy within the last 100 million years. NGC 247 has an optical diameter of about 50,000 light years and a total dynamical mass of about 20 billion suns. Its disk is inclined at a 74° angle from our line of sight. It is part of the Sculptor group of galaxies, a collection that is about 6 million light years across and contains a total of eight galaxies, among which are NGC 55, 253, 300, and 7793, but these are probably not gravitationally bound.

NGC 253

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sculptor	Barred spiral galaxy	00 h 47.6 m, −25° 17′	October 28
Distance	**Age**	**Apparent size**	**Magnitude**
11 million light years		29′×6.8′	7.3

This galaxy is part of the Sculptor group of galaxies (see NGC 247). Its rotation axis is inclined at about 78° from our line of sight. Its stars contain a mass of about 40 billion suns, and it has a luminosity similar to our galaxy. It has active star formation occurring in its disk as well as a starburst nucleus (meaning violent, high-mass star formation is occurring there) fueled by gas funneled inward by the galaxy’s bar. Its nuclear starburst luminosity is among the top four most luminous within 30 million light years (along with the nuclear starbursts in M83, M82, and NGC 4945), forming several sun masses of new stars every year over the past 20–30 million years. Superwinds generated by the starburst nucleus extend out hundreds of light years from the central plane. Its nuclear region contains several young super star clusters with masses of millions of suns. NGC 253 may have accreted a smaller galaxy within the past few hundred million years, which might have triggered its intense nuclear starburst.

NGC 278

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Spiral galaxy	00 h 52.1 m, +47° 33′	October 28
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		2.1′×2.0′	10.7

This is a small galaxy, previously thought to have a bar, but now believed to be without a bar. Its nucleus is dominated by young stars, and star formation is still in process there, extending across a diameter of about 10,000 light years. Its star forming is particularly intense in a nuclear ring, 7,000 light years in diameter, that is unusually large given the galaxy's 22,000 light year diameter disk. Its recent star formation may be the result of a merger with another small galaxy, but the galaxy is now isolated. Its rotation axis is inclined about 28° from our line of sight, meaning it is close to face-on.

NGC 281

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Emission nebula + open cluster	00 h 52.9 m, +56° 38′	October 29
Distance	**Age**	**Apparent size**	**Magnitude**
9,000 light years		35′ × 30′	7.4

Nicknamed the "Pac-Man Nebula," from its resemblance to the character in the Pac-Man video arcade game that gained fame in the early 1980s (Pac-Man looks like a pizza with a slice missing). Like many emission nebulae (e.g., M8 and M16), this is a large ionized hydrogen (i.e., HII) star-forming region that is part of a much larger giant molecular cloud (GMC). In this case the GMC has a mass of almost 40,000 suns. It lies about 1,000 light years off the galactic central plane, having perhaps been blown there by the expansion of a superbubble created by supernovae in the galactic plane that exploded about 20 million years ago and triggered a first generation of star formation throughout a 1,000 light year radius region, including NGC 281. A second generation of star formation in NGC 281, which is ongoing in smaller regions with diameters of a few tens of light years, is thought to have been triggered by interaction of the previously noted first-generation stars with the GMC. NGC 281 is made visible by ionizing radiation from the young, hot stars embedded in it (some of which make up the open cluster IC 1590, which has a diameter of 20 light years). Most of the ionizing is done by the bright star in the center of the nebula (HD 5005, mag. 7.4), which is a quadruple star of which three stars can be seen. The embedded cluster IC 1590 (which is unspectacular in amateur telescopes) is young (a few million years old) and contains numerous pre-main sequence stars that are still contracting and have not yet begun burning hydrogen; 63 members of IC 1590 are brighter than mag. 17.

NGC 288

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sculptor	Globular cluster	00 h 52.8 m, −26° 35′	October 29
Distance	**Age**	**Apparent size**	**Magnitude**
29,000 light years	10–14 billion years	13′	8.1

This lies within 1° of the South Galactic Pole, i.e., it is located along a line nearly opposite to the direction of the axis of rotation of our galaxy. It has a mass of about 50,000 Suns. It orbits the galaxy on a retrograde path inclined by about 47° from the galactic disk, taking a little over 200 million years to complete an orbit that takes it out as far as 35,000 light years from the galactic center and as close in as about 5,000 light years. It is currently near its closest approach to the galactic center. Such close approaches are causing it to be disrupted by tidal forces. Indeed, past tidal interactions with the galactic disk and bulge are thought to have created tails containing more than 1,000 stars that extend out from the cluster for more than 1,000 light years in professional telescopes.

NGC 292 (Small Magellanic Cloud/SMC)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Tucana	Barred spiral galaxy	00 h 52.6 m, −72° 48′	October 28
Distance	**Age**	**Apparent size**	**Magnitude**
200,000 light years		5.3° × 3.4°	2.2

The SMC is a dwarf satellite galaxy of the Milky Way. Sometimes referred to as Nubecula Minor, it is part of the Magellanic System that also includes the Large Magellanic Cloud (see Large Magellanic Cloud) as well as the Magellanic bridge of gas and stars plus the Magellanic stream of neutral hydrogen gas that trails them in their trajectory around the Milky Way. The bridge that connects the two Magellanic Clouds may have been created when the two had a close encounter a couple hundred million years ago. The SMC is the sixth most massive galaxy in our Local Group (after the Milky Way, M31, M33, the LMC, and M110), with a total mass of several billion suns and about a third the mass of the LMC. Its diameter is about two-thirds that of the LMC. Star formation is occurring throughout its disk. It is thought to have an overall spheroidal shape, which may be the result of it merging with another dwarf galaxy a few billion years ago. Its supernovae rate is about 1 every 350 years, compared to 1 every 100 years in the LMC and 1 every 50 years in the Milky Way. Although the LMC has about five times as many star clusters as the SMC, the SMC has a larger portion of large clusters (>100 light years in diameter), perhaps because of lower tidal forces in the SMC. Only four other dwarf satellite galaxies are significantly closer to the Milky Way than the SMC.

NGC 362

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Tucana	Globular cluster	01 h 03.2 m, −70° 51′	October 30
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	14′	6.8

With a mass of about 400,000 suns, this follows an orbit in the galactic halo that has high eccentricity. It is currently near its furthest orbital distance from the galactic center. It crossed the galactic mid-plane approximately 30 million years ago. When its stars' color and magnitude are plotted on a color magnitude diagram (with color on the x-axis and magnitude on the y-axis), a group of this cluster's stars appear along the red end of a horizontal line called the horizontal branch (HB). These red HB stars are low mass red giant stars that are burning helium in their core, surrounded by a hydrogen shell. In NGC 362 they are redder than usual for reasons related to them having lower mass loss rates. In contrast, in the similar globular cluster NGC 288 these HB stars are blue because they are undergoing higher mass loss rates. The reason behind these differences in the HB stars of these two clusters has been a source of controversy, since the metallicity (the abundance of elements heavier than hydrogen) of these two clusters is similar. One possible explanation relates to NGC 362 being a couple billion years younger than NGC 288, but this is uncertain.

NGC 381

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	01 h 08.3 m, +61° 35′	October 31
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	320 million years	7′	9.3

This has a diameter of about 7 light years and was discovered in 1783 by Caroline Herschel (William Herschel's sister). Professional telescopic studies indicate it contains about 60 members. The eclipsing binary star OX Cas was once thought to belong to this cluster but is now considered a field star that is twice as far away.

NGC 404

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Andromeda	Lenticular galaxy	01 h 09.4 m, +35° 43′	November 1 (Daylight Savings Time)
Distance	**Age**	**Apparent size**	**Magnitude**
10 million light years		3.5′	10.0
This is the nearest low-ionization nuclear emission region (LINER – see M81/ NGC 3031 for an explanation) galaxy to us. It is an isolated dwarf galaxy whose nucleus is thought to contain a black hole with a mass somewhere around a million suns. However, its nuclear emission is thought to be powered not by accretion onto its central black hole but instead mainly by radiation from a young nuclear star cluster with a mass of 11 million suns contained within a central 65 light year diameter region. The galaxy has a disk that contains an unusually large amount of neutral hydrogen (HI) gas, whose source remains uncertain but may be the result of either a recent minor merger or else an infall of outlying gas filaments within the past billion years or so. Mild star formation is ongoing in this gas disk, in addition to its nuclear region, although most of the stars in this galaxy are old, with more than 90 % of its disk's stellar content being more than 8 billion years old. The rotation axis of the galaxy has an inclination angle of about 11° to our line-of-sight.			

NGC 436

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	01 h 16.0 m, +58° 49′	November 3 (Daylight Savings Time)
Distance	**Age**	**Apparent size**	**Magnitude**
10,000 light years	80 million years	5′	8.8
This has a diameter of about 15 light years and was discovered in 1787 by William Herschel. It is located in the Perseus arm of our galaxy, which is the next spiral arm outward from our position in the galaxy.			

NGC 457

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	01 h 19.6 m, +58° 17′	November 4 (Daylight Savings Time)
Distance	**Age**	**Apparent size**	**Magnitude**
8,000 light years	20 million years	20′	6.4

This has several nicknames, including the "Owl Cluster," and the "E.T." cluster (the latter from its resemblance to the title character in the Spielberg movie). It has a diameter of about 30 light years and was discovered in 1787 by William Herschel. It has a mass of about 3,000 suns. It is located in the Perseus arm of our galaxy, which is the next spiral arm outward from our position in the galaxy. The two bright stars on the SE edge of the cluster (φ Cas, mag. 5.0 and HD 7902, mag. 7.0) belong to the multiple star ADS 1073, which is a five-star system and believed to be a member of this cluster.

NGC 488

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pisces	Spiral galaxy	01 h 21.8 m, +05° 15′	November 4 (Daylight Savings Time)
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		5.4′ × 3.9′	10.4

This has an unusually high rotational velocity (360 km/s at a distance of 65,000 light years from the nucleus). The rotation axis is inclined at an angle of about 40° from our line-of-sight. It is also a tightly wound spiral, with the spiral arms having a pitch angle (the angle between a spiral arm and a circle) of only 5. Its disk has a mass of about 100 billion suns.

NGC 524

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pisces	Lenticular galaxy	01 h 24.8 m, +09° 32′	November 5 (Daylight Savings Time)
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		2.8′×2.8′	10.4
This has an optical diameter of about 60,000 light years and a total stellar mass of several hundred billion suns. It is nearly face-on and contains a central supermassive black hole with a mass of around 10 billion suns. Very rich in globular clusters for a lenticular galaxy, it contains several thousand of them. It is the namesake member of the NGC 524 galaxy group, which contains 17 nearby (and gravitationally bound) galaxies, including NGC 489 (mag. 12.6, 49′ WSW) and the dimmer NGC 502 (mag. 12.8, 41′ SW), NGC 516 (mag. 13.1, 10′ W), NGC 518 (mag. 13.3, 14′ SSW), and NGC 532 (mag. 12.9, 17′ SSE).			

NGC 559

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	01 h 29.5 m, +63° 18′	November 6 (Daylight Savings Time)
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	55 million years	7′	9.5
This has a diameter of about 5 light years and was discovered in 1787 by William Herschel; about 80 stars have been noted by professional telescopes as belonging to this cluster.			

NGC 581 (M103)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	01 h 33.4 m, +60° 39′	October 24 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	20 million years	6.0′	7.4
Of 228 stars with magnitude 14.5 and brighter that have been examined in professional telescopic studies in the cluster region, 77 are known to be actual cluster members, the rest being field stars (see M39/NGC 7092 for further discussion). The brightest star in the cluster region (a double star, Struve 131, mag. 7.3 and 10.5 with separation 13.8″ along a SE-NW direction) is not a cluster member but is a field star (in the foreground). M103's size of 6′ corresponds to a diameter of about 15 light years.			

NGC 584

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Elliptical galaxy	01 h 31.3 m, −06° 52′	October 24 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		4.1′×2.0′	10.5
This has an unusually high rotational velocity for its galaxy type. It is the namesake member of the NGC 584 galaxy group (containing 11 galaxies) including NGC 586 (spiral galaxy, mag. 13.2 and 5′ ESE), NGC 596 (elliptical galaxy, mag. 10.9 and 26′ ESE – see NGC 596), NGC 600 (barred spiral galaxy, mag. 12.4, 38′ SSE), NGC 615 (spiral galaxy, mag. 11.7, 1° ESE – see NGC 615), NGC 636 (elliptical galaxy, mag. 11.5, 2° ESE), all of which are within a few million light years of each other.			

NGC 596

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Elliptical galaxy	01 h 32.9 m, −07° 02′	October 24 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		3.2′×2.0′	10.9

In professional telescopic studies this galaxy has an odd internal structure that consists of several misaligned ellipsoidal shells. It is part of the NGC 584 galaxy group (see NGC 584).

NGC 598 (M33)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Triangulum	Spiral galaxy	01 h 33.9 m, +30° 39′	October 24 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
2.7 million light years		68.7′×41.6′	5.5

This is the third most luminous galaxy in our Local Group (which contains about 40 galaxies in a radius of a few million light years) after M31 and the Milky Way. It has an optical diameter of about 60,000 light years (about half that of the Milky Way), which is about average for a spiral galaxy. Its luminous mass is about 10 billion suns. It rotates clockwise from our viewpoint with a period of about 200 million years. The size of its central supermassive black hole (if one exists) is less than a couple thousand solar masses. NGC 604, the largest known ionized hydrogen region (1,500 light years in diameter) and second most massive in our Local Group (after 30 Doradus), belongs to this galaxy and is visible as a knot in large amateur telescopes near the NNE edge; its stars are only a few million years old and in total have a mass of a couple hundred thousand suns, with star formation still ongoing. M33 is thought to have had a close encounter with M31 a few billion years ago. It has about a tenth the mass of M31 and may be a satellite of M31, although M33 may have a dwarf spheroidal satellite galaxy of its own, labeled And XXII.

NGC 613

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sculptor	Barred spiral galaxy	01 h 34.3 m, −29° 25′	October 24 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		5.2′×4.2′	9.9

This is a Seyfert galaxy (where a supermassive object in this galaxy's center accumulates nearby gas, resulting in strong emission from the nucleus). It has a strong large-scale bar, which has nudged gas into its nucleus to form a ring of star clusters with a diameter of 0.7″ where star formation is ongoing.

NGC 615

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Spiral galaxy	01 h 35.1 m, −07° 20′	October 25 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		2.7′×0.9′	11.7

This has an optical diameter of about 60,000 light years. The rotation axis of its spiral disk is inclined at an angle of about 60° from our line-of-sight. The nucleus of this galaxy is decoupled from its outer regions (being both chemically and kinematically different), perhaps due to gravitational interaction with another galaxy some billions of years ago. It is part of the NGC 584 galaxy group containing eight galaxies (see NGC 584).

NGC 628 (M74)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pisces	Spiral galaxy	01 h 36.7 m, +15° 47′	October 25 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		10.5′×9.5′	9.1

This has a mass of about 330 billion suns and an optical diameter of about 80,000 light years. It is nearly face-on (its inclination angle, which is the angle between its axis of rotation and our line-of-sight, is less than 10°). Hundreds of ionized hydrogen (HII) star-forming regions (like M42) have been identified in this galaxy in professional telescopes, some of which can be seen as bright knots in large amateur telescopes. In addition, within its inner 0.5′ is a circum-nuclear ring of star formation. All told, these star-forming regions produce several new stars per year. M74 is thought to be part of a gravitationally bound group of perhaps six galaxies that includes NGC 660 (2° 38′ SE) as well as several dimmer galaxies (the brightest of which, at mag. 13, are UGC 1195, 22′ NNW of NGC 660 and UGC 1200, 29′ S of NGC 660), although it has not interacted with any galaxies for more than a billion years. Professional telescopic studies show that beyond its optically visible disk is an extended ring of atomic hydrogen reaching out more than twice its optical diameter. This extended ring is warped, perhaps as the result of two high velocity clouds that are accreting onto the disk.

NGC 637

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	01 h 43.1 m, +64° 02′	October 27 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	10 million years	3′	8.2

This has a diameter of about 6 light years and was discovered in 1787 by William Herschel. It is located in the Perseus spiral arm of our galaxy, which is the next arm outward from the Orion arm that we are located within. It has a mass of more than 500 suns and is a young cluster.

NGC 650/651 (M76)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Planetary nebula	01 h 42.3 m, +51° 34′	October 27 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	6,000 years	3.1′	10.1

Nicknamed the "Little Dumbbell Nebula," different parts of this galaxy are expanding at different rates, whereas typical expansion velocities are a few tens of km/s. The galaxy has a diameter of about 3 light years. The two lobes of the "bowtie" shape are each three-dimensional expanding bubbles, inclined at about 75° from our line-of-sight, with the NW lobe pointing toward us.

NGC 654

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	01 h 44.1 m, +61° 53′	October 27 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	15 million years	6′	6.5

In professional telescopic studies about 300 stars brighter than magnitude 18 are thought to belong to this cluster. It has a diameter of about 10 light years. Two massive nearby stars, HD 15137 (mag. 7.9, 11° SE) and HD 14633 (mag. 7.5, 21° SE), are thought to have once belonged to this cluster but have since been ejected, perhaps when each of their unidentified neutron star companions previously exploded in a supernova. This galaxy is physically close to NGC 663, the two clusters being a little over 100 light years apart. It contains a number of dim (mag. >17.0), young, low-mass stars that are still contracting and have not yet begun hydrogen fusion, meaning they are pre-main sequence stars.

NGC 659

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	01 h 44.4 m, +60° 40′	October 27 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
6,000 light years	40 million years	6′	7.9

This has a diameter of about 10 light years and was discovered by Caroline Herschel (William Herschel's sister) in 1783. Professional telescopic studies suggest it contains about 1,600 stars, including five known Be stars (see M47/NGC 2422).

NGC 663

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	01 h 46.1 m, +61° 14′	October 27 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	15 million years	15′	7.1
With a diameter of about 30 light years, this cluster is estimated to have about 1,500 stars brighter than magnitude 19 in professional telescopes. It has at least 15 variable stars as well as one of the largest percentages of “Be” stars known in any open cluster. Indeed, about one-quarter of its members are Be stars, which are B-type stars that are peculiar because of hydrogen Balmer emission lines in their spectra, due to material expelled by high rotational velocities into a circumstellar disk in the equatorial plane of the star – see M47/NGC 2422. It is physically close to NGC 654, the two clusters being a little over 100 light years apart.			

NGC 720

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Elliptical galaxy	01 h 53.0 m, −13° 44′	October 29 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		4.7′×2.4′	10.2
This has a total mass of several trillion suns, although most of this is dark matter since normal (baryonic) matter makes up only about 10 % of the mass in this galaxy. It contains nearly 700 globular clusters and consists of an old (>5 billion year old) spheroidal bulge plus a younger (<5 billion-year-old) large disk, with its hybrid nature perhaps being the result of a galaxy merger about 4 billion years ago.			

NGC 752

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Andromeda	Open cluster	01 h 57.7 m, +37° 47′	October 30 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
1,500 light years	1 billion years	75′	5.7

Despite being rather old, this cluster has retained much of its mass because it orbits at a large radius from the center of the galaxy (no closer than about 24,000 light years), although it is thought to be dissolving and is now less massive than its initial mass of a few thousand suns. Open clusters that orbit closer in to the galactic center are disrupted more readily, so that almost all old open clusters have orbits that don't venture much closer to the galactic center than we are located (27,000 light years).

NGC 772

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aries	Spiral galaxy	01 h 59.3 m, +19° 00′	October 31 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
110 million light years		7.2′×4.3′	10.3

This is a grand design spiral. It rotates about an axis that is inclined at 54° from our line-of-sight. It has two faint dwarf companion galaxies (UGC 1519, mag. 16, 43′ ENE, and UGC 1546, mag. 15, 1.0° ESE), as well as a satellite galaxy (NGC 770, mag. 12.9 and 4′ SSW), the latter rotating around NGC 772 in a retrograde orbit (opposite to the direction of rotation of NGC 772).

NGC 779

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Barred spiral galaxy	01 h 59.7 m, −05° 58′	October 31 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		4.1′ × 1.2′	11.2

This is a "grand-design" spiral, meaning that it has two symmetrically placed spiral arms that extend over most of its visible disk in professional telescopic images. It has an optical diameter of about 120,000 light years. It is nearly edge-on (inclination angle of about 75°, meaning it rotates about an axis that is inclined at 75° from our line-of-sight).

NGC 869

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Open cluster	02 h 19.1 m, +57° 08′	November 5
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	14 million years	18′	5.3

Combined with NGC 884 it forms the "Double Cluster" – see NGC 884. Sometimes mislabeled *h* Persei, it, and NGC 884 are thought to be at nearly the same distance and have nearly the same age. NGC 869 has a diameter of about 40 light years, and its mass is a little less than 5,000 suns. Including stars in the halo between and surrounding both clusters out to a radius of 25′ from each cluster, the total mass of the Double Cluster is thought to be about 20,000 suns. In professional telescopes, field stars (see M7/NGC 6475) make up about 60 % of the stars within a 10′ radius of each cluster's center.

NGC 884

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Open cluster	02 h 22.5 m, +57° 09′	November 5
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	14 million years	18′	6.1

Together with NGC 869 it forms the "Double Cluster" – see NGC 869. NGC 884 has a diameter of about 40 light years and a mass of a little less than 4,000 suns (i.e., it is about 3/4 as massive as NGC 869), although both clusters contain about the same number of stars (a little less than 3,000 each). It is sometimes referred to as χ Persei, although this name actually refers to both clusters together. The two clusters contain more than 50 known Be stars, which is a much higher fraction of Be stars than in the surrounding field stars (see NGC 663 for a definition of Be stars). This is thought to be related to an enhancement in the proportion of Be stars that occurs as the stars approach the end of their main-sequence lives. Certain stars at this evolutionary stage expel material into a circumstellar disk, for reasons that remain a topic of debate. Since the Double Cluster has proportionately more stars at this evolutionary stage than in the field stars, it also has proportionately more Be stars than in the surrounding field.

NGC 891

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Andromeda	Spiral galaxy	02 h 22.6 m, +42° 21′	November 5
Distance	**Age**	**Apparent size**	**Magnitude**
30 million light years		11.7′×1.6′	10.1

This has an optical diameter of about 100,000 light years. The dust lane in this galaxy is visible in large amateur telescopes and has a width of about 1,500 light years (10″). The galaxy is almost precisely edge-on. It is thought to be quite similar to what our galaxy would look like if viewed edge-on. It has a mass of about 140 billion suns and has only 70 globular clusters, about half as many as the Milky Way. It has a halo of gas, more than a billion suns in mass, that may have arisen due to past outflows from the disk powered by supernovae or by accretion of intergalactic gas. The halo also has several large loops and arcs of old stars at distances of more than 100,000 light years from the disk that may be due to a past accretion event. A thick envelope of stars surrounding the disk may be the result of multiple past satellite galaxy accretions. It is part of the NGC 1023 group of galaxies (see NGC 1023), and group member UGC 1807 is thought to be a satellite of NGC 891.

NGC 908

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Spiral galaxy	02 h 23.1 m, −21° 14′	November 6
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		6.1′×2.7′	10.2

It has an optical diameter of 110,000 light years. It is the largest member of the NGC 908 group of galaxies, which contains four other spirals and four irregular galaxies, including NGC 907 (barred spiral, mag. 12.6, 31′ N), IC 223 (irregular galaxy, mag. 13.4, 33′ NNW), and NGC 899 (irregular galaxy, mag. 12.5, 31′ NNW).

NGC 936

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Barred lenticular galaxy	02 h 27.6 m, −01° 09′	November 7
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		4.7′×4.1′	10.2

With an optical diameter of about 100,000 light years, this is the brightest member of the NGC 936 galaxy group of perhaps 12 galaxies, including NGC 941 (barred spiral, mag. 12.2, 13′ E) and NGC 955 (spiral, mag. 12.1, 45′ E). Professional telescopic studies show its bar extends to an apparent distance of 41″ and rotates as a solid body with a period of about 100 million years. It and the galaxy rotate about an axis that is inclined at about 40° to our line-of-sight. It has a circular nuclear ring, about 10 % the size of the bar, of stars that are thought to be the fossil remnant of a previous circumnuclear starburst that consumed gas and dust driven inward by the bar.

NGC 1022

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Barred spiral galaxy	02 h 38.5 m, −06° 41′	November 9
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		2.4′×2.2′	11.3

The circumnuclear region here contains several giant ionized hydrogen (HII) regions, thought to be the result of massive young stars (formed from gas and dust driven into this region by the bar) that are irradiating the giant molecular clouds they are imbedded within. The galaxy rotates about an axis inclined at about 25° from our line-of-sight. It is part of the NGC 1052 group (see NGC 1052). It has an optical diameter of about 40,000 light years.

NGC 1023

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Barred lenticular galaxy	02 h 40.4 m, +39° 04′	November 10
Distance	**Age**	**Apparent size**	**Magnitude**
30 million light years		7.4′×2.5′	9.5

Thought to contain almost 500 globular clusters, this has a faint disk that is nearly edge-on. The center of this galaxy is thought to contain a supermassive black hole that has a mass of about 40 million suns. Stars near this black hole are moving at very high velocities (>600 km/s), and the visible nucleus is believed to be disk shaped. The diffuse extension off the eastern end, visible in large amateur telescopes, is a dwarf galaxy (NGC 1023A) that is in the process of being accreted into NGC 1023. A previous merger is thought to have occurred several billion years ago, and more mergers are likely since NGC 1023 is the namesake member and lone lenticular galaxy among the gravitationally bound NGC 1023 group of galaxies that contains perhaps 25 galaxies, including NGC 891 (see NGC 891), NGC 1003 (spiral galaxy, 1° 48′ N, mag. 11.3), IC 239 (barred spiral galaxy, 46′ W, mag. 11.0) among other spiral and irregular galaxies.

NGC 1027

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	02 h 42.6 m, +61° 36′	November 10
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	200 million years	15′	6.7

With a diameter of about 15 light years, this was discovered in 1786 by William Herschel. Its orbital radius from the galactic center stays between 30,000 and 40,000 light years, so it avoids tidal interactions with the galactic center and therefore will likely have a relatively long life before it eventually dissolves. It has a mass of about 100 suns.

NGC 1039 (M34)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Open cluster	02 h 42.1 m, +42° 46′	November 10
Distance	**Age**	**Apparent size**	**Magnitude**
1,500 light years	200 million years	25′	5.2

This has a diameter of about 10 light years and was discovered in the middle of the seventeenth century by Giovanni Batista Hodierna. Its stars rotate at rates that are midway between those in the younger Pleiades cluster (100 million years old – see M45) and the older Hyades cluster (600 million years old). This is thought to be the result of rotational braking whose effect on rotation rates becomes more pronounced with age. Such braking is believed to be due to angular momentum loss via magnetic coupling to the chromosphere (the star's atmosphere outside the bright photosphere). In professional telescopes, approximately 60 % of the 700 or so stars with magnitudes between 14 and 24 in this region are cluster stars (the rest are field stars).

NGC 1052

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Elliptical galaxy	02 h 41.1 m, −08° 15′	November 10
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		2.8′×2.0′	10.5

Believed to contain a supermassive central black hole with a mass of about 150 million suns, this black hole is thought to be responsible for low-ionization nuclear emission regions (LINERs – see M81/NGC 3031 for an explanation) and two high-speed jets (traveling at 50 % the speed of light) directed oppositely and emanating from the core. It has a total mass of almost 2 trillion suns, although its stars contain a mass around 100 billion Suns. A merger about a billion years ago may have triggered an extended period of star formation, which might explain 25 young star clusters found within 0.4′ of its center that each contain about 10,000 suns and are less than 10 million years old. It is the namesake member of the NGC 1052 group of galaxies, consisting of perhaps 11 gravitationally bound galaxies including NGC 988 (barred spiral, mag. 11, 1° 47′ SW), NGC 1022 (1° 42′ NNW – see NGC 1022), NGC 1035 (spiral, mag. 12.2, 25′ WNW), NGC 1042 (barred spiral, mag. 10.9, 15′ SW), NGC 1084 (spiral, mag. 10.6, 1° 23′ ENE), and NGC 1140 (irregular galaxy, mag. 12.5, 3° 47′ ESE).

NGC 1055

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Barred spiral galaxy	02 h 41.8 m, +00° 27′	November 10
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		7.6′×2.7′	10.6

This contains about 200 globular clusters. It and nearby M77 (30′ SSE – see NGC 1068/M77) are both part of a galaxy group of perhaps 11 gravitationally bound galaxies that also includes NGC 1073 (barred spiral, mag. 11.0, 1° NNE), plus other non-NGC galaxies. M77's projected distance (distance perpendicular to our line-of-sight) from NGC 1055 is about 400,000 light years.

NGC 1068 (M77)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cetus	Spiral galaxy	02 h 42.7 m, −00° 01′	November 11
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		7.1′ × 6.0′	8.9

This is a well-known Seyfert galaxy, in which emission from the nucleus is thought to occur due to accretion of matter onto a massive central black hole (which is thought to have a mass of about 20 million suns in this galaxy). The galaxy's inner region is complex. It has a 4″ diameter circumnuclear disk containing 300 million-year-old stars throughout, but with a ring of 30 million-year-old stars. Its nucleus also has a bar of stars (0.5′ in length) from which emanate two tightly wound spiral arms (0.5′ in radius) that nearly form a ring, in which intense star formation is occurring. M77 also contains water vapor "masers" in its central region. Maser stands for "microwave amplification by stimulated emission of radiation," the physics of which is the microwave equivalent of a laser, except that lasers are usually designed to produce a beam, while astronomical masers yield emission that radiates from a roughly spherical region. M77 is part of a gravitationally bound group of perhaps 11 galaxies that includes NGC 1055 (30′ NNW), NGC 1073 (1° 25′ N), as well as the much dimmer, mag. 13, UGC 2275 and UGC 2302. M77 has an optical diameter of about 100,000 light years.

NGC 1084

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Eridanus	Spiral galaxy	02 h 46.0 m, −07° 35′	November 11
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		2.8′ × 1.4′	10.7

This is part of the NGC 1052 galaxy group (see NGC 1052). It has an optical diameter of about 50,000 light years. Star formation has occurred in this galaxy in discrete periods over the past 40 million years, perhaps because of accretion of a dwarf galaxy. Among its various bright star-forming knots is a giant one on its NE edge. Total star formation rate in this galaxy is about three stars per year. The galaxy rotates about an axis that is inclined 57° to our line-of-sight, with the SE edge lying closest to us.

NGC 1232

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Eridanus	Barred spiral galaxy	03 h 09.8 m, −20° 35′	November 17
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		7.4′×6.5′	9.8

This galaxy rotates about an axis that is inclined from our line-of-sight by about 30°, meaning that its disk is nearly face-on to us. In professional telescopes it is seen to have a multiple-arm nature instead of the more usual two spiral arms. Ionized hydrogen (HII) star-forming regions are present throughout its arms, collections of which can be seen as brighter "knots" in large amateur telescopes. Some of these HII regions contain tens of thousands of Suns of ionized gas and are ionized by stellar clusters that are only a few million years old, some of which have masses over 100,000 suns and include massive Wolf-Rayet stars, although most are ionized by much smaller clusters. Having a mass of nearly half a trillion suns, this is a relatively massive galaxy (although about two-thirds of this is dark matter). It has an optical diameter of about 130,000 light years.

NGC 1245

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Open cluster	03 h 14.7 m, +47° 14′	November 19
Distance	**Age**	**Apparent size**	**Magnitude**
9,000 light years	1 billion years	10′	8.4

This has a mass of perhaps 2,700 suns. Of nearly 7,000 stars with magnitudes between 15 and 22 observed in professional studies within a 26′ diameter region centered on this cluster, fewer than 900 are thought to be cluster members. It lies 36,000 light years from the center of our galaxy (about 10,000 light years farther out than us) and about 1,500 light years below the galactic plane.

NGC 1342

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Open cluster	03 h 31.6 m, +37° 23′	November 23
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years	400–500 million years	17′	6.7
This has a diameter of about 8 light years and was discovered in 1799 by William Herschel. Professional telescopic studies to date have counted about 120 member stars. It is thought to have just about completed two revolutions around the galaxy since its birth as a cluster.			

NGC 1407

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Eridanus	Elliptical galaxy	03 h 40.2 m, −18° 35′	November 25
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		4.6′×4.3′	9.7
This galaxy is the namesake galaxy in the NGC 1407 group, also called the Eridanus A group, of perhaps 250 galaxies, most of which are dwarf elliptical galaxies. This group itself belongs to the larger Eridanus supergroup of galaxies, all of which are thought to be destined to eventually form a galaxy cluster with NGC 1407 at its core. The NGC 1407 group includes nearby NGC 1400 (elliptical galaxy, mag. 11.0, 12′ WSW) and has an abnormally large proportion of dark matter. Indeed, less than 1 % of this group's mass is normal (baryonic) matter, which is almost 50 times lower than average, for reasons that remain uncertain. The NGC 1407 group consists of about 70 % elliptical/lenticular galaxies and 30 % spirals/irregulars, whereas its parent Eridanus supergroup of galaxies has these percentages reversed. NGC 1407 and NGC 1400 emit about 80 % of the total light from their galaxy group. NGC 1407's stellar mass is about 200 billion suns, which consists entirely of old stars (more than 10 billion years old).			

NGC 1444

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Open cluster	03 h 49.4 m, +52° 40′	November 27
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	100 million years	4′	6.6
Located 30,000 light years from the galactic center and less than 100 light years below the galactic center plane, this cluster has a diameter of about 5 light years.			

NGC 1491

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Emission nebula	04 h 03.2 m, +51° 19′	December 1
Distance	**Age**	**Apparent size**	**Magnitude**
12,000 light years		6′×9′	8.5
This nebula is an ionized hydrogen (HII) region that is part of a larger molecular gas cloud (which is not visible in amateur telescopes) that has a mass of tens of thousands of Suns. The part we are seeing is made visible by ionizing radiation from the young, hot, mag 11.2 star (BD +50 886), which is the brightest star in the immediate vicinity and is just east of the brightest portions of the nebula. The star appears separated from the nebula because its stellar winds have cleared out a hemispherical cavity in the gas cloud adjacent to (west of) the star.			

NGC 1501

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Camelopardalis	Planetary nebula	04 h 07.0 m, +60° 55′	December 2
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years		52″	11.5
Classified as an “elliptical” planetary nebula, this object is sometimes called the Camel’s Eye Nebula. The central star (mag. 14.5) is a Wolf-Rayet star (see NGC 40 for an explanation) with a mass of 0.5–0.6 suns and temperature over 100,000 K. The nebula has a diameter of about 1 light year. It is expanding outward at about 80 km/s.			

NGC 1502

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Camelopardalis	Open cluster	04 h 07.8 m, +62° 20′	December 2
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	10 million years	20′	6.9

This lies on the outer edge of the Orion arm of our galaxy, which is the spiral arm that our Sun is located within. The two brightest members of this cluster, near the center, are a visual binary pair (separation 18″). The more northern of the two stars, SZ Cam, itself is a massive quadruple system (which includes an eclipsing binary pair) with a combined mass of more than 50 suns, while the more southern star is a spectroscopic binary, so this is actually a six-star system (despite its binary appearance in amateur telescopes). The cluster lies at the SE end of "Kemble's Cascade" (a pretty, 2.5° long line of stars visible in binoculars and named after the Canadian amateur astronomer Lucien Kemble). α Cam (6.5° NE) may have once been a member of this cluster but has since been ejected.

NGC 1513

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Open cluster	04 h 09.9 m, +49° 31′	December 3
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	250 million years	10′	8.4

Thought to have lost nearly all its stars with mass less than 2 suns, this is in the process of dissolving. It was discovered in 1790 by William Herschel.

NGC 1514

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Taurus	Planetary nebula	04 h 09.3 m, +30° 47′	December 3
Distance	**Age**	**Apparent size**	**Magnitude**
1,000 light years		2.2′	10.9
The central star (mag. 9.4) in this galaxy is evident in amateur telescopes and known to be a spectroscopic binary. The star responsible for the nebula is not visible, but its bright companion is. The two stars are thought to have shared a common envelope, so that mass transfer occurred from the now invisible central star to its now brighter companion. The nebula has a double shell structure. Professional infrared telescopes also find the nebula contains two stacked dust rings about 3′ in diameter that wrap the outside of the ionized zone of this nebula, providing the nebula with a bipolar shape. Its progenitor star is thought to have had a mass of 4.5 suns, much of which has been shed and now resides in the planetary nebula. The nebula is thought to be a few thousand years old.			

NGC 1528

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Open cluster	04 h 15.4 m, +51° 13′	December 4
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	400 million years	18′	6.4
With a diameter of about 15 light years, this was discovered in 1790 by William Herschel. In professional telescopic studies to date, it contains nearly 500 stars brighter than mag. 20.			

NGC 1535

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Eridanus	Planetary nebula	04 h 14.3 m, −12° 44′	December 4
Distance	**Age**	**Apparent size**	**Magnitude**
6,000 light years		20″	9.6

Turbulence causes fluctuating velocities of about 8 km/s in this nebula, which is thousands of times the fluctuating velocities of turbulent eddies on a windy day on Earth. Professional telescopic studies show an inner shell (diameter near 20″) expanding at tens of km/s that is constricted by a torus of material, in addition to a dim outer shell (with a diameter of nearly 50″). Its central star is thought to have a mass of about 0.6 suns and a temperature of about 70,000 K. This planetary nebula is sometimes called Cleopatra's Eye.

NGC 1545

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Perseus	Open cluster	04 h 20.9 m, +50° 15′	December 5
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years	100 million years	18′	6.2

This lies 30,000 light years out from the center of our galaxy, but within a few light years of the central plane. It has a mass of about 100 suns.

NGC 1647

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Taurus	Open cluster	04 h 45.9 m, +19° 07′	December 12
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years	150 million years	40′	6.4

This has a diameter of about 20 light years. Nearly 200 cluster stars have been counted to date in professional telescopic studies.

NGC 1664

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Auriga	Open cluster	04 h 51.1 m, +43° 41′	December 13
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	300 million years	18′	7.6
It has a diameter of about 20 light years. Nearly 150 member stars have been counted to date in professional telescopic studies of this cluster. Stars near the center of this cluster are spaced an average of about half a light year apart. Interstellar distances in the cluster increase for stars farther from the center, so that near the cluster border, interstellar spacings are close to those in the neighborhood of our Sun (where the interstellar spacing is about 10 light years).			

NGC 1788

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Reflection nebula	05 h 06.9 m, −03° 20′	December 17
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years		5′×3′	9.0
This has a diameter of about 2 light years. Many pre-main sequence stars are thought to be present in this nebula; a young star cluster (less than a few million years old) may be forming here.			

NGC 1817

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Taurus	Open cluster	05 h 12.2 m, +16° 41′	December 18
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	1 billion years	20′	7.7
This contains an unusually high number of δ Scuti variable stars, also called Dwarf Cepheids, with 16 confirmed in this cluster to date. These stars pulsate due to cyclic variations in opacity of their outer layers (see NGC 7790). NGC 1817 contains almost 1,600 member stars in professional telescopic studies down to magnitude 22, which represents about 20 % of the stars in this region (the remaining 80 % are field stars). It is located about 6,000 light years almost directly outward from the galactic center from us and 1,000 light years below the galactic plane. The grouping of stars labeled NGC 1807 is nearby (22′ WSW), but it is no longer thought to be a physical cluster.			

NGC 1851

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Columba	Globular cluster	05 h 14.1 m, −40° 02′	December 18
Distance	**Age**	**Apparent size**	**Magnitude**
40,000 light years	10–14 billion years	12′	7.1
This is thought to be the central remnants of a primeval dwarf galaxy that was merged and disrupted early in our galaxy's formation. The cluster may itself be the result of a merger between two progenitor clusters. It has a mass of 300,000 suns. It is part of the galaxy's halo and is a younger halo cluster with a highly inclined, eccentric orbit about the galaxy. It is thought to have crossed the galactic disk about 40 million years ago.			

NGC 1857

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Auriga	Open cluster	05 h 20.1 m, +39° 21′	December 20
Distance	**Age**	**Apparent size**	**Magnitude**
19,000 light years	100 million years	7′	7.0
This has a diameter of about 40 light years. It lies directly outward from the galactic center from us. The average mass of stars in this cluster is about 1.5 suns. About 350 stars have been counted as members brighter than mag. 21 in this cluster. The open cluster Czernik 20 is very nearby (7′ N) and may be part of the same cluster as NGC 1857.			

NGC 1904 (M79)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Lepus	Globular cluster	05 h 24.2 m, −24° 31′	December 22
Distance	**Age**	**Apparent size**	**Magnitude**
40,000 light years	10–14 billion years	9.6′	7.7
With a mass of about 300,000 suns and a diameter of a little over 100 light years, this may contain a central intermediate-size black hole with a mass of 3,000 suns. Like most globular clusters, it does not orbit our galaxy with the galactic disk as we do. Instead it follows an orbit that takes it out as far as 90,000 light years from the galactic center and then back in as close as about 5,000 light years, on a path inclined to the galactic disk (by about 45°), taking about 400 million years to make one orbit around our galaxy. It has been hypothesized that NGC 1904, along with NGC 1851, NGC 2298 and NGC 2808, were once part of the now accreted Canis Major dwarf galaxy.			

NGC 1907

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Auriga</td><td>Open cluster</td><td>05 h 28.1 m, +35° 20′</td><td>December 22</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>6,000 light years</td><td>300 million years</td><td>6′</td><td>8.2</td></tr>
<tr><td colspan="4">This contains more than 400 stars in professional telescopes and has a diameter of about 10 light years. It is located almost directly outward from the galactic center from us and only about 30 light years below the galactic plane. M38 (NGC 1912), 32′ N was once thought to perhaps be a coevolved twin to NGC 1907, but the two clusters are separated by more than 1,000 light years and are now thought to have had different birth environments and locations.</td></tr>
</table>

NGC 1912 (M38)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Auriga</td><td>Open cluster</td><td>05 h 28.7 m, +35° 51′</td><td>December 23</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>5,000 light years</td><td>300 million years</td><td>15′</td><td>6.4</td></tr>
<tr><td colspan="4">With a diameter of about 20 light years and lying about 55 light years above the galactic plane, this contains more than 600 stars in professional telescopes. It is physically close to M37 and M36 (see M36). NGC 1907, 32′ SSW was once thought to perhaps be a coevolved twin to NGC 1907, but the two clusters are separated by more than 1,000 light years and are now thought to have had different birth environments and locations.</td></tr>
</table>

NGC 1931

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Auriga	Open cluster + emission nebula	05 h 31.4 m, +34° 15′	December 23
Distance	**Age**	**Apparent size**	**Magnitude**
8,000 light years	10 million years	4′	10.1

This has a diameter of about 10 light years. Because of its young age, the remains of the nebula from which the open cluster formed is prominent as the surrounding emission nebula Sharpless 2-237. In addition, a number of young stellar objects are found by professional telescopes in this cluster, including pre-main sequence stars that are still collapsing and have not yet begun nuclear fusion. The total mass of stars in the cluster, both main sequence and pre-main sequence, is estimated to be about 180 suns, although it contains only about 15 main sequence stars (with a mass totaling about 60 suns).

NGC 1952 (M1)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Taurus	Supernova remnant	05 h 34.5 m, +22° 01′	December 24
Distance	**Age**	**Apparent size**	**Magnitude**
6,500 light years	1,000 years (created by a supernova in A.D. 1054)	6′×4′	8.4

Nicknamed the "Crab Nebula," this is one of the most well-studied objects in the sky. At its center is a pulsar, which is a rotating neutron star (about 10 km in diameter with a mass about twice that of the Sun) with a strong magnetic field that emits a narrow beam of radio emission. The Crab pulsar rotates about 30 times a second (i.e., its period is 33 ms), with its beacon pointing at us once each rotation (like a very rapidly rotating lighthouse beam). It is slowly spinning down, so that when the pulsar first formed in A.D. 1054 it is thought to have rotated more than 50 times a second. Of more than 1,000 known radio pulsars, this is one of only six whose pulses are visible in optical wavelengths (with professional telescopes). Pulsars are the remains of a star that went supernova. For the Crab pulsar, the progenitor star is thought to have had a mass about ten times that of our Sun. The Crab Nebula constitutes the remnants of the material ejected by the supernova event of this star, with several solar masses worth of material being present in the luminous portion of the nebula. The filaments in the nebula are moving outward at over 1,000 km/s.

NGC 1960 (M36)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Auriga	Open cluster	05 h 36.3 m, +34° 08′	December 25
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	20 million years	10′	6.0

This is estimated to contain nearly 1,700 stars with masses between 0.1 and 7 times the Sun, although many of these are low mass stars, so that this cluster contains less than 500 stars with masses of 0.5–7 times the Sun. Although it is quite a young cluster, it is old enough that most of its stars have had time to lose their youthful circumstellar disks (that formed when the stars collapsed from the surrounding gas and dust – see NGC 2362). Its neighbors M37 (3° 45′ ESE) and M38 (2° 16′ NW) lie within 1,000 light years of M36.

NGC 1961

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Camelopardalis	Barred spiral galaxy	05 h 42.1 m, +69° 23′	December 26
Distance	**Age**	**Apparent size**	**Magnitude**
180 million light years		4.5′×3.1′	10.9

This is one of the most massive and largest spiral galaxies known. It contains a stellar mass of about 400 billion suns and a total mass, which is approximately 90 % dark matter halo, of perhaps 12 trillion suns. It has an optical diameter of 240,000 light years. It contains a central supermassive black hole with a mass of 300 million suns that gives rise to a LINER galaxy designation (see M81/ NGC 3031). Beyond its optical diameter is an extended, massive halo of hot gas, containing more than twice the matter contained in this galaxy's stars. Such extended hot halos are thought to form from matter accreting into the galaxy's dark matter halo, but have rarely been detected for spiral galaxies. Compared to our galaxy, which is considered a large spiral in its own right, NGC 1961 is perhaps roughly ten times as massive and about twice the diameter. It is part of a group of ten spiral galaxies and is thought to have undergone a minor merger in the past.

NGC 1964

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Lepus	Barred spiral galaxy	05 h 33.4 m, −21° 57′	December 24
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		5.6′ × 1.8′	10.8

A foreground star 3″ E of the nucleus is partly responsible for the starlike appearance of the nucleus. This galaxy has an optical diameter of about 100,000 light years.

NGC 1973/1975/1977

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Reflection and emission nebulae + open cluster	05 h 35.1 m, −04° 44′	December 24
Distance	**Age**	**Apparent size**	**Magnitude**
1,400 light years		20′ × 10′	7

These nebulae are merely the fluorescing parts of a single larger molecular cloud (which is not visible in amateur telescopes). Indeed, they are all part of the group of giant molecular gas clouds called the Orion-Monoceros complex that M42 also belongs to (see M42). The ionized hydrogen (HII) region NGC 1977 contains an embedded young open cluster (most of whose stars are obscured by the dust and gas in the nebulae) that supplies the photons that make these nebulae visible (mostly by scattering off dust in the nebulae, but also by ionizing gas in the nebulae, resulting in emission). The bright star 42 Orionis (mag. 4.7) is responsible for most of the illuminating (although at the south end, some of the light is actually light scattered from M42).

NGC 1976 (M42)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Emission and reflection nebula	05 h 35.3 m, –05° 23′	December 24
Distance	**Age**	**Apparent size**	**Magnitude**
1,400 light years		1°	4.0

Nicknamed the "Orion Nebula," this is the apparently brightest and one of the closest ionized hydrogen star-forming regions (or HII regions) in our sky. It is lit up by the stars in a very young cluster (less than a few million years old and referred to as the Orion Nebula Cluster) containing about 3.5 thousand stars situated in the heart of the nebula. However, many of the stars in this cluster are obscured by material in the nebula. Light from these stars is both scattered off dust, particularly in the outer regions of the nebula, and re-emitted by gas, particularly in the inner regions, making this both a reflection and emission nebula. Four stars in the cluster form a quadrangle (with sides of about 10″–20″) called the "Trapezium" and are all part of the multiple star system θ^1 Orionis. Professional telescopic studies indicate θ^1 Orionis contains at least 14 stars, only six of which can be seen, including the four in the Trapezium, under good seeing conditions in moderate amateur telescopes. θ^1 Orionis is in fact a wide double star with θ^2 Orionis (itself a triple star, so that θ Orionis consists of at least 17 stars!). The brightest (most southern) star in the Trapezium quadrangle (θ^1 Orionis C) is largely responsible for the ionization of the nebula. M42 is actually only a small "blister" on the near side of a much larger cloud of gas and dust (the Orion A complex) which has a mass of about 100,000 Suns. The Orion A complex is itself part of an even larger group of giant molecular gas clouds (the Orion-Monoceros complex) that extend 30° in a SE-NW direction and sit about 5 hundred light years below the Galactic central plane. Formation of the Orion-Monoceros complex may have been triggered by a giant bubble blown out of the Galactic plane by the open cluster Collinder 121. The 1° apparent dimension of M42 corresponds to a diameter of a little more than 20 light years.

NGC 1980

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Emission nebula + open cluster	05 h 35.4 m, −05° 55′	December 24
Distance	**Age**	**Apparent size**	**Magnitude**
1,000 light years	4–5 million years	14′	2.5

This cluster is a little older than the Orion Nebula Cluster (see M42/NGC 1976) and contains about 2,000 stars. It sits in front and on the southern edge of M42 (the Orion Nebula) and has Iota Orionis (44 Orionis, mag 2.8) embedded within it. Iota Orionis is actually a spectroscopic binary that when paired with the mag. 7.7 star 11″ to the SE makes up a triple-star system. It is speculated that the two stars making up Iota Orionis may each have been paired with a different star previously, but a close encounter approximately 2.5 million years ago resulted in the previous partner stars being flung away, leaving Iota in its current spectroscopic binary state. The two run-away stars that are thought to once have been paired with one of each star in Iota Orionis are AE Aurigae and μ Columbae.

NGC 1982 (M43)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Emission nebula	05 h 35.5 m, −05° 16′	December 24
Distance	**Age**	**Apparent size**	**Magnitude**
1,400 light years		20′	9.0

This is part of the same gas and dust cloud as M42 (the Orion A complex), lying just NE of M42, separated from M42 by a wall of dust between the two. M43 has relatively little dust, so its light is largely from gas emission (it is an ionized hydrogen, i.e., HII, region). The nebula is visible because it is ionized by the bright variable star NU Orionis (i.e. HD 37061, mag. 6.9) in its center. Professional telescopic studies find planet-forming ("protoplanetary") disks are present around several stars in M43 (as well as in M42), some of which contain water ice.

NGC 1999

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Emission and reflection nebula	05 h 36.4 m, –06° 43′	December 25
Distance	**Age**	**Apparent size**	**Magnitude**
1,400 light years		2′	

The nebula is illuminated by the star V380 (mag. 10.3), which is the only bright star near the center of the nebula. A small dark patch, 20″–30″ in diameter, that is visible in moderately large amateur telescopes in this nebula's central region is thought to be a cavity in the nebula carved out by jets emanating from the star V380. The cavity has a diameter of about 10 thousand times the Earth-Sun distance, i.e., 10,000 AU. Professional telescopes find two Herbig-Haro objects nearby (HH 1, 3′ SW and HH 2 lying 6′ S). Herbig-Haro objects are thought to arise when surrounding gas and dust spiral into a young star. A portion of this accreting material is flung out perpendicular to the accretion disk in two opposing jets moving at a few hundred kilometers per hour. As the jets slam into the surrounding gas, shock waves arise that heat this gas into emission. The appearance of the resulting glowing jet in professional telescopic images has been likened to that of a flame-thrower.

NGC 2022

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Planetary nebula	05 h 42.1 m, +09° 05′	December 26
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years		28′′	11.6

This is a prolate spheroid in shape (an extreme example of a prolate spheroid is a cigar), with a major to minor axis ratio of 1.2. Professional telescopes show a second, fainter, outer spherical shell expanding more slowly than the inner one seen in amateur telescopes and extending out to a diameter of 39″, giving NGC 2022 a total diameter of about 1 light year. Its progenitor star is thought to have had a relatively low mass of less than 3 suns, concomitant with its relatively large distance off the Galactic plane.

NGC 2024

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Emission nebula	05 h 41.7 m, −01° 51′	December 26
Distance	**Age**	**Apparent size**	**Magnitude**
1,400 light years		30′	

Nicknamed the "Flame Nebula," this is a star-forming region. Professional telescopes show an embedded young open cluster, with one member of this cluster responsible for ionizing the nebula. The cluster is about a million years old, with 85 % of its members still retaining remnants of their circumstellar disks. The visible nebula is thought to be a small ionized hydrogen (HII) blister on the front of the giant Orion B molecular cloud (see M78/NGC 2068) that is itself part of the much larger Orion-Monoceros complex (see M42/NGC 1976). Cold molecular material lying just in front of this ionized hydrogen (HII) region creates the dark lanes that are apparent in this nebula, and which hide the embedded open cluster from the view of amateur telescopes.

NGC 2068 (M78)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Reflection nebula	05 h 46.8 m, +00° 05′	November 11
Distance	**Age**	**Apparent size**	**Magnitude**
1,400 light years		8′	8

M78 is a star-forming region. Its size of 8′ corresponds to a diameter of a few light years. It is illuminated by the triple star labeled HD 38563. M78 is part of the giant molecular cloud Orion B, also known as LDN (Lynds Dark Nebula) 1630, that has a size of about 8° in professional telescopic studies (and also includes the fellow star-forming regions NGC 2071, NGC 2023 and NGC 2024) and is part of the much larger Orion-Monoceros complex (see M42).

NGC 2070

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Columba	Emission nebula and open cluster	05 h 38.7 m, −69° 06′	December 24
Distance	**Age**	**Apparent size**	**Magnitude**
170,000 light years		30′ × 20′	8

This massive star-forming ionized hydrogen (HII) region lies within the Large Magellanic Cluster. It is also called the Tarantula Nebula or 30 Doradus. The moniker NGC 2070 is often applied only to the 3′ diameter stellar cluster (containing about 2,400 OB stars) in the heart of this region. At the very heart of the nebula lies the 10″ diameter cluster Radcliffe 136 (R136), the densest known concentration of very massive stars, containing about 40 stars of spectral type O3 that are only a few million years old, some of which may have masses in excess of 150 suns and are the most luminous stars known in our galaxy. The Tarantula Nebula is the most luminous star-forming region in our Local Group of galaxies. It has a highly complex structure, containing giant glowing arcs and shells that are ionized by its central star cluster. The nebula's overall morphology is thought to be that of a hemispherical bowl that we are looking directly into. The intense concentration of gas and dust in the nebula may have arisen when a gas cloud arrived there a couple hundred million years ago after the near collision of the two Magellanic Clouds. Star formation has occurred at somewhat different times in different regions of this nebula, leading to differing ages of its stars, resulting in the birth of very young stars in some regions (e.g., R136) while older stars die in other regions: Supernova 1987a is one such expired star on the outskirts of this nebula.

NGC 2099 (M37)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Auriga	Open cluster	05 h 52.3 m, +32° 33′	December 29
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	400–500 million years	15′	5.6

It has a diameter of about 20 light years. It lies close to M38 and M36 (see M36/NGC 1960). This is a rich cluster, with nearly 5,000 stars considered to be members in professional telescopic studies. No planets have yet been detected among its member stars, despite observations of nearly a third of its stars.

NGC 2126

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Auriga	Open cluster	06 h 02.5 m, +49° 52′	December 31
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	1 billion years	6′	10.2
This lies relatively far above the galactic plane for an open cluster (1,000 light years) at a distance of about 31,000 light years from the galactic center. It has a diameter of nearly 10 light years.			

NGC 2129

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Gemini	Open cluster	06 h 01.1 m, +23° 19′	December 31
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	10 million years	5′	6.7
This cluster lies about 800 light years below the galactic plane and about 35,000 light years from the galactic center. It has a diameter of about 10 light years. It has been suggested that it consists of two overlapping clusters.			

NGC 2158

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Gemini	Open cluster	06 h 07.4 m, +24° 06′	January 1
Distance	**Age**	**Apparent size**	**Magnitude**
13,000 light years	2 billion years	5′	8.6
This is a populous cluster which may have started with a mass of perhaps 15,000 suns, but now contains perhaps 80 % of this initial mass due to supernovae and tidal losses. It lies almost directly in the galactic anti-center direction (i.e. directly outward from us in the opposite direction from the center of the galaxy). It lies over 40,000 light years from the center of the galaxy, but only 500 light years above the central plane of our galaxy. It has a diameter of about 20 light years. M35 (NGC 2168) lies only 24′ NE, but is not near NGC 2158 in space (the two lie roughly 10,000 light years apart).			

NGC 2168 (M35)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Gemini	Open cluster	06 h 09.0 m, +24° 21′	January 2
Distance	**Age**	**Apparent size**	**Magnitude**
2,000–3,000 light years	100–200 million years	25′	5.1
It lies almost directly in the galactic anticenter direction (i.e., directly outward from us in the opposite direction from the center of the galaxy), about 100 light years above the galactic central plane. The open cluster NGC 2158 (see NGC 2158) lies only 24′ SW, but is not near M35 in space (NGC 2158 is roughly 10,000 light years farther away). The total mass of M35 is several thousand suns.			

NGC 2169

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Open cluster	06 h 08.4 m, +13° 58′	January 2
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	10 million years	6′	5.9
It has a mass of a few hundred suns. It contains the mag. 10.8 star GSC 00742-02169 near the center of the cluster (see Fig. 3.2). Professional telescopic studies show that this star is a variable, chemically peculiar "Ap" star (sometimes instead designated "CP2"), the variations (of <0.1 magnitude) being caused by misalignment between the magnetic field poles and the rotation axis (making this a so-called "oblique rotator"), which is a common phenomenon with Ap stars. Ap stars have abnormally strong absorption in certain spectral lines (in this case due to the presence of silicon). A more easily seen Ap star of this type is θ Aurigae (mag. 2.6), which is 23° N of this cluster.			

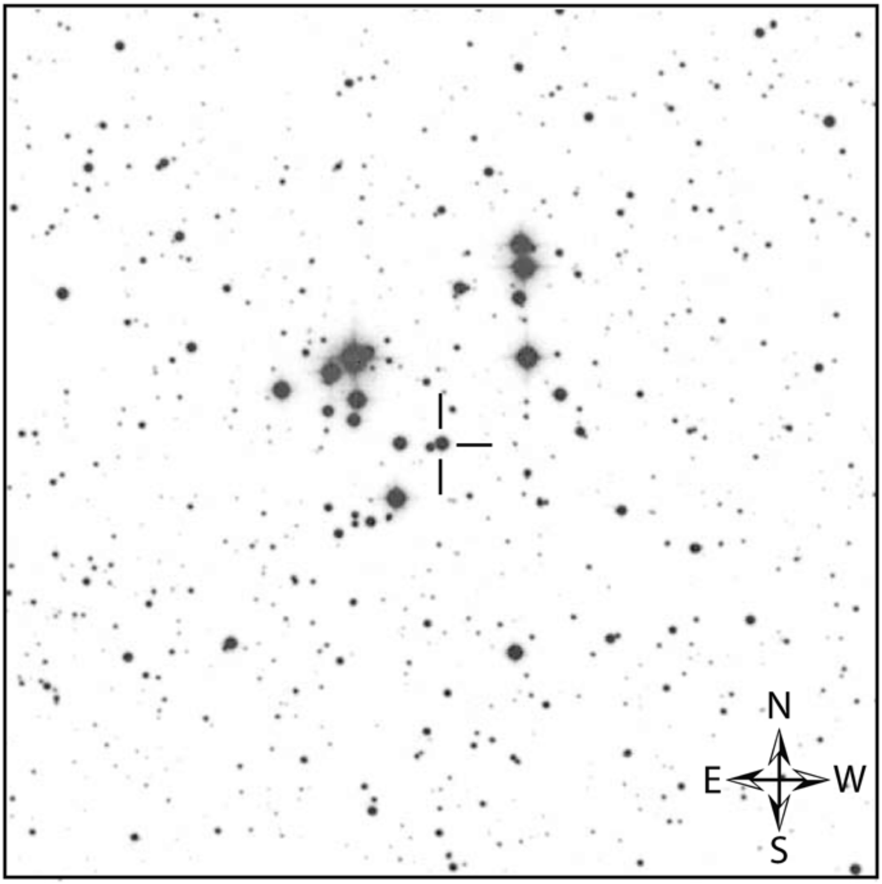

Fig. 3.2 The *cross-hairs* indicate the chemically peculiar (Ap or CP2) star GSC 00742-02169 in the open cluster NGC 2169. The area shown is 15′×15′. (From the Digitized Sky Survey, Space Telescope Science Institute, based on photographic data of the National Geographic Society, Palomar Observatory Sky Survey, POSS I.)

NGC 2185

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Reflection nebula	06 h 11.0 m, −06° 14′	January 2
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years		1′	
Three faint reflection nebulae are lined up nearby in a westerly direction: NGC 2183 (4.5′ W), the brighter NGC 2182 (25′ W), and NGC 2170 (55′ W), which along with NGC 2185, all belong to the so-called Mon R2 association. This is a collection of reflection nebulae and B stars that are all within a few hundred light years of each other and are thought to be midway in the evolution process between a cold dust/gas cloud and an emission nebula/O star-forming region like the Orion Nebula (M42).			

NGC 2186

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Open cluster	06 h 12.1 m, +05° 28′	January 3
Distance	**Age**	**Apparent size**	**Magnitude**
9,000 light years	200 million years	4′	8.7
This has a diameter of roughly 10 light years. It lies almost 1,000 light years below the galactic central plane and was discovered in 1786 by William Herschel.			

NGC 2194

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Orion	Open cluster	06 h 13.8 m, +12° 48′	January 3
Distance	**Age**	**Apparent size**	**Magnitude**
6,000–12,000 light years	400–900 million years	9′	8.5
This cluster has not received much attention from researchers. It has a diameter of about 15–30 light years and was discovered by William Herschel in 1784.			

NGC 2204

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canis Major	Open cluster	06 h 15.5 m, −18° 40′	January 3
Distance	**Age**	**Apparent size**	**Magnitude**
9,000–13,000 light years	1–2 billion years	10′	8.6
This is one of the furthest open clusters from the galactic central plane (lying 3,000–4,000 light years below it). It is roughly 30 light years in diameter. NGC 2211 (barred lenticular galaxy, 1.4′×0.7′, mag. 12.7) lies 39′ E, and forms a galaxy pair with the faint galaxy NGC 2212 (barred lenticular galaxy, 1.5′×0.8′, mag. 13.4, 2′ NE of NGC 2211). At 90 million light years distance, these two galaxies lie approximately 10,000 times farther away from us than NGC 2204.			

NGC 2215

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster	06 h 20.8 m, −07° 17′	January 5
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	200 million years	8′	8.4
This has a diameter of about 10 light years and was discovered in 1785 by William Herschel.			

NGC 2232

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster	06 h 28.0 m, −04°51′	January 6
Distance	**Age**	**Apparent size**	**Magnitude**
1,000 light years	25 million years	45′	4.2

This is one of the nearest open clusters to us (only about ten of the 1,500 or so open clusters in our galaxy are closer). It has a diameter of about 30 light years and a mass less than a hundred suns. It belongs to the Gould Belt, a grouping of young (<30 million year old) OB star associations surrounded by a ring of gas and dust with a diameter of about 2,000 light years and thickness of about 60 light years. The center of the Gould Belt is thought to lie only a few hundred light years from us, and its torus/ring/belt shape lies in a plane that is inclined by 17° to the galactic plane.

NGC 2244

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster + emission nebula	06 h 31.9 m, +04° 57′	January 7
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	2 million years	24′	4.8

Part of the giant molecular gas cloud from which this young cluster formed within is visible as the surrounding emission nebula, called the "Rosette Nebula," which extends out to a diameter of 60′–80′. The nebula is thought to be roughly a spherical shell with a diameter of several hundred light years, with the "donut hole" shape we see actually being a hole in the near side of this shell. Bits and pieces of the Rosette Nebula complex have variously been given individual NGC numbers and include NGC 2237, 2238, 2239, 2244 and 2246. Besides the open cluster NGC 2244, which contains a few thousand stars in professional telescopic studies and is thought to be destined to dissolve in a few tens of millions of years, there are several smaller very young open clusters embedded in the complex that each contain several hundred stars. The Rosette Nebula complex with associated giant molecular cloud has a mass of several hundred thousand Suns. The Rosette Nebula complex is part of the much larger Northern Monoceros Region, a structure that extends out nearly 8° N of the Rosette Nebula and also includes NGC 2264, NGC 2252, and the Mon OB2 Cloud.

NGC 2251

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster	06 h 34.6 m, +08° 22′	January 8
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	300 million years	10′	7.3
This lies very close to the galactic central plane (less than 10 light years above it). It has a diameter of about 12 light years.			

NGC 2261

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Reflection nebula	06 h 39.2 m, +08° 45′	January 9
Distance	**Age**	**Apparent size**	**Magnitude**
2,500 light years		3′ × 1′	
Nicknamed "Hubble's Variable Nebula," this fan-shaped reflection nebula is illuminated by the variable star R Mon (which lies at the south end of the nebula but is obscured at optical wavelengths by the nebula itself). R Mon is a Herbig Be star (see M47/NGC 2422 for explanation of Be stars) that has not yet reached the main sequence. Professional telescopes find it is a binary star (with separation 0.7″). The nebula that R Mon is lighting up is thought to consist of a bipolar shell, with the southern half not visible in amateur telescopes. The northern half of the shell that we see as NGC 2261 resembles a parabola that has been rotated about a nearly north–south line. In other words, it is like a wine-glass without its stem, with R Mon at the bottom of the wine-glass. The parabolic shell is thought to be thin (0.01 light years thick, which is 800 times the Earth-Sun distance) and nearly edge-on with its symmetry axis inclined from our line-of-sight by about 70°. In other words, we are looking at its wine-glass shape nearly side-on with its bottom on the south end. The parabolic shell may be the result of material being ejected from an accretion disk that surrounds R Mon. Filaments of this material are thought to cast shadows on the walls of the shell, resulting in the variable appearance of the nebula that gives it its nickname. R Mon and the nebula it has created are thought to be only a few hundred thousand years old.			

NGC 2264

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster + emission nebula	06 h 41.0 m, +09° 54	January 10
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	3 million years	40′	4.1

Nicknamed the "Christmas Tree Cluster" due to its apparent shape when viewed with south at the top of the eyepiece, this is a star-forming region containing perhaps a couple thousand stars, most of which are obscured from optical view by the cloud from which they have formed. Indeed, although the nebulosity in which the cluster is embedded is largely ionized hydrogen, directly behind this (and not optically visible) is a cloud of molecules (including ammonia, carbon monoxide, formaldehyde) having a mass of 10,000 suns. This cluster is so young that almost half of its stars still have circumstellar disks (see NGC 2362). At the south end of the cluster (i.e., just south of the tip of the Christmas tree) is the "Cone Nebula." This is a cone-shaped dark molecular cloud (5′ × 10′) and a challenging object in large amateur telescopes. It may be the remains of what was once a larger cloud that has been disintegrated by nearby star-forming activity, similar to the "Pillars of Creation" region in M16 (see M16/NGC 6611). The cone-shape appears to have been protected from stellar winds by a dense globule at the tip of the cone.

NGC 2266

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Gemini	Open cluster	06 h 43.3 m, +26° 58′	January 10
Distance	**Age**	**Apparent size**	**Magnitude**
9,000–11,000 light years	0.7–1 billion years	12′	9.5

This sits far from the galactic central plane for its age. (It lies 2,000 light years above this plane, while other clusters this far off the disk are typically older.) It has a diameter of about 10–20 light years.

NGC 2281

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Auriga	Open cluster	06 h 48.3 m, +41° 05′	January 12
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years	400 million years	25′	5.4
About 100 member stars have been identified to date in professional telescopic studies. It has a diameter of about 15 light years.			

NGC 2286

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster	06 h 47.7 m, −03° 09′	January 12
Distance	**Age**	**Apparent size**	**Magnitude**
9,000 light years	200 million years	15′	7.5
This has a mass of about 150 suns and a diameter of about 40 light years. It was discovered by William Herschel in 1785.			

NGC 2287 (M41)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canis Major	Open cluster	06 h 46.0 m, −20° 46′	January 11
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years	200–300 million years	39′	4.5
This has a diameter of about 20 light years. A large percentage (perhaps as high as 80 %) of its stars are binary stars. Open clusters are beasts of the galactic disk, and are stripped of their stars over time by gravitational interaction with material in the disk as they jostle about the disk while rotating with it. For an open cluster in our vicinity of the galaxy, like this one, typical lifetimes are thought to be a little over half a billion years, so that this cluster is approaching middle age. The cluster has about 70 members with magnitude brighter than 12, although our view of the cluster to this magnitude is "contaminated" by about as many field stars as cluster members (see M39).			

NGC 2301

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster	06 h 51.8 m, +00° 28′	January 13
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	200 million years	12′	6.0

This cluster region has many field stars (i.e., background and foreground stars that are not members of the cluster but which happen to lie along the same line-of-sight as the cluster – see M39/NGC 7092 for further discussion of this). Indeed, of 900 stars studied in professional telescopic studies to mag. 17 within the cluster region, only about 100 are considered members. The cluster is about 10 light years in diameter.

NGC 2304

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Gemini	Open cluster	06 h 55.2 m, +17° 59′	January 13
Distance	**Age**	**Apparent size**	**Magnitude**
13,000 light years	800 million years	10′	10.0

This has a diameter of about 40 light years and was discovered by William Herschel in 1783. It is located in the direction of the galactic anti-center. The region between us and this cluster has low levels of interstellar light extinction, since intervening dust dims the stars in this cluster by only 0.08 magnitudes per kiloparsec (3,260 light years). This is much less than the average two magnitudes of dimming for every kiloparsec that is typical when light travels in the central plane of our galaxy.

NGC 2311

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster	06 h 57.8 m, −04° 37′	January 14
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	100 million years	6′	9.6
Of 945 stars observed to mag. 21 in this cluster by professional telescopes, only about 50 are thought to be members. It has a diameter of about 16 light years and was discovered by William Herschel in 1786.			

NGC 2323 (M50)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster	07 h 02.7 m, −08° 23′	January 15
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	130 million years	15′	5.9
This contains about 2,000 stars brighter than mag. 23, which is about half the number of stars in this region (the other half are field stars). Its apparent diameter corresponds to about 14 light years. The interstellar gas and dust in the disk of our galaxy is not uniformly distributed at light year length scales, but instead is clumped into patches with typical masses of a few hundred suns. Open clusters are thought to form from such interstellar clouds of gas and dust.			

NGC 2324

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster	07 h 04.1 m, +01° 03′	January 16
Distance	**Age**	**Apparent size**	**Magnitude**
13,000 light years	600 million years	8′	8.4
This has a diameter of about 30 light years. It is thought to follow a relatively eccentric orbit for an open cluster, moving out as far as 37,000 light years and coming in as close as 24,000 light years to the galactic center.			

NGC 2335

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster	07 h 06.8 m, −10° 02′	January 16
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	200 million years	7′	7.2
This has a diameter of about 6 light years and a mass of about 700 suns. The emission + reflection nebula Gum 1 (20′ in diameter) lies 38′ E and 26′ S.			

NGC 2343

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster	07 h 08.1 m, −10° 37′	January 17
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	100 million years	6′	6.7
This has a diameter of about 5 light years. The faint emission nebula IC 2177 (120′ × 40′) is centered 45′ to the east.			

NGC 2353

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster	07 h 14.5 m, −10° 16′	January 18
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	100 million years	18′	7.1
This has a diameter of about 20 light years and reveals over 200 stars to mag. 21 in professional telescopic studies. It lies only 20 or so light years above the galactic central plane at a distance of about 30,000 light years from the center of our galaxy. The brightest star in the field (HD 55879, mag. 6.0) is not thought to be a member of this cluster but is instead a much younger star that is probably part of a group of young O and B stars called the Canis Major OBI stellar association that is spread out over a 4° × 4° area centered near this location.			

NGC 2354

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canis Major	Open cluster	07 h 14.2 m, −25° 41′	January 18
Distance	**Age**	**Apparent size**	**Magnitude**
13,000 light years	100 million years	18′	6.5
With a diameter of about 70 light years, this has a relatively eccentric orbit for an open cluster, traveling in as close as about 22,000 light years and as far out as 41,000 light years from the galactic center in its orbit. A magnitude 11.8 eclipsing binary variable star (QU CMa, or GSC 06528–01240) in the SW part of this cluster (see Fig. 3.3) is also a blue straggler (see NGC 6633 for the meaning of "blue straggler"), making it a binary blue straggler. Its "blueness" may be due to mass exchange between stars in this close binary pair, with mass accreting from the small, red, dim secondary star onto the brighter (blue straggler) primary star.			

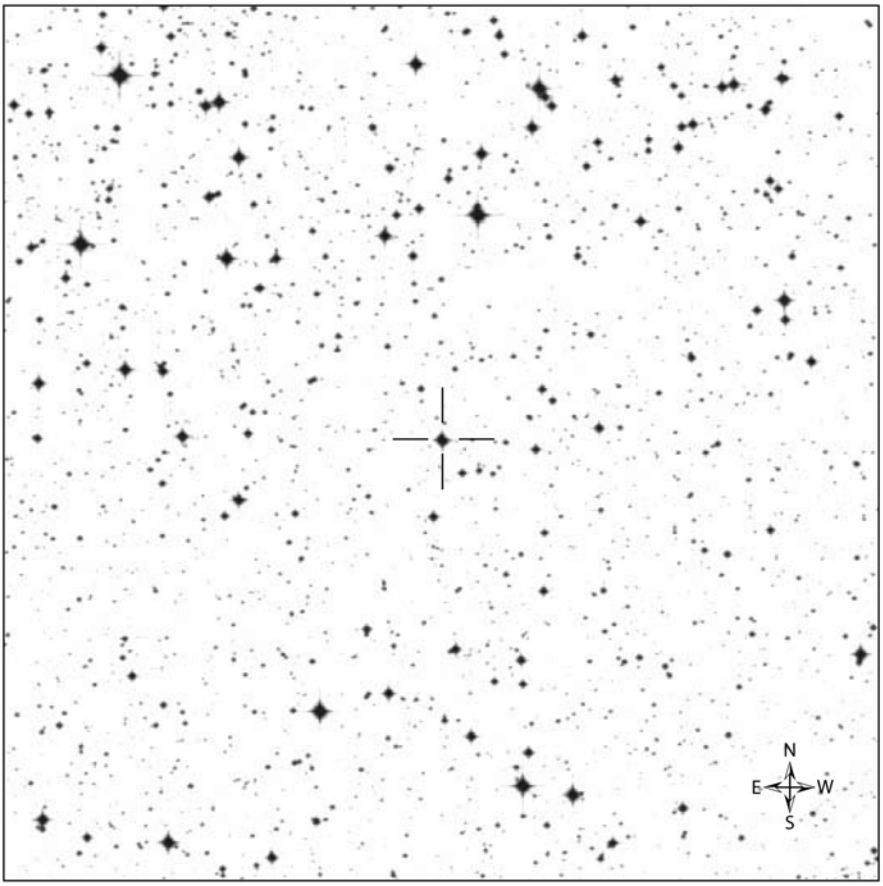

Fig. 3.3 The SW portion of the open cluster NGC 2354 is shown with the blue straggler QU CMa marked by *crosshairs*. The area shown is 15′ × 15′. (From the Digitized Sky Survey, Space Telescope Science Institute, based on photographic data of the National Geographic Society, Palomar Observatory Sky Survey, POSS I.)

NGC 2355

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Gemini	Open cluster	07 h 17.0 m, +13° 45′	January 19
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	700 million years	9′	9.7

As with all relatively old open clusters, NGC 2355 stays fairly far out in the galaxy, never approaching closer than about 26,000 light years to the galactic center. Its secret to long life is its avoidance of other galactic matter that is more concentrated at locations both closer in to the galactic center and in the galactic disk. Indeed, in its approximately three or so revolutions around the galaxy in its lifetime, it has spent less than 10 % or so of its time in the thin layer of the galactic disk (150 light years in thickness) where encounters with large molecular clouds could begin to disrupt it, having crossed this disk perhaps more than a dozen times. In its present location it sits 1,500 light years above the galactic disk, which is near its maximum distance above the galactic disk of 1,900 light years, and so it is about to reverse direction to head below the galactic disk.

NGC 2359

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canis Major	Emission nebula	07 h 18.5 m, −13° 14′	January 19
Distance	**Age**	**Apparent size**	**Magnitude**
16,000 light years		9′×6′	

The appearance of this galaxy has resulted in the nickname “Thor’s Helmet” or the “Duck Nebula.” It is an ionized hydrogen (HII) region surrounding a WN Wolf-Rayet star (designated HD 56925 or HIP 35378 and lying at mag. 11.4 near the middle of the northern ring-like segment of the nebula – see Fig. 3.4; see NGC 2403 for more on Wolf-Rayet stars). The visible nebula is part of a larger neutral gas cloud, the HII region fluorescing due to ionizing radiation from the Wolf-Rayet star. The stellar wind from this star has blown out a “bubble” in the HII region that gives a 4.5′ ring-like appearance to the northern segment in professional telescopic studies. The ionized (visible) nebula is thought to have a mass of a few hundred suns, with several times this amount of mass contained in the adjacent (nonvisible) neutral gas clouds (with most of the neutral gas lying at the south end of the nebula, south of the duck’s “bill”).

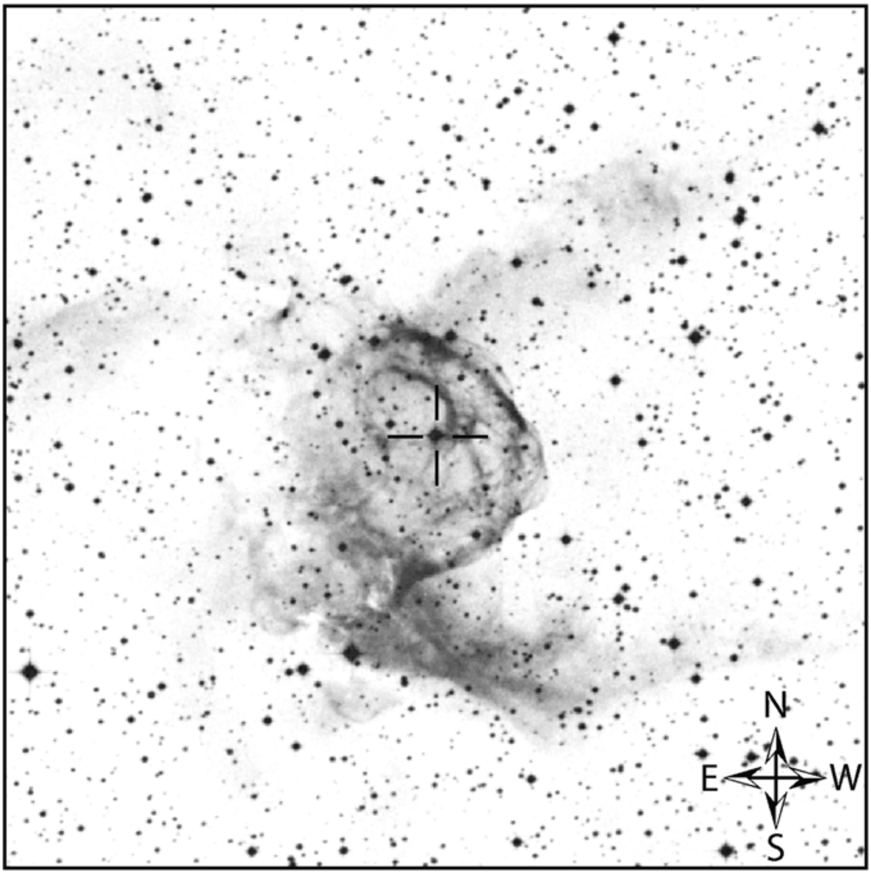

Fig. 3.4 The emission nebula NGC 2359 is shown with the ionizing Wolf-Rayet star marked by *crosshairs*. The area shown is $15' \times 15'$. (From the Digitized Sky Survey, Space Telescope Science Institute, based on photographic data of the National Geographic Society, Palomar Observatory Sky Survey, POSS I.)

NGC 2360

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canis Major	Open cluster	07 h 17.7 m, −15° 38′	January 19
Distance	**Age**	**Apparent size**	**Magnitude**
3,000–6,000 light years	0.6–1.8 billion years	14′	7.2

Professional telescopes indicate this contains about 5,000 stars and has a mass of about 1,800 suns. This is an unusually large number of stars for such an old cluster, but is partly explained by the relative lack of giant molecular clouds in this region of the galaxy that would otherwise have sped the dissolution of this cluster. It has a diameter of about 20 light years and was discovered in 1783 by Caroline Herschel (William Herschel's sister).

NGC 2362

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canis Major	Open cluster	07 h 18.7 m, −24° 57′	January 19
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	5 million years	6′	3.8

With a mass of more than 500 suns, about 17 % of the stars in this young cluster still have primordial circumstellar disks around them that formed as these stars collapsed from the surrounding gas and dust. Since this cluster is approximately 5 million years old and started with a much higher fraction of stars with disks, it is thus thought that planets must form within about 5 million years of the parent star's formation, since planets form from circumstellar disks and make these disks disappear. The brightest star in this cluster (τ CMa, mag. 4.4) is actually a quadruple-star system in professional telescopes, with three of the stars in this system having masses around 50 times that of our Sun and radii nearly ten times that of our Sun. This quadruple system is thought to have perhaps formed when two binary systems merged.

NGC 2371

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Gemini	Planetary nebula	07 h 25.6 m, +29° 29′	January 21
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	13,000 years	1′	11.2

This has a diameter of about 1 light year. The central star (mag. 14.8) is a Wolf-Rayet star (see NGC 40 for explanation) with a temperature of about 135,000 K and a mass of about 0.6 suns. Before expelling its planetary nebula, this star is thought to have had a mass of 2 suns. The central star is visible in large amateur telescopes. The two segments of this elliptical shell nebula are separated by a dark lane and so have been given individual NGC numbers (NGC 2371 and 2372) but are parts of the same planetary nebula (see NGC 2372). Professional telescopes reveal filaments throughout the nebula, as well as two ansae located symmetrically NW and SE of the central star at a radius of 66″ that are the result of earlier mass outflow.

NGC 2372

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Gemini	Planetary nebula	07 h 25.6 m, +29° 29′	January 21
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years		1′	11.2

This has a diameter of about 1 light year. It is the other, dimmer (NE) half of the same planetary nebula of which NGC 2371 is the SW half (see NGC 2371).

NGC 2392

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Gemini	Planetary nebula	07 h 29.2 m, +20° 55′	January 22
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	9,000 years	1′	9.1

Nicknamed the "Clown Face Nebula" or the "Eskimo Nebula," professional telescopic studies suggest that this nebula consists of a 16″ diameter bright, inner, prolate spheroid (i.e., cigar or peanut shape – see NGC 2022) viewed nearly pole-on and expanding at high speed (120 km/s) along its length. This is surrounded by an outer shell that is thought to be an oblate spheroid (like a squashed tennis ball) expanding at <20 km/s. Thus, this nebula consists of a peanut-shaped region exploding into an outer spherical region. The outer shell is thought to contain three separate patches, or caps, that make up much of the "fur" of the "hood." Bipolar jets are thought to extend through the outer shell from near the ends of the inner peanut-shaped region. A fringe of filaments and knots (which add to the "hood" part of the nebula) outside the inner shell are thought to lie in a roughly planar disk region. It is believed that in less than a few thousand years or so the inner shell will have completely expanded through the surrounding outer shell. The central star (mag. 10.5), which shed the complex mess of gas making up the nebula, is visible in amateur telescopes.

NGC 2395

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Gemini	Open cluster	07 h 27.2 m, +13° 37′	January 22
Distance	**Age**	**Apparent size**	**Magnitude**
1,000–2,000 light years	1 billion years	15′	8.0

This has an apparent diameter less than 10 light years. Of 163 stars brighter than mag. 15.75 in professional telescopes in a 25′ diameter region, only 20 are thought to possibly be cluster members so that this is a fairly dissolved cluster, if it is indeed a real cluster.

NGC 2403

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Camelopardalis	Barred spiral galaxy	07 h 36.8 m, +65° 36′	January 24
Distance	**Age**	**Apparent size**	**Magnitude**
10 million light years		23.4′ × 11.8′	8.2

This has an optical diameter of about 70,000 light years and is accompanied by five orbiting dwarf galaxies. It is thought to be part of the M81 group of gravitationally bound galaxies, which includes galaxies in a region with a radius of about 5 million light years (see M81/NGC 3031). The galaxy rotates (at speeds up to 170 km/s at a distance of 10″ from its center) about an axis that is inclined from our line-of-sight at about 60°. It has a morphology similar to M33 (see M33/NGC 598). It contains several compact star-forming regions that are bright ionized hydrogen emission (HII) regions. The brightest of these is 2′ E of the center of this galaxy and has its own NGC number (NGC 2404 – see Fig. 3.5); this HII region is 2 thousand light years in diameter and contains 30–40 Wolf-Rayet stars (both WN and WC types). These “Population I” Wolf-Rayet stars in NGC 2403 are far more massive (with masses several tens of times that of our Sun) than the Wolf-Rayet stars that occur in planetary nebulae like NGC 40 (which have a mass less than our Sun). Population I Wolf-Rayets are one of the evolutionary stages undergone by massive stars (which live only a few million years before blowing up in supernovae, so that this HII region must be only a few million years old).

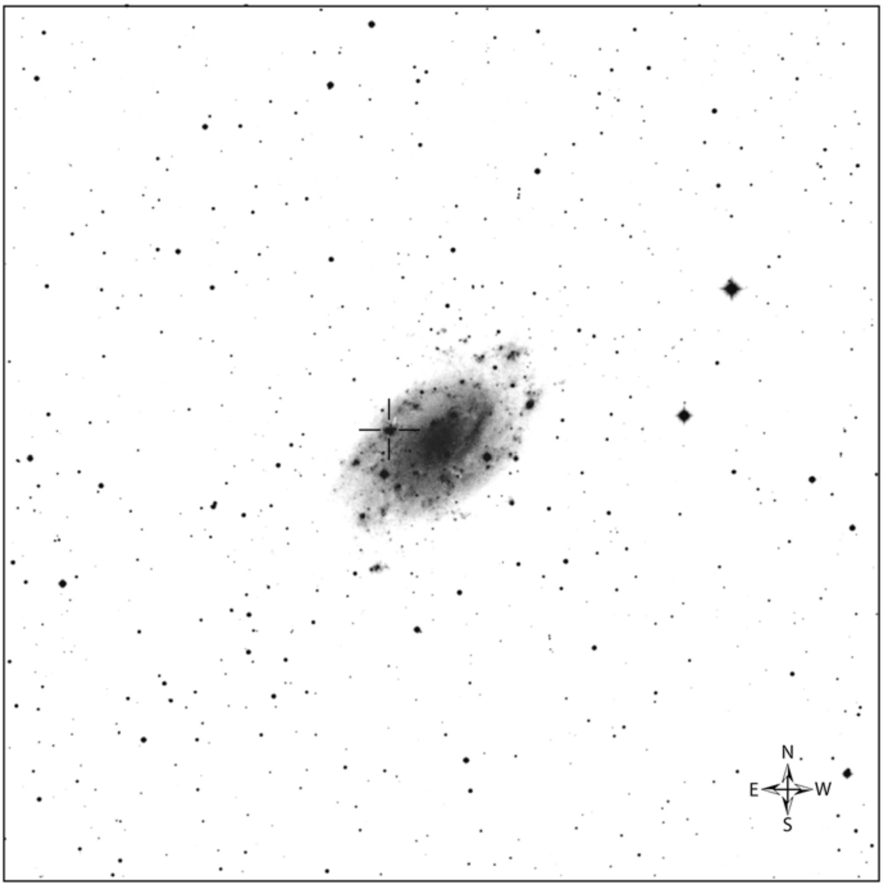

Fig. 3.5 The *cross-hairs* mark the brightest HII region (NGC 2404) in the galaxy NGC 2403. The area shown is 30′ × 30′. (From the Digitized Sky Survey, Space Telescope Science Institute, based on photographic data of the National Geographic Society, Palomar Observatory Sky Survey, POSS I.)

NGC 2419

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Lynx	Globular cluster	07 h 38.1 m, +38° 53′	January 24
Distance	**Age**	**Apparent size**	**Magnitude**
300,000 light years	10–14 billion years	4.6′	10.3

Once thought to be an intergalactic cluster (thus its nickname "The Intergalactic Wanderer"), this is now recognized as being gravitationally bound to our galaxy, although it lies far out in the halo of our galaxy (see NGC 7006 for explanation of "halo"). Its stars contain unique subpopulations having different, and unusual, chemical compositions, suggesting more than one star forming episode. This may be because this object is the remains of the core of a previously accreted dwarf spheroidal galaxy, but this remains uncertain. NGC 2419 is one of the five most luminous globular clusters in our galaxy. It has a mass of approximately a million suns.

NGC 2420

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Gemini	Open cluster	07 h 38.4 m, +21° 34′	January 24
Distance	**Age**	**Apparent size**	**Magnitude**
8,000 light years	1–2 billion years	6′	8.3

This contains about 700 member stars brighter than mag. 20. It has an apparent diameter of about 14 light years. This cluster orbits the galactic center at a radial distance that varies from about 20,000–35,000 light years (it presently sits about 33,000 light years from the galactic center). Its orbit always stays within about 3,000 light years above and below the galactic central plane (it currently sits near its maximum distance above the galactic central plane). Like all older open clusters that spend their lives fairly far from the galactic center, it contains lower amounts of compounds heavier than helium (i.e., "metals"). In fact, the farther out an open cluster is from the galactic center, the less "metal" its stars usually contain. The metal abundance of NGC 2420 is about half that of our Sun.

NGC 2421

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	07 h 36.2 m, −20° 37′	January 24
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	80 million years	6′	8.3
This has a diameter of about 12 light years and was discovered in 1799 by William Herschel.			

NGC 2422 (M47)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	07 h 36.6 m, −14° 29′	January 24
Distance	**Age**	**Apparent size**	**Magnitude**
1,600 light years	100 million years	25′	4.4
This has a mass of a few hundred suns. Interstellar dust between us and the stars in this cluster cause its stars to appear dimmer by only a few tenths of a magnitude, which is much less than the average two magnitudes of dimming for every kiloparsec (3,260 light years) that is typical when light travels in the central plane of our galaxy. Several Be stars are known in this cluster, the brightest of which is HD 60856 at mag. 8 and is readily visible in amateur telescopes (see Fig. 3.6). Be stars are B-type stars that are peculiar because of hydrogen Balmer emission lines in their spectra, due to atomic transitions in material expelled by high rotational velocities into a circumstellar disk in the equatorial plane of the star.			

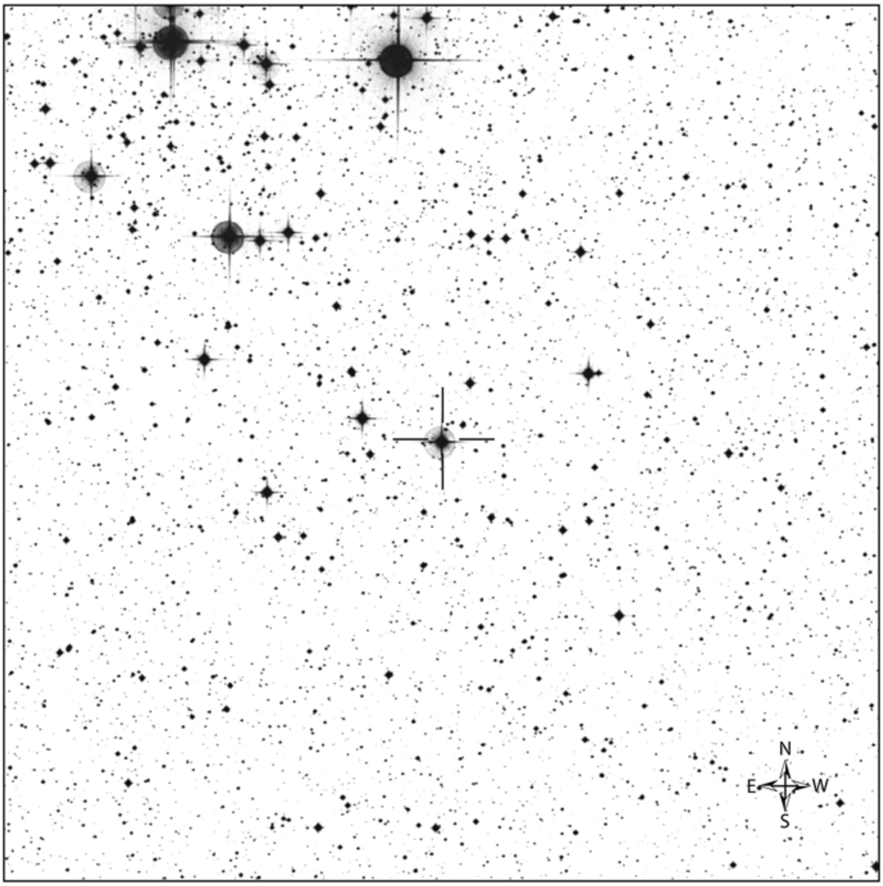

Fig. 3.6 The SW portion of the open cluster NGC 2422 (M47) is shown with the Be star HD 60856 in the *center* of the figure (marked by *crosshairs*, not diffraction spikes like the other stars not in the center of the figure). The area shown is 30′ × 30′. (From the Digitized Sky Survey, Space Telescope Science Institute, based on photographic data of the National Geographic Society, Palomar Observatory Sky Survey, POSS I.)

NGC 2423

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	07 h 37.1 m, −13° 52′	January 24
Distance	**Age**	**Apparent size**	**Magnitude**
2,500 light years	800 million years	12′	6.7
This cluster contains 71 members down to mag. 13 in professional photometric studies. M47 (NGC 2422) is 39′ S, but the two are about 1,000 light years apart. NGC 2423 is one of only a few open clusters containing a star that may harbor a planet/brown dwarf, possibly orbiting the mag. 10.0 star TYC 5409-2156-1 and having a minimum mass of 10.6 Jupiters.			

NGC 2437 (M46)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	07 h 41.8 m, −14° 49′	January 25
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	200 million years	20′	6.1
With a mass of approximately 1,000 suns, this lies about 400 light years above the galactic central plane at a distance of about 30,000 light years from the galactic center. Although NGC 2438 lies on the NE edge of the open cluster M46 (see M46/NGC 2437), their differing relative velocities and the young age of M46 together suggest that NGC 2438 is not part of M46, despite them lying at a similar distance.			

NGC 2438

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Planetary nebula	07 h 41.8 m, −14° 44′	January 25
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years		1.3′	10.8

The diameter of 1.3′ here implies an actual diameter of about 2 light years, but this nebula extends out several times this size in professional telescopic images in a spherical halo outside the inner spherical portion visible in amateur telescopes. The nebula is thought to have begun its formation about 45 thousand years ago, and so is considered an old planetary nebula. Although NGC 2438 lies on the NE edge of the open cluster M46 (see M46/NGC 2437), their differing relative velocities and the young age of M46 together suggest that NGC 2438 is not part of M46, despite them lying at a similar distance.

NGC 2440

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Planetary nebula	07 h 41.9 m, −18° 12′	January 25
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years		1.3′	9.4

Professional telescopic studies find that this planetary nebula consists of at least two interlocking bipolar structures (i.e., two "hourglass" structures joined at the "waist" of the hourglass), the main one with position angle of 35° and lined up at a 90° angle from our line-of-sight, the other with position angle of 85° and inclined at a 40° angle from our line-of-sight. A third bipolar structure may exist with a position angle of 60°. The two sets of bipolar lobes are thought to have been caused by two separate mass ejection events from the central star that ejected the lobes in different directions, perhaps because the circumstellar toroidal ring of material that leads to the formation of the jets was oriented in different directions (possibly due to precession of this ring). It is one of only seven known planetary nebulae with a double bipolar (i.e. quadrapolar) structure. The nebula is thought to be 10,000–20,000 years old. Its central star (B mag. 18.9) is a very hot (170,000–200,000 K) white dwarf.

NGC 2447 (M93)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	07 h 44.5 m, −23° 51′	January 26
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	400 million years	10′	6.2
This lies just above the galactic central plane (by a few light years) a couple thousand light years farther from the galactic center than we are. It has a diameter of about 10 light years and a mass of about 700 suns.			

NGC 2451

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	07 h 45.3 m −37° 58′	January 25
Distance	**Age**	**Apparent size**	**Magnitude**
	50 million years	50′	2.8
Interspersed among each other and the bright field stars (see M7) that form a pretty asterism in this region are two open clusters, NGC 2451A and NGC 2451B, that lie along the same line of sight but are at different distances. NGC 2451A is about 700 light years distant, while NGC 2451B is at about 1,200 light years. About 90 stars are counted in NGC 2451A in professional telescopic studies, while NGC 2451B has about twice this number of stars. Both are relatively young clusters. NGC 2451A is one of the ten nearest open clusters. Nearby NGC 2477 (see NGC 2477), 1.5° SE, is a much older open cluster (about a billion years old) and is farther away, at a distance of 4,000 light years.			

NGC 2477

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	07 h 52.2 m, −38° 32′	January 28
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	1 billion years	20′	5.8
This is an intermediate age open cluster. Its stars brighter than 17th magnitude have a total mass of more than 5,000 suns, making it one of the richest known open clusters. It has a diameter of about 20 light years.			

NGC 2479

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	07 h 55.1 m, −17° 42′	January 29
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	1 billion years	11′	9.6
This was discovered in 1790 by William Herschel. Of 2,490 stars observed in this region in professional telescopes down to mag. 21, 38 are thought to be cluster members.			

NGC 2482

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	07 h 55.2 m, −24° 16′	January 29
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	300–400 million years	10′	7.3
This has a diameter of about 13 light years. It lies less than a couple hundred light years above the galactic central plane at a distance of about 29,000 light years from the center of our galaxy. It has a mass of about 600 suns.			

NGC 2489

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	07 h 56.3 m, −30 ° 04′	January 29
Distance	**Age**	**Apparent size**	**Magnitude**
6,000 light years	500 million years	7′	7.9
The diameter here is about 11 light years. It was discovered in 1785 by William Herschel and lies less than 100 light years below the galactic plane.			

NGC 2506

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Monoceros	Open cluster	08 h 00.0 m, −10° 46′	January 30
Distance	**Age**	**Apparent size**	**Magnitude**
11,000 light years	2 billion years	12′	7.6
This contains about 1,100 stars as seen in professional telescopic studies. It has a diameter of about 40 light years. Its inner region contains mostly giants and more massive main sequence stars, while its outer regions are dominated by lower mass stars. This mass segregation is a natural consequence of kinetic energy tending to equalize among cluster members, resulting in massive stars having lower velocities and sinking to orbits that stay near the cluster center.			

NGC 2509

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	08 h 00.8 m, −19° 03′	January 30
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	1 billion years	12′	9.3
This was discovered in 1783 by William Herschel. Little research has been done on this cluster to date.			

NGC 2527

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	08 h 05.0 m, −28° 09′	January 31
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years	400–500 million years	10′	6.5

This has a diameter of about 6 light years and a mass of about 700 suns. It is a relatively loose cluster, with the stars spaced an average of a few light years apart, although this is still considerably denser than the average 10 light year interstellar spacing in the neighborhood of our Sun.

NGC 2516

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Carina	Open cluster	07 h 58.1 m, −60° 45′	January 28
Distance	**Age**	**Apparent size**	**Magnitude**
1,300 light years	150 million years	22′	3.8

This is a relatively rich cluster, with a mass well over 1,000 suns. It is referred to as the False Cross Cluster, the Southern Beehive Cluster and sometimes the Southern Pleiades, although the latter is more commonly applied to IC 2602. While it shares a similar age to the Pleiades (M45), it is about twice as massive. It contains the chemically peculiar star HD 65949 (mag. 8.4), which is thought to have the highest mercury abundance of any known star. It also contains the star HD 66318 (mag. 9.6), which has perhaps the highest known magnetic field of any non-degenerate star, with a field strength of 1.5 T. HD 66318 has a mass of 2.1 suns and is also chemically peculiar but fits into the Ap category (see NGC 2169), unlike HD 65949.

NGC 2539

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	08 h 10.6 m, −12° 49′	February 2
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	400 million years	15′	6.5
It has a mass of more than 400 suns. In professional telescopic studies, nearly 200 stars have been counted to date, which are spaced an average of several light years apart. This interstellar spacing is relatively large for an open cluster but still gives about 20 times as many stars per unit volume as in our galactic neighborhood. It has a diameter of about 20 light years.			

NGC 2548 (M48)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hydra	Open cluster	08 h 13.7 m, −05° 45′	February 2
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years	400 million years	1°	5.8
Of 750 stars brighter than mag. 15.0 in this region, about 300 stars are thought to be cluster members. It lies about 28,000 light years from the center of our galaxy and nearly 700 light years above the galactic central plane. Its current position is close to its maximum excursion of 800 light years from this plane, having crossed it perhaps ten times in its lifetime, while making a little less than two revolutions about the galactic center. It has a diameter of about 30 light years. Messier's discovery and subsequent listing of this object resulted in an error in its quoted position, so that its location in some old star charts (before T. F. Morris' correction of this error in 1959) is incorrect.			

NGC 2567

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	08 h 18.5 m, −30° 38′	February 4
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	300 million years	11′	7.4

This has a diameter of about 15 light years. The region between us and this cluster has low levels of interstellar light extinction, since the stars in this cluster are dimmed by only a few tenths of a magnitude by intervening dust. This is much less than the average two magnitudes of dimming for every kiloparsec (3,260 light years) that is typical when light travels in the central plane of our galaxy.

NGC 2571

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Puppis	Open cluster	08 h 18.9 m, −29° 45′	February 4
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	50 million years	12′	7.0

This has a diameter of about 15 light years. It lies about 28,000 light years from the center of our galaxy and 270 light years above the central galactic plane. The cluster does not have a high stellar density. Indeed, to magnitude 18 there are 34 stars per square arcminute in the inner 4′ of the cluster, which is only 17 % more dense than the background stellar density.

NGC 2613

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pyxis	Spiral galaxy	08 h 33.4 m, −22° 58′	February 7
Distance	**Age**	**Apparent size**	**Magnitude**
85 million light years		6.5′ × 1.4′	10.4

This rotates about an axis that is inclined at about 80° from our line-of-sight (with the south side closer to us). This is a massive galaxy, having a dynamical mass of 750 billion suns and an optical diameter of 160,000 light years. It is thought to harbor an active galactic nucleus (AGN, where high energy emission occurs from the nucleus). It has a small (5 billion solar mass) companion galaxy (ESO 495-G017, mag. 15, 7′ NW). Tidal interaction with this companion may explain the tail of neutral hydrogen (HI) extending off the southeastern side just in front of NGC 2613 in professional telescopes.

NGC 2627

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pyxis	Open cluster	08 h 37.2 m, −29° 57′	February 8
Distance	**Age**	**Apparent size**	**Magnitude**
6,000 light years	1–2 billion years	9′	8.4

This has a diameter of about 20 light years and was discovered in 1793 by William Herschel. It lies about 700 light years above the galactic plane and 30,000 light years from the center of the galaxy.

NGC 2632 (M44)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cancer	Open cluster	08 h 40.6 m, +19° 40′	February 9
Distance	**Age**	**Apparent size**	**Magnitude**
600 light years	600 million years	1.2°	3.1

This is nicknamed the "Beehive Cluster" or "Praesepe" (which means manger in Latin, its common-use anglicized pronunciation being pree-SEE-pee). It contains perhaps 1,100 members. In professional telescopes its tidal diameter is 7°. It is one of only a few open clusters thought to have stars harboring planets, in this case two Jupiter mass planets in low radius orbits ("hot Jupiters") having orbital periods of a few days. M44 and the Hyades (60° W) may be part of a single, moving group, although M44 is thought to be perhaps 50 million years younger than the Hyades.

NGC 2655

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Camelopardalis	Barred lenticular galaxy	08 h 55.6 m, +78° 13′	February 13
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		4.9′×4.1′	10.1

The stellar disk here rotates about an axis that is inclined 25° from our line-of-sight. The nucleus has a mass of about 10 billion suns within a diameter of 2,000 light years of the center and its rotation appears to be decoupled from the motion of the rest of the galaxy. The nucleus has strong emissions associated with photoionization intermediate between that of Seyfert (see NGC 3227) and LINER galaxies (see M81/NGC 3031). The galaxy has a twisted disk of neutral hydrogen (HI) extending out to a diameter of 200,000 light years that may be from a previous merger. It is the brightest member of a group of ten gravitationally bound galaxies that includes NGC 2715 (mag. 11.1, 39′ E).

NGC 2681

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred lenticular galaxy	08 h 53.5 m, +51° 19′	February 13
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		3.6′ × 3.3′	10.2

Its stellar mass is 80 billion suns. It also contains a disk of gas and stars that is inclined from the rest of the galaxy's disk. It has an optical diameter of about 60,000 light years and is nearly face-on. The nucleus of this galaxy is thought to harbor a central black hole with a mass of at most 60 million suns, and probably close to 8 million suns. This central black hole is accreting gas and stars, resulting in photoionization of surrounding gas and a nuclear emission region (that is less than about 20 light years in diameter). The central region of this galaxy (within 2,000 light years, or about 0.1′, of the nucleus) is thought to have undergone a short burst of star formation about 1 billion years ago (like that which is currently occurring in M82), perhaps due to a merger with another galaxy.

NGC 2682 (M67)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cancer	Open cluster	08 h 51.3 m, +11° 48′	February 11
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	4 billion years	25′	6.9

This is one of the oldest open clusters known. Indeed, most open clusters disassociate within a few hundred million years of their formation. M67's large initial mass and distance from the galactic center have allowed it to reach its old age, although it is thought to have lost more than three-quarters of its original stellar mass and it is reaching its end of life as a bound cluster. As clusters age, mass segregation of stars (see NGC 2506) results in star mass decreasing with radial distance from the cluster center, and M67 is no exception. Professional telescopes find 1,400 members (down to magnitude 23) in this cluster. Its size of 30′ corresponds to a diameter of about 20 light years.

NGC 2683

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Lynx	Spiral galaxy	08 h 52.7 m, +33° 25′	February 12
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		9.3′×2.1′	9.7
This has an optical diameter of about 70,000 light years. Professional telescopic studies indicate that it contains about 120 globular clusters. It is nearly edge-on to us and may contain a bar, whose presence may explain the boxy (rectangular) shape of its bulge in professional telescopes.			

NGC 2742

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	09 h 07.6 m, +60° 29′	February 16
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		3.0′×1.5′	11.4
This has an optical diameter of about 80,000 light years. There is a large central concentration of mass (about 10 billion suns within the inner thousand light years, which has an apparent radius of 2″). Most of the disk of this galaxy rotates at about 100 km/s (the rotation axis is inclined at an angle of about 60° from our line-of-sight).			

NGC 2768

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Lenticular galaxy	09 h 11.6 m, +60° 02′	February 17
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		6.4′ × 3.0′	9.9
The diameter of this galaxy is about 130,000 light years. It has an active galactic nucleus and may be a Seyfert galaxy (see NGC 3227). It contains gas in its central regions that rotates about an axis perpendicular to that of its stellar disk rotation, suggesting that this gas has been accreted separately, possibly in a recent and perhaps ongoing event.			

NGC 2775

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cancer	Spiral galaxy	09 h 10.3 m, +07° 02′	February 17
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		4.3′ × 3.3′	10.4
The total luminous mass of this galaxy is about 150 billion suns, about 40 % of which is in the disk and the rest is in the central bulge. Dark matter, largely in the halo of this galaxy, adds at most another 30 billion suns to the mass of this galaxy. The galaxy rotates about an axis inclined at 44° from our line-of-sight. Its position angle is 155° (i.e., the major axis of its elliptical shape is aligned 155° counterclockwise from north, which is a SE direction). It has an optical diameter of about 80,000 light years. It is the principal member of a group of perhaps nine gravitationally bound galaxies, including NGC 2777 (mag. 13.1, 12′ NE).			

NGC 2782

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Lynx	Barred spiral galaxy	09 h 14.1 m, +40° 07′	February 17
Distance	**Age**	**Apparent size**	**Magnitude**
110 million light years		3.7′ × 2.4′	11.4

This galaxy has an optical diameter of about 120,000 light years. Intense star formation (called a "starburst") is occurring within a 20″ diameter region at the center of this galaxy, creating supernovae and stellar winds that drive a powerful outflow from this region. It also has an active galactic nucleus (AGN) in which energetic emission is caused by accretion onto a massive central object. Professional telescopic studies find a gas-rich bar (of radius 7.5″) exists in the nucleus of this galaxy, which is thought to be funneling gas into the starburst region. The starburst and nuclear bar are expected to die away within 500 million years. This galaxy underwent a merger in the recent past (about 200 million years ago), which is the cause of the two "tails" to this galaxy that appear in professional telescopic images.

NGC 2787

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred lenticular galaxy	09 h 19.3 m, +69° 12′	February 19
Distance	**Age**	**Apparent size**	**Magnitude**
25–45 million light years		3.1′ × 1.8′	10.9

This galaxy has an optical diameter of about 20,000 light years. It rotates about an axis inclined at 55° from our line-of-sight. It is a LINER (low-ionization nuclear emission region) galaxy, with emission in its nucleus thought to be associated with accretion onto a central supermassive black hole (having a mass of about 100 million suns for this galaxy). It has a stellar mass of about 40 billion suns. It is surrounded by a ring of neutral gas with a diameter of 6.4′ (more than twice its apparent visual diameter).

NGC 2808

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Carina	Globular cluster	09 h 12.0 m, −64° 52′	February 16
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	14′	6.2
This is one of the most luminous globular clusters in our galaxy, with only three Milky Way globular clusters being appreciably brighter in absolute magnitude. It has a mass of more than a million suns. It, along with NGC 1851, NGC 1904, NGC 2298, may be remnant globular clusters from a single accreted, disrupted dwarf satellite galaxy. This cluster has three distinguishable subpopulations of its main sequence stars, which may be the result of multiple star-forming epochs each occurring with different amounts of helium and heavier elements. Differences in chemical composition among stellar subpopulations are also thought to be responsible for its oddly blue and multimodal horizontal branch (see NGC 362). It orbits the galaxy with a period of about 150 million years, never straying more than about 50,000 light years from the center of the galaxy.			

NGC 2811

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hydra	Barred spiral galaxy	09 h 16.2 m, −16° 19′	February 18
Distance	**Age**	**Apparent size**	**Magnitude**
95 million light years		2.5′×0.9′	11.4
This has an optical diameter of 70,000 light years. It is nearly edge-on, with an inclination angle of about 70° (an angle of 90° would be edge-on).			

NGC 2841

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	09 h 22.0 m, +50° 59′	February 19
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		8.1′×3.5′	9.3

This galaxy has a weak LINER (low-ionization nuclear emission region – see M81/NGC 3031 for explanation) in its nucleus. In addition, its nucleus has a different chemical composition from the rest of the galaxy. The galaxy rotates about an angle that is inclined at about 66° from our line-of-sight. It has a total mass of about perhaps 500 billion suns. It also has a giant reflection nebula that covers an area of 4,000×7,000 light years slightly above the disk on the near side of the galaxy. Because of the galaxy's inclination to our line-of-sight, light from the central bulge in the galaxy reflects off the dust in this nebula, making this huge dust cloud visible in professional telescopic images. The nebula is very dense – light is dimmed by 13 magnitudes for every kiloparsec (32,600 light years) that it travels through this nebula (compare this to the average two magnitudes of dimming that occurs over a similar distance in the central plane of our galaxy). Numerous star forming regions having massive star clusters, each with hundreds of thousands of stars and ages less than a few hundred million years, are observed in the disk of this galaxy in professional telescopes.

NGC 2859

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo Minor	Barred lenticular galaxy	09 h 24.3 m, +34° 31′	February 20
Distance	**Age**	**Apparent size**	**Magnitude**
90 million light years		4.6′×4.1′	10.9

This galaxy has separate inner and outer bars. In professional telescopic studies this galaxy also has a detached outer ring around it, making it unusual, since only about 10 % of galaxies have this feature. However, outer rings are common with barred lenticular galaxies (about 2/3 of them have an outer ring). This may be due to the more dynamically evolved state of lenticular galaxies compared to other galaxies, since outer rings are thought to occur relatively late in a galaxy's evolution. Outer rings also require a galaxy to avoid tidal interactions with other galaxies (since such interactions destroy these rings). As a result, galaxies that are part of groups rarely have outer rings. This galaxy has an optical diameter of about 120,000 light years.

NGC 2903

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred spiral galaxy	09 h 32.2 m, +21° 30′	February 22
Distance	**Age**	**Apparent size**	**Magnitude**
30 million light years		12.0′×6.0′	8.8

Star-forming regions in its spiral arms that are bright ionized hydrogen emission (HII) regions, individually containing millions of stars, give the disk a splotchy appearance that is visible in large amateur telescopes. NGC 2905, in the northern portion of this galaxy, is one of the brightest of these knots. NGC 2903 is also a "starburst" galaxy where rapid star formation is occurring in its nucleus. These nuclear star-formation regions appear as splotchy "hotspots" in professional telescopic images of the nucleus because gas and dust in the nucleus block the view. This galaxy has a mass of about 100–200 billion suns.

NGC 2950

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred lenticular galaxy	09 h 42.6 m, +58° 51′	February 25
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		2.7′×1.8′	10.9

Professional telescopic studies show that the disk of this galaxy gives off 48 % of the total light from the galaxy, while the nucleus accounts for 29 % of the light and the primary bar the remaining 22 %. It actually has a secondary, inner nuclear bar that is thought to be counter-rotating relative to the primary bar. The galaxy rotates about an axis that is inclined to our line-of-sight by about 48° and it has a position angle of 144° (i.e., its major axis lies 144° counterclockwise from N).

NGC 2964

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred spiral galaxy	09 h 42.9 m, +31° 51′	February 25
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		3.0′ × 1.7′	11.2

This has an active galactic nucleus (AGN) and four spiral arms. It forms a non-interacting triplet with NGC 2968 (irregular galaxy, mag. 12, 6′ NNE) and NGC 2970 (elliptical galaxy, mag. 13.6, 11′ NE). NGC 2964 has an optical diameter of 60,000 light years. NGC 2964 rotates about an axis inclined at about 55° from our line-of-sight (and has a position angle of 96°, i.e., its major axis is aligned nearly E-W), while NGC 2968 has an inclination angle of 40° and a position angle of 44° (i.e., elongated NE-SW).

NGC 2974

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sextans	Elliptical galaxy	09 h 42.6 m, −03° 42′	February 25
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		3.4′ × 2.1′	10.9

This galaxy contains unusual features for an elliptical galaxy; its inner few arc seconds are thought to contain a two-armed spiral gas feature with a mass of 70,000 suns, while at radii of 1′–2′ there is a neutral hydrogen (HI) ring with a mass of 550 million suns which is coincident with a ring of ionized gas due to star formation. It also contains a nuclear bar (of length 5″), and perhaps a larger scale bar (length 50″). This galaxy has an unusually high rotation rate for an elliptical galaxy (up to 250 km/s). The luminous mass of this galaxy is several hundred billion suns, and dark matter in its halo makes the total mass more than double this value.

NGC 2976

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Peculiar spiral galaxy	09 h 47.2 m, +67° 55′	February 26
Distance	**Age**	**Apparent size**	**Magnitude**
12 million light years		5.9′×2.7′	10.1

This is a dwarf galaxy with a total mass of a few billion suns. It is part of the M81 group of gravitationally bound galaxies (see M81/NGC 3031). Indeed, professional telescopic studies find a bridge of neutral hydrogen (HI) gas that is a quarter million light years long and connects NGC 2976 to M81. This bridge has a mass of about 20 billion suns and is the result of gravitational interactions between these galaxies. A star formation burst in NGC 2976 has occurred over the past few hundred millions years that has depleted its gas and as a result is now thought to be ending.

NGC 2985

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	09 h 50.4 m, +72° 17′	February 27
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		4.6′×3.4′	10.4

This galaxy has a low-ionization nuclear emission region (LINER – see M81/NGC 3031 for explanation) as well as many ionized hydrogen (HII) star-formation regions, particularly within a radius of 5″–30″ of the galaxy's center. Its nucleus contains a 1″ diameter star-forming ring. HII regions give the galaxy a mottled appearance outside its nucleus in large amateur telescopes. The galaxy forms a non-interacting (gravitationally bound) pair with NGC 3027 (barred spiral, 25′ E, mag. 11.8) and rotates about an axis that is inclined by an angle of about 40° from our line-of-sight.

NGC 3003

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo Minor	Barred spiral galaxy	09 h 48.6 m, +33° 25′	February 26
Distance	**Age**	**Apparent size**	**Magnitude**
75 million light years		5.7′ × 1.4′	11.5
This is nearly edge-on. Active star formation is occurring in this galaxy with many ionized hydrogen star-forming regions (i.e., HII regions) some of which are visible as bright knots in large amateur telescopes. Nearby NGC 3021 (31′ E) is thought to be about 15 million light years farther away than NGC 3003.			

NGC 3031 (M81)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	09 h 55.6 m, +69° 04′	February 28
Distance	**Age**	**Apparent size**	**Magnitude**
12 million light years		24.9′ × 11.5′	7.0
M81 is a LINER (low-ionization nuclear emission region) galaxy, which is a low-luminosity class of "active galactic nuclei" (AGN). The mechanism for LINERs varies but in some galaxies it may be due to a supermassive black hole in the nucleus that is accreting gas and stars, resulting in photoionization of surrounding gas. (Indeed, some suggest that LINER galaxies represent an evolutionary stage between quasars and ordinary galaxies). Alternatively, some LINERs may instead be caused by intense star-formation activity in the nucleus (a "starburst"). M81 is thought to be in the former class (a LINER whose emission is associated with a central black hole), with its supermassive black hole estimated to contain perhaps 70 million solar masses. About one-third of all galaxies are LINERs. M81 is the namesake member of the M81 group of about 30 gravitationally bound galaxies that includes NGC 2403 (14° W), NGC 2976 (1° 23′ SW), IC 2574 (3° E), NGC 4236 (12° E), in addition to nearby M82/NGC 3034 and NGC 3077 with which M81 has had strong past interactions (see NGC 3077 and M82/NGC 3034). M81 has an optical diameter of about 90,000 light years and a mass roughly similar to the Milky Way. To date, 144 globular clusters have been identified in M81.			

NGC 3034 (M82)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	09 h 55.9 m, +69° 41′	February 28
Distance	**Age**	**Apparent size**	**Magnitude**
13 million light years		11.2′×4.3′	8.6

This is the prototypical starburst galaxy (in which intense star formation is occurring in its central region). Indeed, about ten new stars are formed every year in the center of this galaxy (within a radius of about 0.5′ of this galaxy's center), which is several times the rate at which stars form in the entire Milky Way. Supernovae occur in this starburst region about once a decade (which is several times the rate for the entire Milky Way). These supernovae blow material out of the center of this galaxy in a superwind (moving at speeds up to more than 1,000 km/s) that forms two jets perpendicular to the plane of the galaxy. These jets (which pick up material on their way out, possibly by turbulent shear layer mixing and by evaporating nearby gas in the galaxy), are believed to be slamming into gas outside the galaxy's disk. This gas is thought to be left over from earlier gravitational interactions with nearby M81. Material in the superwind jets is thought to be moving faster than the escape velocity of the galaxy and so will become intergalactic material. M82 is part of the M81 group of gravitationally bound galaxies (see M81/NGC 3031) and is thought to have had strong interactions with M81 over the last several hundred million years that have triggered the starburst in M82. Associated with the bright star-forming regions, over a thousand "super star clusters" are known in M82, containing several hundred thousand suns each. The optical diameter of M82 is about 40,000 light years and its mass is roughly 10 billion suns.

NGC 3077

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	10 h 03.3 m, +68° 44′	March 2
Distance	**Age**	**Apparent size**	**Magnitude**
13 million light years		5.2′×4.7′	10.0

This galaxy has an optical diameter of about 20,000 light years. It is considered a dwarf galaxy and belongs to the M81 group of gravitationally bound galaxies (see M81/NGC 3031). It has interacted with M81 (the strongest such interaction having occurred several hundred million years ago), and professional telescopic studies show that long streamers containing neutral hydrogen gas, star forming regions that form a star every few thousand years, and molecular gas bridge the two galaxies. Like nearby M82, NGC 3077 is a starburst galaxy in which intense star formation is occurring in its nucleus and star clusters. The starburst in NGC 3077 is thought to be fueled by gas falling back into the galaxy after having been torn out in an earlier interaction with M81.

NGC 3079

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	10 h 02.0 m, +55° 41′	March 2
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		8.1′×1.3′	10.8

The nucleus of this galaxy contains one of the most luminous known water vapor masers. Maser stands for "microwave amplification by stimulated emission of radiation," the physics of which is the microwave equivalent of a laser (except that lasers are usually designed to produce a beam, while astronomical masers yield emission that radiates from a roughly spherical region). The nucleus of this galaxy appears to be both an AGN (or "active galactic nucleus," in which energetic emission is caused by accretion onto a massive central object) and a starburst (in which intense star formation is occurring). A superbubble driven by either the AGN or starburst is the result of jets flowing out of the nucleus perpendicular to the disk that impact with surrounding dense clouds. This galaxy has an optical diameter of about 120,000 light years.

NGC 3115

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sextans	Lenticular galaxy	10 h 05.2 m, –07° 43′	March 2
Distance	**Age**	**Apparent size**	**Magnitude**
30 million light years		7.2′×2.4′	9.1
Nicknamed the “Spindle Galaxy,” although NGC 5866 also has this nickname, NGC 3115 is believed to harbor a supermassive black hole in its nucleus, with a mass of about 2 billion suns. However, it is not an active galactic nucleus (i.e., intense emission is not occurring from the nucleus), so that this black hole is not being fed well. This galaxy hosts more than 500 globular clusters. The galaxy is nearly edge-on (inclination angle of 86°), and its apparent size corresponds to an optical diameter of about 60,000 light years, although a stellar halo extends to about 100,000 light years in professional telescopic studies.			

NGC 3132

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Vela	Planetary nebula	10 h 07.0 m, –40° 26′	March 17
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years		1.5′	9.2
The central star here has a temperature of 110,000 K. It is sometimes called the Eight-burst Nebula, or the Southern Ring Nebula. Its structure may be similar to that of an hourglass, with the rotational symmetry axis of the hourglass oriented 40° from the line of sight. Professional telescopes reveal a dark double helix filament in the nebula that consists of magnetized clumps of gas and dust driven into shape by expanding gas pushed by the central stars’ wind and radiation. It is relatively rich in helium and nitrogen, making it a so called Type I planetary nebula.			

NGC 3147

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Draco	Spiral galaxy	10 h 16.9 m, +73° 24′	March 5
Distance	**Age**	**Apparent size**	**Magnitude**
135 million light years		3.9′×3.5′	10.6

This galaxy has an active galactic nucleus (AGN, where a supermassive object in the galaxy's center accumulates nearby gas resulting in strong emission from the nucleus). In this case the AGN is classified as a true Seyfert Type 2 because its spectra lacks broad lines due to a relatively weak AGN accretion rate. Very active star formation is occurring in a ring that lies at a radius of 7,000–8,000 light years (about 10 arc seconds) from the center of the galaxy. It is nearly face-on (with an inclination angle of 27°) and has an optical diameter of about 150,000 light years.

NGC 3166

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sextans	Barred lenticular galaxy	10 h 13.8 m, +03° 26′	March 5
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		4.8′×2.3′	10.5

This is nearly edge-on (inclination angle of 73°) and is the namesake member of the NGC 3166 group of five gravitationally bound galaxies that includes nearby NGC 3169 (spiral galaxy, 6′ ENE, mag. 10.3 – see NGC 3169), the dimmer NGC 3156 (lenticular galaxy, 23.5′ SW, mag. 12.1), and the much dimmer NGC 3165 (spiral galaxy, 5′ SW, mag. 13.9). A bridge of neutral hydrogen (HI) gas is found to connect NGC 3166 and 3169 in professional telescopes, which is the result of gravitational interactions between the two. Another tidal tail of HI gas streaming off to the SE of NGC 3166 is thought to possibly have formed an unusual second generation dwarf galaxy at its tip. NGC 3166 is a LINER (low-ionization nuclear emission region) galaxy (see M81/NGC 3031 for explanation).

NGC 3169

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sextans	Spiral galaxy	10 h 14.2 m, +03° 28′	March 5
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		4.2′×2.9′	10.3

This has an active galactic nucleus (AGN, where a supermassive object, in this case a black hole with a mass of about 160 million suns, in the galaxy's center accumulates nearby gas resulting in strong emission from the nucleus). It is the most massive and central galaxy of the NGC 3166 group of gravitationally bound galaxies. It is thought to be interacting (i.e. changing shape or mass due to gravitational interaction) with NGC 3166 (see NGC 3166). A coordinated burst of star formation is thought to have occurred in the centers of NGC 3166, NGC 3169 and NGC 3156 about a billion years ago. NGC 3169 contains an inner nuclear bar (but no outer bar) that may have fed its billion-year-old nuclear starburst. It rotates about an axis that is inclined at about 54° from our line-of-sight.

NGC 3184

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	10 h 18.3 m, +41° 25′	March 6
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		7.4′×6.9′	9.6

The stellar mass of this is about 14 billion suns. This galaxy has had a remarkable five supernovae observed in it (with two occurring in 1921). It is nearly face-on (with an inclination angle of about 20°). Several star-forming, ionized hydrogen (HII) regions are visible as knots in its disk in large amateur telescopes, with two of them labeled with NGC numbers (3180 and 3181). Professional telescopes find thousands of these knots in an outer disk beyond NGC 3184's optical radius. It has a nuclear star cluster that may host an active galactic nucleus (AGN, see NGC 3079 for explanation). It may belong to a small scattered association of galaxies that includes NGC 3104 (mag. 13.2), NGC 3198 (mag. 10.2, see NGC 3198) and NGC 3319 (mag. 10.8) that are each several degrees away.

NGC 3190

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Spiral galaxy	10 h 18.1 m, +21° 50′	March 6
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		4.4′×1.5′	11.1

Nearly edge-on (it rotates about an angle inclined at 70° from our line-of-sight), this has an optical diameter of about 100,000 light years, and has a low-ionization nuclear emission region (LINER – see M81/NGC 3031 for explanation). It is the namesake member of the NGC 3190 group of 13 gravitationally bound galaxies. The ten NGC members of this group include NGC 3162 (barred spiral galaxy, 1° 24′ NW, mag. 11.4), NGC 3185 (barred spiral galaxy, 11′ SW, mag. 12.0), NGC 3193 (6′ NE – see NGC 3193), NGC 3177 (spiral galaxy, 48′ SSW, mag. 12.2), NGC 3187 (barred spiral, 5′ WNW, mag. 12.9), NGC 3213 (spiral, 2° 18′ SSE, mag. 13.5), NGC 3226 (2° 18′ SSE – see NGC 3226), NGC 3227 (2° 20′ SSE – see NGC 3227), NGC 3287 (barred spiral, 3° 53′ E, mag. 12.3) and NGC 3301 (lenticular galaxy, 4° 22′ E, mag. 11.4).

NGC 3193

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Elliptical galaxy	10 h 18.4 m, +21° 54′	March 6
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		2.0′×2.0′	10.8

This is part of the NGC 3190 galaxy group (see NGC 3190). It has an optical diameter of about 55,000 light years.

NGC 3198

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	10 h 19.9 m, +45° 33′	March 6
Distance	**Age**	**Apparent size**	**Magnitude**
45 million light years		8.5′ × 3.3′	10.2
This is nearly edge-on (with an inclination angle of about 70°). Professional telescopic studies show this galaxy has little or no bulge (the bulge is the central spherical region in disk galaxies). Most of the disk that makes up the luminous part of this galaxy rotates at about 150 km/s. About half of the mass of this galaxy resides in a spherical dark matter halo, which is thought to be very extended and of such low density that it has little effect on the dynamics of the disk.			

NGC 3201

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Vela	Globular cluster	10 h 17.6 m, –46° 25′	March 20
Distance	**Age**	**Apparent size**	**Magnitude**
16,000 light years	10–14 billion years	20′	6.9
This orbits our galaxy's halo in a retrograde orbit with a period of about 300 million years in a plane inclined about 18° from the galactic disk, straying as far as 90,000 light years from the galaxy center. It is one of only a few globular clusters with significant variations in heavy element abundance among its stars, the mechanism for which remains unknown. It passed through the galactic disk only a few million years ago, causing tidal clumping of some its stars along the galactic north-south direction. It has a mass of about 200,000 suns.			

NGC 3226

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Elliptical galaxy	10 h 23.4 m, +19° 54′	March 7
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		2.8′×2.0′	11.4

This is part of the NGC 3190 galaxy group (see NGC 3190). It is a dwarf galaxy and is thought to harbor a low-luminosity active galactic nucleus (AGN – see NGC 3079 for explanation), which is a LINER (low-ionization nuclear emission region – see M81/NGC 3031). It is interacting with nearby NGC 3227 (which is 2.5′ SE – see NGC 3227).

NGC 3227

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred spiral galaxy	10 h 23.5 m, +19° 52′	March 7
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		6.6′×5.0′	10.3

This is part of the NGC 3190 galaxy group (see NGC 3190). This is a Seyfert galaxy, one of 12 such galaxies first identified by Seyfert himself, in which emission from the nucleus is thought to occur due to accretion of matter onto a massive central black hole, in this case having a mass of 10–20 million suns. Molecular gas close to the nucleus is thought to be partly obscuring the nucleus, reducing the intensity of nuclear emission that we see. It is interacting with NGC 3226, resulting in a tidal tail of gas north of NGC 3227 that may have birthed a second-generation tidal dwarf galaxy.

NGC 3242

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hydra	Planetary nebula	10 h 24.8 m, −18° 39′	March 7
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years		40″	7.7

Nicknamed the "Ghost of Jupiter" since it is about the same apparent size as Jupiter, this galaxy's central star (mag. 12.1), visible in amateur telescopes, has a surface temperature of about 60,000 K and has a mass less than half that of our Sun. The bright inner ring (with a diameter of about 20″–30″) visible in large amateur telescopes is expanding at about 25 km/s and has an actual diameter of a few tenths of a light year. This ring is thought to be part of an inner ellipsoidal shell. In professional telescopes, the NW and SW edges of the inner ring have fast, low-ionization emission regions ("FLIERS" – see NGC 7662). In professional telescopes, the nebula extends out in an elliptical outer shell containing multiple outer rings.

NGC 3245

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo Minor	Lenticular galaxy	10 h 27.3 m, +28° 30′	March 8 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
75 million light years		3.2′ × 1.8′	10.7

This galaxy has a circumnuclear disk (with a radius of 1″) that is photoionized from matter accreting onto a central black hole containing 200 million solar masses. This emission is responsible for the LINER (low-ionization nuclear emission region) classification of this galaxy. It is part of the NGC 3254 group of galaxies (see NGC 3277).

NGC 3277

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo Minor	Spiral galaxy	10 h 32.9 m, +28° 31′	March 9 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
75 million light years		2.1′ × 1.8′	11.7

This has an optical diameter of about 50,000 light years. It is nearly face-on (having an inclination angle of about 27°, meaning that it rotates about an axis that is inclined from our line-of-sight by 27°). It is part of the NGC 3254 group of five gravitationally bound galaxies, that includes NGC 3245 (1° 14′ W – see NGC 3245) and NGC 3254 (spiral galaxy, 1° 16′ NW, mag. 11.7), as well as the much dimmer NGC 3265 and NGC 3245A.

NGC 3293

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Carina	Open cluster	10 h 35.9 m, −58° 14′	March 25
Distance	**Age**	**Apparent size**	**Magnitude**
9,000 light years	10 million years	5′	4.7

This is a young cluster, known as the Gem cluster. It is within the nebulosity of NGC 3372 (see NGC 3372), but is itself relatively gas and dust free. It is thought to be a twin of NGC 3324 (27′ NW), having perhaps formed together but now separated by about 70 light years. It has a diameter of about 10 light years. Professional telescopes count nearly 300 stars in this cluster, containing a mass of 1,300 suns, giving the average star in this cluster a mass 4.5 times that of the Sun.

NGC 3294

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo Minor	Spiral galaxy	10 h 36.3 m, +37° 19′	March 10 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
95 million light years		3.4′ × 1.8′	11.8

This has an optical diameter of about 90,000 light years. It rotates about an axis inclined from our line-of-sight by about 60° (which is its "inclination angle"). The major axis of the ellipse that results by viewing its circular disk at this inclination angle is along a line that is 122° counterclockwise from north (which is its "position angle").

NGC 3310

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Peculiar barred spiral galaxy	10 h 38.8 m, +53° 30′	March 11 (Standard Time)
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		3.1′ × 2.4′	10.6

This galaxy has a number of interesting features in professional telescopic studies, including

- A 3,000 light year (8″–12″) diameter circumnuclear ring of intense star formation (i.e., a "starburst"), which has been active for about 100 million years.
- Hundreds of young star clusters (tens of millions of years old) each containing hundreds of thousands of stars.
- A "bow and arrow" shape on the western side. The bow is at a radius of 30″ and thought to contain older stars which are perhaps debris from the disk of a cannibalized galaxy, while the "arrow" points NW extending from about 20″–50″ from the galaxy center and is made of hot, young stars the same age as the starburst ring just mentioned.
- A 1.5″ offset between the stellar nucleus and the dynamical center of the galaxy.

These and other features suggest that this galaxy underwent a merger with another galaxy in the not too distant past. The galaxy is thought to have a mass of several tens of billions of suns, and harbors a supermassive black hole in its nucleus with a mass of perhaps tens of millions of suns.

NGC 3344

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo Minor	Barred spiral galaxy	10 h 43.5 m, +24° 55′	March 27
Distance	**Age**	**Apparent size**	**Magnitude**
20 million light years		7.1′×6.5′	9.7

Professional telescopes show this galaxy has an inner ring (0.5′ in diameter) and an outer ring (3′ in diameter) around it, both of which are star-forming regions. Inner rings are a common feature of spiral galaxies (about 60 % of spiral galaxies have them), but outer rings are rarer (with only 10 % of galaxies having an outer ring or pseudo-ring). Outer rings are even more uncommon in "late-type" spirals like this galaxy (where the spiral arms are loosely "wound" and there is only a small central bulge compared to the extended disk), and it has been hypothesized that this galaxy's outer ring may be due to a past merger. This galaxy is nearly face-on (with an inclination angle of about 25°) and has an optical diameter of 40,000 light years.

NGC 3351 (M95)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred spiral galaxy	10 h 44.0 m, +11° 42′	March 27
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		7.4′×5.0′	9.8

This is part of the M96 (NGC 3368) galaxy group – see M96/NGC 3368. It is a nuclear starburst galaxy. Indeed, professional telescopes find that M95 has an inner ring (7″ in radius) containing ionized hydrogen (HII) star-forming regions each with millions of suns divided among several clusters and being the result of orbital resonant interactions with this galaxy's bar, which itself is about 1.6′ long. M95 has an optical diameter of about 80,000 light years.

NGC 3368 (M96)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred spiral galaxy	10 h 46.8 m, +11° 49′	March 28
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		7.8′×5.2′	9.3

The nucleus here harbors a black hole with a mass of about 7.5 million suns, and a nuclear bar with a radius of 5″. It is thought to also have a separate outer bar with length of 1′, as well as an inner disk with a diameter of about 0.5′. It is the namesake member of the M96 (NGC 3368) group of about a dozen galaxies that includes NGC 3299, NGC 3351 (M95), NGC 3377 (see NGC 3377), M105 (NGC 3379), NGC 3384 (see NGC 3384), NGC 3412 (see NGC 3412), and NGC 3489 (see NGC 3489). This group is part of the larger Leo I group that includes M65 and M66. M96 has an optical diameter of about 80,000 light years and is a LINER galaxy (see M81/NGC 3031).

NGC 3372

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Carina	Emission nebula	10 h 45.1 m, −59° 52′	March 27
Distance	**Age**	**Apparent size**	**Magnitude**
7,500 light years		2°	3

Referred to as the Carina Nebula or the Eta Carina Nebula, this is one of the most massive star-forming regions in our galaxy, creating a new star every hundred years or so over the past 5 million years. It has a diameter of a few hundred light years. The dust and gas in this nebula has a total mass of several hundred thousand suns. The nebula is ionized by more than a hundred OB stars embedded within several high mass star clusters (particularly Trumpler 14 and 16, but also Trumpler 15 among several others) that are less than a few million years old, and whose intense radiation and stellar winds have sculpted intricate structures within the gas and dust. Some of these stars are among the most massive in our galaxy, with masses of more than 100 suns. Tens of thousands of stars are thought to be embedded in this nebula. It contains the star η Carina, which is among the top seven most luminous known stars in our galaxy, having more than 5 million times the sun's luminosity. This star is thought to be a binary. Its stellar winds give off an entire solar mass every thousand years. It, along with a number of other very high mass stars in this nebula, are expected to explode as supernovae in the next few million years. η Carina is surrounded by the small Homunculus Nebula, which was ejected by this star in a tremendous eruption whose energy rivaled that of a supernova and briefly made it the second brightest star in our sky in the mid nineteenth century. The star survived this "supernova imposter" event. The cause of this incredible explosion remains to be elucidated. The dark Keyhole Nebula within the Carina Nebula complex is thought to be made of cool (<15 K) foreground remnant clumps of the giant molecular cloud from which the entire Carina Nebula complex formed.

NGC 3377

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Elliptical galaxy	10 h 47.7 m, +13° 59′	March 28
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		5.0′×3.0′	10.2
The center of this galaxy is believed to harbor a supermassive black hole containing nearly a hundred million solar masses. This galaxy is part of the M96 (NGC 3368) group of galaxies that includes about a dozen gravitationally bound galaxies (see M96/NGC 3368). The galaxy is a flattened ellipsoid in shape (elliptical galaxies don't get much flatter than this one) with a minor/major axis ratio of 0.5, viewed nearly edge-on.			

NGC 3379 (M105)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Elliptical galaxy	10 h 47.8 m, +12° 35′	March 28
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		5.3′×4.8′	9.5
This is part of the M96 (NGC 3368) group of galaxies (see M96/NGC 3368). It has a stellar mass of about 100 billion suns, but its total mass including dark matter is about ten times this value. Its nucleus contains a supermassive black hole with a mass of perhaps as much as 400 million suns. Nearly 300 globular clusters are thought to orbit this galaxy, which is about twice as many as the Milky Way. NGC 3384 is nearby (see NGC 3384), as is the dimmer NGC 3389 (spiral galaxy, 10′ ESE, mag. 11.8, with a mass similar to M105). However, NGC 3389 is actually a background object and is instead about twice as far away and part of the NGC 3338 group of galaxies that includes NGC 3338, NGC 3389 and NGC 3346.			

NGC 3384

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred lenticular galaxy	10 h 48.3 m, +12° 38′	March 28
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		5.4′×2.7′	9.9

About 120 globular clusters orbit this galaxy. It is part of the M96 (NGC 3368) galaxy group – see M96 (NGC 3368). Professional telescopic studies show an unusual intergalactic ring of atomic hydrogen (HI) gas with a diameter of 650,000 light years (about 1°) in diameter centered near this galaxy. This ring of gas is thought to be the remains of a collision between this galaxy and M96 (NGC 3368) that occurred about a billion years ago, and that also left a tidal bridge of HI gas between the two galaxies. Although NGC 3384 forms an optical triplet with M105 (8′ WSW – see M105/NGC 3379) and NGC 3389 (spiral galaxy, 7′ SSE, mag. 11.8), NGC 3389 is actually a background object (about twice as far away) so that only M105 and NGC 3384 are actual companions.

NGC 3395

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo Minor	Barred spiral galaxy	10 h 49.8 m, +32° 59′	March 29
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		2.1′×1.1′	11.8

This galaxy is interacting with its nearby companion NGC 3396 (barred spiral galaxy, 1′ E, mag. 12.0). A tail of atomic hydrogen 10′ in apparent length (200,000 light years in actual length) extends off to the SW of the NGC 3395/3396 pair in professional telescopic studies and is thought to be gas that was stripped from NGC 3395 in a previous close encounter with NGC 3396. The two galaxies are thought to be heading for another close encounter and are within about 50 million years of their closest approach. The present interaction appears to be driving intense star formation in both galaxies. The bridge between the two galaxies (visible in large amateur telescopes) is thought to be due to gravitational interaction rather than actual collision of material. Both NGC 3395 and NGC 3396 are part of the NGC 3396 group of perhaps seven gravitationally bound galaxies whose brighter members include nearby NGC 3381 (peculiar barred spiral, 1° 44′ N, mag. 11.8), NGC 3424 (barred spiral, 26′ E, mag. 12.4), NGC 3430 (barred spiral, 30′ E, mag. 11.5). Although also nearby, NGC 3413 (lenticular galaxy, 23′ SE, mag. 12.1) is actually a foreground object (at a little more than half the distance to NGC 3395) and not part of this galaxy group.

NGC 3412

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred lenticular galaxy	10 h 50.9 m, +13° 25′	March 29
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		3.7′×2.2′	10.4

This is part of the M96 (NGC 3368) galaxy group. The population of young stars in the central region of this galaxy may be the result of the bar having recently driven disk material into the central region. Its inclination angle is about 56°, meaning that it rotates about an axis inclined at 56° from our line-of-sight. Its bar has a length of about 1′.

NGC 3414

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo Minor	Barred lenticular galaxy	10 h 51.3 m, +27° 59′	March 29
Distance	**Age**	**Apparent size**	**Magnitude**
90 million light years		3.5′ × 2.6′	10.9

This has a low-ionization nuclear emission region ("LINER" – see M81/NGC 3031) and its nucleus contains a supermassive black hole with a mass of about 250 million suns.

NGC 3432

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo Minor	Barred spiral galaxy	10 h 52.5 m, +36° 37′	March 29
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		6.6′ × 1.6′	11.1

This is an edge-on dwarf galaxy (its rotation axis is inclined from our line-of-sight by 79° and the SW side is receding from us in its rotation about this axis). It is distorted due to interactions with a nearby dwarf galaxy (UGC 5983, 4′ WSW, mag. 15.5) that it is probably accreting. Tidal disturbances from its interaction with UGC 5983 are expected to cause intense star formation (a starburst) in the next few tens to hundreds of millions of years. It has an optical diameter of about 80,000 light years.

NGC 3486

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo Minor	Barred spiral galaxy	11 h 00.4 m, +28° 59′	March 31
Distance	**Age**	**Apparent size**	**Magnitude**
45 million light years		7.1′×5.2′	10.3
This rotates about an axis inclined at about 40° from our line-of-sight. Its major axis is aligned at an angle of 80° counterclockwise from north. It has an optical diameter of about 90,000 light years. It is a Seyfert galaxy (where a supermassive object in this galaxy's center accumulates nearby gas resulting in strong emission from the nucleus).			

NGC 3489

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred lenticular galaxy	11 h 00.3 m, +13° 54′	March 31
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		3.6′×2.2′	10.2
Part of the M96 (NGC 3368) galaxy group (see M96/NGC 3368), this rotates about an axis inclined at about 55° from our line-of-sight. It has an active galactic nucleus (AGN), although it remains undetermined yet if this is of LINER (see M81/NGC 3031) or Seyfert type. Its central supermassive black hole has a mass of about 6 million suns.			

NGC 3504

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo Minor	Barred spiral galaxy	11 h 03.2 m, +27° 58′	April 1
Distance	**Age**	**Apparent size**	**Magnitude**
65 million light years		2.7′×2.1′	10.9

Professional telescopic studies find intense star formation (a "starburst") is occurring in the center of this galaxy, which is thought to have begun about 100 million years ago and may be occurring in a circumnuclear ring (of radius 1″) associated with the inner of two so-called "inner Lindblad resonances" (where the speed of density waves resonantly amplifies oscillations in the orbits of matter in the disk). It and NGC 3512 (mag. 12.3, 11′ ENE) are a non-interacting pair.

NGC 3521

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred spiral galaxy	11 h 05.8 m, –00° 02′	April 2
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		11.2′×5.4′	9.2

This is a so-called "flocculent" spiral galaxy, meaning that it lacks obvious azimuthally symmetric spiral arms. This is generally attributed to the absence of strong spiral density waves. These waves normally travel around the disks of spiral galaxies, "firing up" stars as they go along giving rise to the spiral arms that are so obvious in "grand-design" spirals like M51 (the process is mildly analogous to "the wave" at a large stadium if people took turns turning on flashlights instead of standing as "the wave" goes by). In NGC 3521, these waves are much weaker than usual and so only a weak, tightly wound two-arm spiral structure is found in professional telescopic studies. It has an optical diameter of about 80,000 light years and is a LINER galaxy (see M81/NGC 3031).

NGC 3532

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Carina	Open cluster	11 m 05.7 m, −58° 45′	April 2
Distance	**Age**	**Apparent size**	**Magnitude**
1,600 light years	300 million years	50′	3.0
This is a rich, intermediate age cluster containing about 2,000 stars in professional telescopes. It has a diameter of about 20 light years. It is sometimes referred to as the "Football Cluster".			

NGC 3556 (M108)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	11 h 11.5 m, +55° 40′	April 3
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		8.6′×2.4′	9.9
Professional telescopic studies find that this galaxy has two giant loops of atomic hydrogen gas, one at the east and one at the west end. These loops have diameters of 10,000–20,000 light years, have masses around 50 million suns and are expanding outward but parallel to the disk of the galaxy at 40–50 km/s. They are thought to have originated about 50 million years ago. The loops may be the result of the rapid expansion of material shot outward from an active galactic nucleus, with the jets "flaring" into shells as they reach the less dense outer regions of the galaxy. The nuclear activity has since largely subsided. The galaxy is nearly edge-on (having an inclination angle of about 75°, meaning that it rotates about an axis inclined at 75° from our line-of-sight) and has an optical diameter of about 100,000 light years. It is thought to have nearly 300 globular clusters. Its stellar mass is estimated to be a little over a hundred billion suns and its nucleus harbors a supermassive black hole with a mass of 20–30 million suns.			

NGC 3587 (M97)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Planetary nebula	11 h 14.8 m, +55° 01′	April 4
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years		3.8′	9.9

Nicknamed the "Owl Nebula" because it resembles two owl's eyes in a round disk when viewed at high power in large amateur telescopes, the nebula is expanding at a few tens of km/s and has a mass of perhaps a couple tenths that of our Sun (not including the central star, whose mass is about two-thirds that of the Sun and is a challenging object in amateur telescopes). The three-dimensional structure of this nebula is complex in professional telescopic studies, although the "owl's eyes" are thought to be a bipolar ("hourglass") cavity (inclined from our line-of-sight by about 30°) that is inside three separate elliptical shells. The inner shell of the three gives rise to the round outer shape visible in amateur telescopes.

NGC 3593

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Lenticular galaxy	11 h 14.6 m, +12° 49′	April 5
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		5.2′ × 1.9′	11.0

Professional telescopic studies find that this galaxy possesses two stellar disks that are counter-rotating. This unusual situation may be the result of the accretion of gas several billion years ago which formed a counter-rotating circumnuclear disk. The gas in this disk now fuels a nuclear starburst (i.e., intense star formation in the nucleus). At the current rate that this gas is formed into stars (about a star every year and a half), this activity will subside within about 600 million years. It has an optical diameter of about 40,000 light years and may be part of the M66 galaxy group (see M66/NGC 3627).

NGC 3607

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Lenticular galaxy	11 h 16.9 m, +18° 03′	April 5
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		4.6′×4.0′	9.9

This galaxy is thought to have acquired material from its neighbor NGC 3608 (6′ N – see NGC 3608) that has formed into a dust ring in the inner 10″–20″ of NGC 3607. It is also thought to have had three individual major epochs of star formation occurring 1, 5 and 13 billion years ago, perhaps associated with merger events. It is a LINER galaxy (see M81/NGC 3031) and hosts a central black hole with a mass of about 120 million suns. It is the namesake member of the NGC 3607 galaxy whose membership is somewhat uncertain but is thought to include the following NGC galaxies among perhaps 31 galaxies: 3507 (barred spiral galaxy, 3° 11′ W, mag. 11.9), 3592 (spiral galaxy, 59′ SW, mag. 13.9), 3599 (lenticular galaxy, 22′ W, mag. 11.8), 3605 (elliptical galaxy, 2.5′ SW, mag. 12.1), 3608 (6′ NNE – see NGC 3608), 3626 (49′ ENE – see NGC 3626), 3655 (2° SE – see NGC 3655), 3659 (barred spiral galaxy, 1° 39′ E, mag. 12.2), 3681 (barred spiral, 2° 35′ ESE, mag. 11.6), 3684 (spiral, 2° 39′ ESE, mag. 11.5), 3686 (barred spiral, 2° 42′ ESE, mag. 11.2), 3691 (peculiar barred spiral, 2° 55′ ESE, mag. 12.4). The NGC 3607 group is itself associated with the larger Leo II collection of groups and the Virgo galaxy cluster (see M49/NGC 4472).

NGC 3608

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Elliptical galaxy	11 h 17.0 m, +18° 09′	April 5
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		3.2′×2.6′	10.7

This is part of the NGC 3607 galaxy group (see NGC 3607), which contains 16 galaxies brighter than visual magnitude 15. It rotates at an angle of 54° from our line of sight. The core of this galaxy counterrotates from the rest of the galaxy. It contains a supermassive black hole with a mass of about 200 million suns.

NGC 3610

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Elliptical galaxy	11 h 18.4 m, +58° 47′	April 5
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		2.7′×2.3′	10.7

This galaxy is thought to have undergone a major merger a few billion years ago. Professional telescopes find an unusual "warped disk" is present in the region within 2.7″ of the center of this galaxy ("warped" meaning the plane of the disk changes with radius), which is a byproduct of its past merger. This galaxy is part of the NGC 3642 group of gravitationally bound galaxies that consists of NGC 3642 (spiral galaxy, 35′ ENE, mag. 10.8), NGC 3619 (1° S – see NGC 3619), NGC 3674 (lenticular galaxy, 2° SSE, mag. 12.2), and NGC 3683 (barred spiral galaxy, 2° 15′ SSE, mag. 12.5).

NGC 3613

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Elliptical galaxy	11 h 18.6 m, +58° 00′	April 5
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		3.9′×1.9′	10.8

This is the namesake member of the NGC 3613 group of perhaps 11 gravitationally bound galaxies that also includes NGC 3625 (barred spiral, 20′ SE, mag. 13.1) and NGC 3669 (barred spiral, 57′ ESE, mag. 12.4). Although NGC 3619 is nearby from our line-of-sight (15′ SSE – see NGC 3619), NGC 3619 instead belongs to the NGC 3642 galaxy group (see NGC 3610), although the two galaxy groups are considered associated.

NGC 3619

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Lenticular galaxy	11 h 19.4 m, +57° 46′	April 5
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		2.7′×2.3′	11.5

This is part of the NGC 3642 galaxy group (see NGC 3610). It has a total dynamical mass of about 70 billion suns and contains an unusually large amount of hydrogen gas (about a billion suns). This is unusual for a lenticular galaxy (which tend to be gas-poor) and may be due to a previous merger with a gas-rich galaxy. Although NGC 3613 is nearby from our line-of-sight (15′ NNW – see NGC 3613), it has its own separate galaxy group, although that group and the NGC 3610 group form an association.

NGC 3621

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hydra	Barred spiral galaxy	11 h 18.3 m, −32° 49′	April 5
Distance	**Age**	**Apparent size**	**Magnitude**
20 million light years		12.3′×6.8′	9.4

Present in this galaxy are many ionized hydrogen regions (HII regions), like M42 (the Orion Nebula) or the Rosette Nebula (see NGC 2244). These regions are ionized by young stars (spectral type O and B) that formed within them. In NGC 3621 they have a median mass of a few hundred thousand suns and a median age of about 100 million years. The galaxy has a dynamical mass of 2 hundred billion suns, an optical diameter of about 80,000 light years and an inclination angle of about 60° (90° is edge-on while 0° is face-on). The galaxy is of Seyfert type (where a supermassive object in this galaxy’s center accumulates nearby material and produces strong emission) and thought to be in its early stages of rapidly accreting onto a relatively small central black hole, whose mass is perhaps around 10,000 suns. The nucleus also contains a giant compact star cluster with a mass of about 10 million suns.

NGC 3623 (M65)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred spiral galaxy	11 h 18.9 m, +13° 05′	April 5
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		9.8′ × 2.9′	9.2

M65 is nearly edge-on with its rotation axis inclined by 71° from our line-of-sight. It has an optical diameter of about 100,000 light years. It is part of a gravitationally bound group of galaxies that includes NGC 3593 (1° SW), as well as nearby M66 (see M66/NGC 3627) and NGC 3628 (see NGC 3628) with which it forms the "Leo Triplet." Its stars are unusually similar in age (0.7–0.9 billion years) across its central bulge and disk regions, perhaps because of central bulge star formation induced by past interaction with its fellow Leo Triplets.

NGC 3626

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Lenticular galaxy	11 h 20.1 m, +18° 21′	April 5
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		2.7′ × 1.9′	10.9

Gas in the central regions of this galaxy is counter-rotating relative to the stars, and is thought to be the result of a past minor merger with a gas-rich satellite galaxy. In the central few arc seconds, the gas is thought to actually rotate about an axis nearly perpendicular to the rest of the galaxy, forming a so-called "polar ring." Although the optical diameter of the galaxy is about 55,000 light years, professional telescopic studies also find a ring of neutral hydrogen gas that extends out several times this distance. This gas may have been stripped from a gas-rich satellite galaxy as it was being accreted. NGC 3626 is part of the NGC 3607 galaxy group (see NGC 3607).

NGC 3627 (M66)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred spiral galaxy	11 h 20.3 m, +12° 59′	April 5
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		9.1′×4.1′	8.9
M66 is part of the "Leo Triplet" that includes nearby M65 (see M65/NGC 3623) and NGC 3628, which form a gravitationally bound group of four galaxies (the fourth member being nearby NGC 3593), and which are part of the Leo I galaxy group (see M96/NGC 3368). Professional telescopes find a quarter million light year (40′) long plume of stars and gas extending to the east of NGC 3628, with a mass of hundreds of millions of suns, that is thought to be the result of an interaction with M66 nearly a billion years ago. Distortions in the disk and arms within M66 itself may be the result of a dwarf galaxy careening in from the SE and colliding with M66 within the past few tens of millions of years. M66 has an optical diameter of about 90,000 light years and has an active galactic nucleus (AGN) of either LINER (see M81/NGC 3031) or Seyfert type (where a supermassive object in this galaxy's center accumulates nearby material and produces strong emission). It has an 12″ long inner bar nested inside its large-scale 1.4′ long outer bar, with a 45° angle between the two bars.			

NGC 3628

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Spiral galaxy	11 h 20.3 m, +13° 35′	April 5
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		13.1′×3.1′	9.5

This galaxy is nearly edge-on with an optical diameter of about 130,000 light years. It forms a triplet with M65 (NGC 3623) and M66 (NGC 3627), with which it forms a gravitationally bound group of galaxies that also includes NGC 3593 (1° 36′ WSW – see NGC 3593). Intense star formation (a “starburst”) is occurring in the nucleus of NGC 3628 which blows material out of the center in a collimated outflow perpendicular to the plane of the galaxy (see M82 for further explanation). An X-ray point source is offset 20″ WSW (several thousand light years) from the nucleus of the galaxy. The origin of this source may be due to accretion onto an intermediate sized black hole (with a mass of about a thousand suns) that is separate from the galaxy nucleus. Professional telescopes also find a quarter million light year (40′) long plume of stars and gas extending to the east of NGC 3628 that is thought to be the result of an interaction with M66 nearly a billion years ago.

NGC 3631

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	11 h 21.0 m, +53° 10′	April 6
Distance	**Age**	**Apparent size**	**Magnitude**
45 million light years		5.0′×3.7′	10.1

This is a “grand-design” spiral, meaning that it has two symmetrically placed spiral arms that extend over most of its visible disk in professional telescopic images. The radius of corotation (where the waves responsible for the spiral arms are traveling at the same speed as the disk matter itself) is situated 42″ from the galaxy center.

NGC 3640

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Elliptical galaxy	11 h 21.1 m, +03° 14′	April 6
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		4.0′ × 3.2′	10.3
It is the namesake member of the NGC 3640 galaxy group that contains perhaps twelve gravitationally bound galaxies, including NGC 3630 (lenticular galaxy, 20′ SW, mag. 12.1), NGC 3664 (peculiar barred spiral galaxy, 50′ E, mag. 12.6), NGC 3611 (spiral galaxy, 1° 36′ NW, mag. 11.9) and NGC 3641 (elliptical galaxy, 2.5′ SE, mag. 13.1). For an elliptical galaxy, NGC 3640 rotates at an unusually high velocity (up to 120 km/s), about its major axis (which is aligned E-W). This galaxy is also interacting with NGC 3641. This interaction may be causing patchy shell-like structures in NGC 3640 but is not thought to be responsible for the fast rotation of NGC 3640. Instead, this rotation may be the result of a past merger (and accretion of) a disk galaxy.			

NGC 3655

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Spiral galaxy	11 h 22.9 m, +16° 35′	April 6
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		1.5′ × 1.0′	11.6
This is part of the NGC 3607 galaxy group (see NGC 3607). It has an optical diameter of about 30,000 light years, an inclination angle of about 50° (meaning its axis of rotation is inclined at 50° from our line-of-sight) and a position angle of 30° (meaning its major axis is aligned 30° counterclockwise from N).			

NGC 3665

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Lenticular galaxy	11 h 24.7 m, +38° 46′	April 7
Distance	**Age**	**Apparent size**	**Magnitude**
90 million light years		4.3′×3.3′	10.7

This galaxy is thought to be oblate in shape (meaning it is shaped like a squashed tennis ball). It has a mass of about 3 hundred billion suns. A thin dust lane is present in professional telescopic studies. Two symmetric radio jets (due to synchrotron emission of high-speed electrons gyrating wildly in a magnetic field) emanate perpendicular to this dust lane near the center of the galaxy, extending outward for 1.5′ (40,000 light years) and thought to be confined by a gaseous halo. The jets are thought to be driven by an active galactic nucleus (in which energetic emission is caused by accretion onto a massive central object e.g., a black hole). It is the namesake member of the NGC 3665 group of gravitationally bound galaxies that includes perhaps 11 galaxies, among them being NGC 3648 (lenticular galaxy, 1° 11′ NNW, mag. 12.5), NGC 3652 (peculiar barred spiral, 1° 5′ SSW, mag. 12.1) and NGC 3658 (lenticular galaxy, 15′ SW, mag. 12.1).

NGC 3675

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	11 h 26.1 m, +43° 35′	April 7
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		5.9′×3.1′	10.0

This galaxy has an optical diameter of about 95,000 light years, a mass of 200 billion suns and an inclination angle of about 60°. Its spiral arms coalesce in an inner ring near its center in professional telescopes.

NGC 3686

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred spiral galaxy	11 h 27.7 m, +17° 13′	April 7
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		3.1′×2.4′	11.2

This is the namesake member of a possible group of perhaps six galaxies that includes NGC 3681, NGC 3684, NGC 3691, which are all associated with the NGC 3607 group of galaxies (see NGC 3607), the Leo II collection of groups and the Virgo galaxy cluster (see M49/NGC 4472). The NGC 3686 group moves about with an average time for one of them to traverse the space enclosed by their group (called the "crossing time") being about a billion years. NGC 3686 has an optical diameter of about 60,000 light years.

NGC 3726

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	11 h 33.3 m, +47° 02′	April 9
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		6.0′×4.1′	10.4

This has a mass of 100-200 billion suns and an optical diameter of about 90,000 light years. Its inclination angle is about 45° (i.e., it rotates about an axis tilted at 45° to our line-of-sight) and its position angle is 10° (i.e. its major axis is aligned 10° counterclockwise from N-S). It is part of the Ursa Major galaxy cluster (see M109/NGC 3992) as well as the NGC 3992 (M109) galaxy group.

NGC 3729

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Peculiar barred spiral galaxy	11 h 33.8 m, +53° 08′	April 9
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		2.9′×1.9′	11.4

This has a total mass of about 40 billion suns and an optical diameter of about 50,000 light years. It is part of the NGC 3631 galaxy group (see NGC 3631), as is its close neighbor NGC 3718 (12′ WSW), the latter having a "warped disk" (meaning the central parts of its disk lie in a different plane than the outer regions). NGC 3718 has about ten times the total mass of NGC 3729 (giving it a total mass of about 400 billion suns). NGC 3729 and NGC 3718 are thought to be an interacting pair.

NGC 3766

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Centaurus	Open cluster	11 h 36.2 m, −61° 36′	April 9
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	20 million years	15′	5.3

With nearly a third of its brightest stars showing emission lines, this has the largest known number of Be stars of any of the nearly 1,800 known galactic open clusters. Be stars have high rotational velocities and circumstellar disks that produce emission lines (see NGC 2422/M47 for further explanation). Professional telescopes count nearly 300 stars in this cluster with a mean mass of 1.5 suns.

NGC 3810

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Spiral galaxy	11 h 41.0 m, +11° 28′	April 11
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		4.1′ × 2.7′	10.8
This has a mass of about 50 billion suns and an optical diameter of about 50,000 light years. NGC 3773 (lenticular galaxy, 57′ NW, mag. 12.0) is thought to be a companion to this galaxy.			

NGC 3813

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	11 h 41.7 m, +36° 33′	April 11
Distance	**Age**	**Apparent size**	**Magnitude**
85 million light years		2.0′ × 1.0′	11.5
This has an optical diameter of about 50,000 light years, an inclination angle of about 60° and a position angle of 87° (meaning its major axis is aligned E-W).			

NGC 3877

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	11 h 46.1 m, +47° 30′	April 12
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		5.3′ × 1.2′	11.2
A foreground star (in our galaxy) superimposed on the nucleus gives the center of this galaxy a stellar appearance in large amateur telescopes. The galaxy is nearly edge-on (with an inclination angle of 83°) and has an optical diameter of about 80,000 light years and mass of about 50 billion suns. It is part of the Ursa Major galaxy group (see M109/NGC 3992) as well as the NGC 3992 galaxy group.			

NGC 3893

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	11 h 48.6 m, +48° 43′	April 13
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		4.5′×2.8′	10.2

This is a "grand-design" spiral, meaning that it has two symmetrically placed spiral arms that extend over most its visible disk in professional telescopic images. It has a mass of 50–80 billion suns. It forms a pair with NGC 3896 (barred lenticular galaxy, 4′ SE, mag. 12.8) whose close presence may have caused a higher rotation velocity in the north of NGC 3893 than in the south. It is part of the Ursa Major galaxy cluster (see M109/NGC 3992), as well as the NGC 3992 galaxy group.

NGC 3898

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	11 h 49.3 m, +56° 05′	April 13
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		4.4′×2.6′	10.8

This is a "flocculent" spiral galaxy (see NGC 3521). With several billion solar masses worth of neutral hydrogen gas, this galaxy is quite gas-rich for its galaxy type (it is an "early-type" spiral), although the density of this gas is well below that needed for spontaneous star formation from gravitational collapse. Thus, other, local mechanisms are thought to be responsible for the formation of the young, bright stars seen in its flocculent pattern, although without the help of the gravitational collapse of gas clouds, star formation rates in this galaxy are much lower than may have occurred when more gas was perhaps present earlier in this galaxy's life. The total mass of the galaxy is several hundred billion Suns and its optical diameter is about 90,000 light years. It contains a tiny (120 light year diameter) nuclear stellar disk and is the namesake member of the NGC 3898 group of seven gravitationally bound galaxies that includes NGC 3733 (barred spiral, 2° 22′ WSW, mag. 11.8), NGC 3756 (barred spiral, 2° 31′ SW, mag. 11.2), NGC 3804 (barred spiral, 1° 10′ W, mag. 12.9), NGC 3850 (barred spiral, 33′ WSW, mag. 13.4), NGC 3982 (1° 24′ SE, see NGC 3982), and NGC 3846A (irregular barred, 1° 16′ SW, mag. 13.3). This group is part of the Ursa Major galaxy cluster (see M109/NGC 3992).

NGC 3900

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Lenticular galaxy	11 h 49.2 m, +27° 01′	April 13
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		3.2′ × 1.7′	11.4

This has an optical diameter of about 90,000 light years. It is thought to be part of a gravitationally bound group of three galaxies that includes NGC 3912 (34′ SSE – see NGC 3912) and the much dimmer UGC 6791 (spiral, 17′ S, mag. 14). NGC 3900 is believed to have undergone a minor merger in its past, the remains of which are seen in the unusual motions of some of the gas in this galaxy in professional telescopic studies.

NGC 3912

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Leo	Barred spiral galaxy	11 h 50.1 m, +26° 29′	April 13
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		1.5′ × 0.9′	12.6

This is part of the NGC 3900 galaxy group (see NGC 3900). It has an optical diameter of about 40,000 light years, an inclination angle of about 60°, and a position angle of 5°. NGC 3899 is a duplicate entry of NGC 3912.

NGC 3938

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	11 h 52.8 m, +44° 07′	April 14
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		5.4′ × 4.9′	10.1

This is nearly face-on (with an inclination angle of approximately 20°) and has an optical diameter of about 90,000 light years. Most of the disk rotates at about 150 km/s. This galaxy is part of the Ursa Major galaxy cluster (see M109/NGC 3992) and the NGC 4051 subgroup of this cluster (see NGC 4051).

NGC 3941

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred lenticular galaxy	11 h 52.9 m, +36° 59′	April 14
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		3.5′×2.5′	10.3
Professional telescopic studies find an extended disk of counter-rotating gas, a double bar, consisting of an inner bar with position angle 30° and an outer bar with position angle of 166°, and inner spiral arms. It is a Seyfert galaxy (where a supermassive object in this galaxy's center accumulates nearby material and produces strong emission).			

NGC 3945

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred lenticular galaxy	11 h 53.2 m, +60° 41′	April 14
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		5.2′×3.5′	10.5
Professional telescopic studies find an inner disk and two nested bars in this galaxy (one about 5″ in length, the other about 80″ in length and surrounded by inner and outer rings, the latter being common in barred lenticular galaxies – see NGC 2859). The bars are at different position angles and probably rotate independently of each other. Bars in galaxies can transport material from the disk into the nucleus, thereby fueling activity in the nucleus. Whether this is what fuels the LINER (low-ionization nuclear emission region – see M81/NGC 3031 for explanation) in the nucleus of this galaxy is not known.			

NGC 3949

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	11 h 53.7 m, +47° 52′	April 14
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		2.9′ × 1.7′	10.6
This is part of the Ursa Major galaxy cluster (see M109/NGC 3992) as well as the NGC 3992 galaxy group. It has a mass of about 30 billion suns, an optical diameter of about 50,000 light years, an inclination angle of about 55°, and a position angle of 120° (SE–NW).			

NGC 3953

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	11 h 53.8 m, +52° 20′	April 14
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		6.9′ × 3.6′	9.8
This is part of the Ursa Major galaxy cluster (see M109/NGC 3992) as well as the NGC 3992 galaxy group (see M109/NGC 3992). It has a mass of about 140 billion suns, an optical diameter of about 120,000 light years, an inclination angle of about 60° and a position angle of 13°. It is a LINER (low-ionization nuclear emission region) galaxy (see M81/NGC 3031) with ionized hydrogen (HII) regions (like M42).			

NGC 3962

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Crater	Elliptical galaxy	11 h 54.7 m, −13° 58′	April 15
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		2.6′×2.2′	10.7
This galaxy contains an inner disk of ionized gas with several tens of thousands of solar masses, which is in contrast to the classical notion that elliptical and lenticular (so-called "early-type") galaxies contain no interstellar matter. However, it is has been recognized for some time now that perhaps about half of early-type galaxies contain significant amounts of dust and gas, one suggested source of this material being accretion from past mergers with other galaxies. Indeed, professional telescopic studies find an odd arc-like structure of ionized gas in NGC 3962 that may have been accreted in an earlier merger with another galaxy.			

NGC 3982

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	11 h 56.5 m, +55° 08′	April 15
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		2.3′×2.0′	11.1
This is nearly face-on (with an inclination angle of 26°) and is part of the NGC 3898 galaxy group (see NGC 3898), as well as the Ursa Major galaxy cluster (see M109/NGC 3992). This galaxy is a Seyfert galaxy (see NGC 3227) and has a circumnuclear ring of very active star formation (at radii 5″–20″ from the center, with many ionized hydrogen HII regions). A mini-spiral exists between this ring and the Seyfert active galactic nucleus (in which energetic emission is caused by accretion, fed by the mini-spiral, onto the massive central black hole). This galaxy is also a multiple-armed spiral (as opposed to a "grand-design" spiral which has only two symmetrically placed arms, or a "flocculent" spiral where star formation occurs in patches throughout the disk with no obvious spiral arms).			

NGC 3992 (M109)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	11 h 57.6 m, +55° 22′	April 15
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		7.5′×4.4′	9.8

This has a mass of about 250 billion suns and a diameter of about 130,000 light years. It is part of the Ursa Major galaxy cluster, which contains nearly 300 galaxies, one of only three major galaxy clusters within 150 million light years of us (the others being the Virgo cluster and the Fornax cluster). The Ursa Major cluster contains about 1/30 the mass of the Virgo cluster (see M49/NGC 4472) and is part of the Virgo supercluster (see see M49/NGC 4472). The Ursa Major cluster is an unusual cluster in that it consists almost entirely of late-type galaxies (e.g., Sc and SBc and later galaxies in Hubble's galaxy classification scheme; Sc and SBc spirals are "late-type" spirals that have prominent, loosely wound, spiral arms and only a very small central bulge relative to an extended disk). In contrast, most galaxy clusters consist of "early-type" galaxies (i.e., elliptical and lenticular, and early-type spirals, the latter having relatively tightly wound spiral arms and a large central bulge). Indeed, three-quarters of the Virgo cluster galaxies are early type. M109 is the namesake member of the M109/NGC 3992 galaxy group of about 30 gravitationally bound galaxies that is a subgroup of the Ursa Major cluster.

NGC 3998

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Lenticular galaxy	11 h 57.9 m, +55° 27′	April 15
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		2.7′ × 2.3′	10.6
This galaxy is part of the NGC 3631 galaxy group (see NGC 3631), as well as the Ursa Major galaxy cluster (see M109/NGC 3992). NGC 3998 is a LINER (“low-ionization nuclear emission region”) galaxy (see M81/NGC 3031), which although in general may be due to several possible mechanisms, in this case is thought to be one of about half of LINERs where the nuclear emission is due to accretion onto a supermassive black hole. The mass of the central black hole in this galaxy is thought to be about 800 million Suns. The presence of some interstellar matter (dust and gas) in NGC 3998 is thought to be due to accretion of a dwarf galaxy about a billion years ago. NGC 3990 (lenticular galaxy, 5′ W, mag. 12.6) is nearby both apparently and physically, but the two galaxies show only weak interaction.			

NGC 4026

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Lenticular galaxy	11 h 59.4 m, +50° 58′	April 16
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		5.2′ × 1.3′	10.7
Part of the Ursa Major galaxy cluster (see M109/NGC 3922) and the NGC 3992 galaxy group (see M109/NGC 3992), this is nearly edge-on (with an inclination angle of 80°) and has an optical diameter of about 80,000 light years and a total mass of about 80 billion suns. Professional telescopic studies find several filaments of neutral hydrogen (HI) gas that are each over a hundred thousand light years long (containing billions of solar masses), lying in the neighborhood of NGC 4026 and its nearby companions UGC 6917 (barred spiral, 42′ SW, mag. 12), and the much dimmer UGC 6922 and UGC 6956. This gas is expected to be captured by NGC 4026 over the coming millions to billions of years, possibly forming into a ring around this galaxy. The nucleus of NGC 4026 contains a supermassive black hole with a mass of about 200 million suns.			

NGC 4027

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Corvus	Barred spiral galaxy	11 h 59.5 m, −19° 16′	April 16
Distance	**Age**	**Apparent size**	**Magnitude**
90 million light years		3.3′ × 2.4′	11.0

This galaxy is an oddity in professional telescopic images because it is a one-armed spiral (its northern arm is far stronger than its southern arm) and its prominent bar is off-center. NGC 4027A (mag. 14) lies 4′ S. The two galaxies are interacting – indeed the dark matter halo of NGC 4027 extends out to NGC 4027A. Their interaction is thought to have caused the lopsidedness of NGC 4027's spiral arms, as well as a ring of atomic hydrogen (HI) gas around NGC 4027 (in professional telescopic studies) that has been stripped from NGC 4027A. NGC 4027A orbits NGC 4027 with a period of about 500 million years and is about 250 million years from its last closest approach. NGC 4027 has a mass of about 60 billion suns and is part of the NGC 4038 galaxy group (see NGC 4038). Its bulge is atypically small, being about 1/25 the size of its disk, and tidal interaction with NGC 4027A may have been important in the formation of NGC 4027's bulge.

NGC 4030

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Spiral galaxy	12 h 00.4 m, −01° 06′	April 16
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		4.2′ × 3.2′	10.6

This has an optical diameter of about 100,000 light years, a mass of nearly 200 billion suns, an inclination angle of about 40° and a position angle of 27°. It is the namesake member of the NGC 4030 group of perhaps seven gravitationally bound galaxies, the others being non-NGC galaxies, the brightest of which is UGC 7000 (irregular barred galaxy, mag. 14, 17′ SE), all of which are associated with the Virgo galaxy cluster (see M49/NGC 4472).

NGC 4036

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Lenticular galaxy	12 h 01.5 m, +61° 54′	April 16
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		4.3′ × 1.7′	10.5

This is a LINER (low-ionization nuclear emission region) galaxy (see M81/ NGC 3031). It is the namesake member of the NGC 4036 group of perhaps six gravitationally bound galaxies that includes NGC 4041 (15′ NNE – see NGC 4041) and IC 758 (barred spiral, 41′ NNE, mag. 13.4). NGC 4036 is nearly edge-on (inclination angle 71°). Its central couple arc seconds contains a tilted stellar disk in professional telescopes.

NGC 4038

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Corvus	Barred spiral galaxy	12 h 01.9 m, −18° 52′	April 16
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		3.4′ × 1.7′	10.3

Together with NGC 4039 this is nicknamed the "Ring-Tail Galaxy" or the "Antennae." The two disk galaxies are colliding, a process that began a few hundred million years ago. The merger is causing intense star formation (perhaps a dozen stars per year) including many hundreds of compact young star clusters (a few of which may survive some billions of years and become like globular clusters in our galaxy). These star clusters occur throughout the two galaxies. The most luminous clusters have ages of a few million years, while the most massive are several hundred million years old. These clusters individually contain masses up to several million suns. Several tens of X-ray point-sources are found in these two galaxies, the brightest of which are associated with starburst regions, but most are thought to be associated with black holes having masses of several tens of suns. This galaxy is the namesake member of the NGC 4038 galaxy group that includes perhaps 20 nearby gravitationally bound galaxies.

NGC 4041

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	12 h 02.2 m, +62° 08′	April 16
Distance	**Age**	**Apparent size**	**Magnitude**
75 million light years		2.7′×2.6′	11.1

This is part of the NGC 4036 galaxy group (see NGC 4036). It has a stellar mass of about 35 billion suns, is about 60,000 light years in diameter, and nearly face-on (with an inclination angle of about 20°). It may have undergone a past minor merger, giving higher star formation rates in its central regions as well as a nucleus that has an odd doublet nature, with emission peaks from two regions that are slightly offset from the center. It has a two part disk, with its inner disk (20″ in radius) having more tightly wound arms than its looser multiple-arm outer spiral disk.

NGC 4051

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	12 h 03.2 m, +44° 32′	April 16
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		5.2′×3.9′	10.0

The SW side is the nearer side of this galaxy. It is a Seyfert galaxy and one of 12 such galaxies so identified by Seyfert himself. Such galaxies have a supermassive object in the center (about 1.7 million solar masses for this galaxy) that accumulate nearby material, resulting in strong emission from the nucleus. Nearby NGC 4013 (spiral galaxy, 1° SW, mag. 11.5) has been suggested as a companion galaxy that tidally disturbed NGC 4051 in the past, creating gravitational instability in the disk of NGC 4051 that led to its Seyfert character. NGC 4051 is part of the Ursa Major galaxy cluster (see M109/NGC 3992) and is the namesake member of the NGC 4051 group of 16 galaxies that includes nearby NGC 3906 (4° 32′ NNW), NGC 3938 (1° 54′ WSW – see NGC 3938), IC 750 (2° SSW), NGC 4143 (2° 19′ SSE – see NGC 4143), NGC 4096 (3° N), NGC 4111 (1° 38′ SSE – see NGC 4111), NGC 4117 (1° 38′ SSE), NGC 4138 (1° 25′ SE), NGC 4183 (2° ESE), NGC 4218 (4° 12′, NNE), NGC 4389 (4° 07′ ENE), NGC 4288 (3° 31′ ENE) and NGC 4346 (4° 19′ NE – see NGC 4346.)

NGC 4085

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	12 h 05.4 m, +50° 21′	April 17
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		2.8′×0.8′	12.0
This is part of the Ursa Major galaxy cluster as well as the NGC 3992 galaxy group (see M109/NGC 3992). It forms a pair with NGC 4088 (see NGC 4088, 12′ N). It has an optical diameter of about 35,000 light years.			

NGC 4088

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	12 h 05.6 m, +50° 32′	April 17
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		5.6′×2.1′	10.3
This is part of the Ursa Major galaxy cluster and the NGC 3992 galaxy group (see M109/NGC 3992). It rotates about an axis inclined at about 70° from our line-of-sight, with the NE portion of the galaxy rotating much more slowly (at about 100 km/s) than the SW portion of the galaxy (where the rotation speed is about 200 km/s). One explanation for this asymmetry is tidal interaction with nearby NGC 4085 (12′ S – see NGC 4085). NGC 4088 has an optical diameter of about 100,000 light years.			

NGC 4102

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	12 h 06.4 m, +52° 43′	April 17
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		3.1′×1.7′	11.3
This is part of the Ursa Major galaxy cluster (see M109/NGC 3992). This galaxy has intense star formation occurring in a 10″ diameter ring in its nucleus (a “starburst” ring) and is also a LINER (see M81/NGC 3031). Its central black hole has a mass of about 80 million suns. It has an optical diameter of about 50,000 light years.			

NGC 4111

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Lenticular galaxy	12 h 07.0 m, +43° 04′	April 17
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		4.6′×1.0′	10.8
This is part of the Ursa Major galaxy cluster (see M108/NGC 3992) and the NGC 4051 galaxy group (see NGC 4051). This is a LINER galaxy (see M81/NGC 3031) whose nuclear emission is thought to be due to the presence of young, hot stars in its center (rather than photoionization associated with accretion onto a central black hole as in M81/NGC 3031). It has a circumnuclear “polar” ring of gas and dust, meaning that this ring’s axis is aligned perpendicular to the main rotational symmetry axis of the galaxy.			

NGC 4143

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Barred lenticular galaxy	12 h 09.6 m, +42° 32′	April 18
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		2.3′ × 1.4′	10.8
This is part of the Ursa Major galaxy cluster and the NGC 4051 subgroup of this cluster (see NGC 4051). It is a LINER galaxy (see M81/NGC 3031).			

NGC 4147

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Globular cluster	12 h 10.1 m, +18° 33′	April 18
Distance	**Age**	**Apparent size**	**Magnitude**
60,000 light years		4.4′	10.4
This globular cluster has a mass of about 50,000 suns and its size corresponds to a diameter of about 80 light years. Like almost all other globular clusters in our galaxy, this cluster doesn′t orbit with the material in the galaxy's disk. Instead it spends about 2/3 of its time at distances farther than 130,000 light years from the galactic center (out in the halo of the galaxy) in a precessing path that orbits the galaxy about once every half billion years and is inclined to the galactic central plane by about 45°. Professional telescopes find two tidal tails extending out from this cluster, one leading and one trailing the cluster, which were created by ongoing gravitational forces of the galaxy.			

NGC 4150

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Lenticular galaxy	12 h 10.6 m, +30° 24′	April 18
Distance	**Age**	**Apparent size**	**Magnitude**
45 million light years		2.3′ × 1.6′	11.4
This has a stellar mass of about 6 billion suns. It is thought to have undergone a minor merger event in which the accreted galaxy had a mass about 1/20 that of NGC 4150. The merger is responsible for star formation in the past billion years, as well as a kinematically decoupled core where the core of the galaxy rotates about a different axis than the rest of the galaxy. It is thought to be part of the Coma I galaxy cloud, which is on the outskirts of the Virgo galaxy cluster (see M49/NGC 4472).			

NGC 4151

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Barred spiral galaxy	12 h 10.5 m, +39° 24′	April 18
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		6.8′ × 5.3′	10.8
This has an optical diameter of about 80,000 light years. This is a Seyfert galaxy, where nuclear emission is thought to be due to accretion onto a central black hole, which in this case may be a binary black hole consisting of two orbiting black holes, one with a mass of 12 million suns and the other with a mass of 44 million suns, with an orbital period of about 16 years. The nuclear emission from this galaxy varies considerably on different time scales as short as a day, which may be due to motion and variations in the density of intervening matter in the central regions of NGC 4151. NGC 4151 is not interacting with nearby NGC 4156 (barred spiral, 5′ NE, mag. 13.1).			

NGC 4157

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	12 h 11.1 m, +50° 29′	April 18
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		6.7′ × 1.2′	11.3
This is part of the Ursa Major galaxy cluster (see M109/NGC 3992) as well as the M109/NGC 3992 group of galaxies (see M109/NGC 3992). This galaxy is nearly edge-on (its rotation axis is inclined about 80° from our line-of-sight). It has a mass of about 100 billion suns and an optical diameter of about 120,000 light years. It contains about 80 globular clusters.			

NGC 4179

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Lenticular galaxy	12 h 12.9 m, +01° 18′	April 18
Distance	**Age**	**Apparent size**	**Magnitude**
65 million light years		4.2′ × 1.3′	10.9
This is part of the NGC 4123 group of gravitationally bound galaxies that contains five galaxies, including NGC 4116 (barred spiral, 1° 56′ NW, mag. 11.6) and NGC 4123 (barred spiral, 1° 58′ NW, mag. 11.0).			

NGC 4192 (M98)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 13.8 m, +14° 54′	April 20
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		9.8′×2.8′	10.1

M98 is part of the Virgo galaxy cluster (see M49/NGC 4472), near its western edge and thought to be lying toward the front of this cluster. It has a mass of about 200 billion suns and an optical diameter of about 150,000 light years. It is nearly edge-on (with its axis of rotation inclined by about 80° from our line-of-sight). It has emission from its nucleus (perhaps from a LINER that is powered by both a starburst and accretion onto a massive central object – see M81/NGC 3031).

NGC 4203

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred lenticular galaxy	12 h 15.1 m, +33° 12′	April 19
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		3.5′×3.2′	10.7

This is a LINER galaxy (see M1/NGC 3031) that is thought to belong to the class of LINERs that harbor a supermassive central black hole, having a mass of about 60 million suns in this galaxy. It is also relatively rich in atomic hydrogen gas for its galaxy type, perhaps having obtained this gas by accretion of another galaxy more than a billion years ago. It is part of the NGC 4274 galaxy group (see NGC 4274).

NGC 4214

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Irregular barred galaxy	12 h 15.6 m, +36° 20′	April 19
Distance	**Age**	**Apparent size**	**Magnitude**
10 million light years		8.0′×6.6′	9.6

This is a dwarf galaxy, similar in mass to the Large Magellanic Cloud, with intense star formation (a "starburst") in its central-northwest and southeast regions (0.5′ SE), consisting of more than a dozen young massive clusters each containing many tens of thousands of hot young O-type stars that are only a few million years old. Several of these young massive clusters are visible as bright knots in large amateur telescopes. The central-northwest starburst regions contain numerous Wolf-Rayet stars (see NGC 2403 for explanation of "Wolf-Rayet" stars). The starbursts may have arisen because of a past merger or collision with another galaxy. It is part of the NGC 4631 galaxy group (see NGC 4631).

NGC 4216

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 15.9 m, +13″ 09′	April 19
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		8.1′×1.8′	10.3

Professional telescopes find several stellar filaments extending out from this galaxy that are thought to be the tidal streams of disrupted dwarf galaxies. The nucleus of this galaxy has a different chemical make-up than the rest of the galaxy (the nucleus is richer in "metals," i.e., elements heavier than helium) and is also thought to be several billion years younger than its surrounding bulge. In addition, the nucleus (out to a radius of about 10″) rotates independently of the rest of the galaxy (i.e., it is "kinematically decoupled"). This galaxy is nearly edge-on (with an inclination angle of about 85°) and has an optical diameter of about 140,000 light years. It is part of the Virgo galaxy cluster (see M49/NGC 4472), belonging to the M87 clump of this cluster.

NGC 4244

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Spiral galaxy	12 h 17.5 m, +37° 48′	April 20
Distance	**Age**	**Apparent size**	**100.154 pt**
15 million light years		16.6′×1.9′	10.0

This is part of the Canes Venatici I galaxy group of about 40 galaxies, and is the second most luminous galaxy in this group after M94 (NGC 4736). The only other bright galaxy in this group is NGC 4449 (see NGC 4449). It has a stellar mass of about 2 billion suns, an optical diameter of about 70,000 light years and is almost exactly edge-on. Its nucleus contains a star cluster with a mass of about 16 million suns within a 4″ diameter region. It also has a somewhat warped neutral hydrogen (HI) disk, a common feature of spiral galaxies.

NGC 4245

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 17.6 m, +29° 36′	April 20
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		2.9′×2.2′	11.4

This has a circumnuclear ring of star formation, about 10″ in diameter, thought to be fed by this galaxy's large scale bar. Another ring inside this ring is chemically distinct and may be the remains of previously located bar-fed star formation. It is part of the NGC 4274 galaxy group (see NGC 4274) and has a very low mass of atomic hydrogen (about 10 million suns), perhaps due to ram pressure stripping by the intergalactic medium of its galaxy group.

NGC 4251

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred lenticular galaxy	12 h 18.1 m, +28° 10′	April 20
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		3.6′ × 1.5′	10.6
This is part of the NGC 4274 galaxy group (see NGC 4274). It has a diameter of about 40,000 light years and is nearly edge-on. It has a very low mass of atomic and molecular hydrogen (less than 15 million suns worth of each), which is typical of "early-type" galaxies like this lenticular galaxy.			

NGC 4254 (M99)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Spiral galaxy	12 h 18.8 m, +14° 25′	April 21
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		5.3′ × 4.6′	9.7
This is one of several galaxies whose nickname is the "Pinwheel Galaxy" (due to its multiple spiral arms evident in professional telescopic images). It is part of the Virgo galaxy cluster (see M49/NGC 4472) and may be a new entry to this cluster. It has a mass of a little under 200 billion suns and an optical diameter of about 90,000 light years. Vigorous star formation is occurring throughout this galaxy. In professional telescopes, one of this galaxy's spiral arms is much more pronounced, possibly caused by a close encounter with a massive galaxy, perhaps NGC 4162 (0.5° NNE, spiral galaxy, mag. 12.0), a few hundred million years ago. A huge cloud of neutral hydrogen (HI) with a mass of about 200 million suns lies about ½ million light years from NGC 4254 and has been hypothesized to be tidal debris from a previous high velocity encounter with M98 (see NGC 4192/M98) about three-quarters of a billion years ago.			

NGC 4258 (M106)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 19.0 m, +47° 18′	April 20
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		18.6′ × 7.2′	8.3

This is a Seyfert galaxy (see NGC 3227) and is thought to harbor a central black hole with a mass of about 40 million suns that is accreting much less than 1 solar mass per year. This galaxy has bipolar nuclear jets, driven by the central black hole. These jets are thought to emanate from the nucleus at about a 30° angle from the plane of the disk and interact with material in the disk which appear as "anomalous arms" in professional telescopic studies. The nucleus of this galaxy also contains water masers (see NGC 3079) contained in a thin warped disk with diameter of only 10 light years. This galaxy has an optical diameter of about 130,000 light years. It is at the north end of the NGC 4258 (M106) group of about 15 gravitationally bound galaxies that includes NGC 4144 (1° 45′ WSW), NGC 4242 (1° 42′ S), NGC 4460 (3° SE), NGC 4490 (6° SSE – see NGC 4490), NGC 4485 (6° SSE – see NGC 4485), NGC 4618 (7° SE – see NGC 4618), NGC 4625 (7° SE), and possibly NGC 4248 (14′ WNW).

NGC 4261

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 19.4 m, +05° 49′	April 20
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		4.1′ × 3.6′	10.4

This nearly edge-on galaxy has a central black hole with a mass of about 500 million suns and is a LINER galaxy (see M81/NGC 3031). It has a kinematically decoupled disk of dust and gas (with a diameter of 1.7″, corresponding to about 1,000 light years). Professional telescopes find two jets pointing out from the nucleus perpendicular to this disk (one pointed E, the other pointed W) and extending for thousands of light years. About 2,400 globular clusters have been cataloged in this galaxy. It may have undergone a galaxy merger or interaction in the past couple billion years. NGC 4261 and nearby NGC 4264 (3.5′ NE) both belong to the NGC 4261 group of gravitationally bound galaxies that contains more than 80 galaxies and lies "behind" the Virgo galaxy cluster (see M49/NGC 4472) at roughly twice the distance of the Virgo cluster.

NGC 4273

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 19.9 m, +05° 21′	April 20
Distance	**Age**	**Apparent size**	**Magnitude**
115 million light years		2.3′×1.5′	11.7

This is part of the NGC 4261 galaxy group (see NGC 4261), as are its near neighbors, NGC 4277 (2′ E) and NGC 4268 (4′ SSW). Professional telescopes find NGC 4673 has a distorted shape whose cause remains unknown but may be due to tidal distortion within the past billion years or so with another (unidentified) member of the NGC 4261 galaxy group.

NGC 4274

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 19.8 m, +29° 37′	April 20
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		6.8′×2.4′	10.5

This is part of the NGC 4274 group of about 14 gravitationally bound galaxies, that includes nearby NGC 4136 (2° 18′ W), NGC 4173 (1° 41′ WSW), NGC 4245 (28′ W – see NGC 4245), NGC 4278 (20′ S), NGC 4283 (19′ SSE), NGC 4314 (40′ ENE – see NGC 4314), NGC 4310 (42′ SE), NGC 4251 (1° 30′ SSW – see NGC 4251), NGC 4359 (2° 07′ NNE), NGC 4020 (4° 36′ W), NGC 4062 (4° NE), NGC 4525 (3° 06′ ENE), and NGC 4203 (3° 43′ NNW – see NGC 4203). A number of the galaxies in this group are deficient in atomic hydrogen (HI), and NGC 4274 is no exception – it is gas poor for its galaxy type, containing only about 200 million suns of atomic hydrogen. It has an optical diameter of about 80,000 light years and is nearly edge-on (with an inclination angle of about 70°).

NGC 4278

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Elliptical galaxy	12 h 20.1 m, +29° 17′	April 20
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		3.8′ × 3.8′	10.1
The nucleus here has nuclear emissions and has been classified as a LINER galaxy (see M81/NGC 3031). It is thought to contain a supermassive black hole at its center that has a mass of a few hundred million suns and is thought to be responsible for a two-sided nuclear jet that extends out a few light years from the nucleus in professional telescopes. It is part of the NGC 4274 galaxy group (see NGC 4274), as is its close neighbor NGC 4283 (3′ NE). It is surprisingly rich in atomic hydrogen (HI) for an elliptical galaxy (containing hundreds of millions of solar masses of HI in a 5′ diameter ring) and contains about 250 globular clusters, both of which may be the result of this galaxy having swallowed a companion galaxy in the past.			

NGC 4281

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Lenticular galaxy	12 h 20.4 m, +05° 23′	April 20
Distance	**Age**	**Apparent size**	**Magnitude**
110 million light years		3.0′ × 1.6′	11.4
Like its five immediate neighbors to the west (NGC 4273, NGC 4277, NGC 4268, NGC 4259 and NGC 4270), this galaxy belongs to the NGC 4261 galaxy group (see NGC 4261), which is roughly twice as far away from us as the Virgo galaxy cluster is (see M49/NGC 4472).			

NGC 4293

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred lenticular galaxy	12 h 21.2 m, +18° 23′	April 21
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		5.6′×2.6′	10.3

This is a LINER galaxy (see M81/NGC 3031). It is part of the Virgo galaxy cluster (see M49/NGC 4472), lying in the M87 clump of the Virgo cluster.

NGC 4303 (M61)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 21.9 m, +04° 28′	April 21
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		6.5′×5.8′	9.3

This has a total mass of about 70 billion suns. It has an active galactic nucleus containing a central supermassive black hole with a mass of a few millions suns. Its nucleus also contains a few million year old starburst cluster with a mass of about 100,000 suns. It also has a massive circumnuclear star-forming disk (with a diameter of about 10″ and a mass of about 50 million suns) that itself has a bar and spiral structure. This galaxy has a diameter of about 100,000 light years. It is part of the Virgo cluster (see M49/NGC 4472) and is a grand-design spiral, meaning that it has two symmetrically placed spiral arms that extend over most its visible disk in professional telescopic images. Many giant, ionized hydrogen (star-forming) regions are present along its spiral arms, giving the arms an uneven brightness along their length in large amateur telescopes. The total star-formation rate in this galaxy is probably 1–2 solar masses/year (which is similar to that occurring in our galaxy, but our galaxy is more than ten times as massive). It is probably interacting with nearby NGC 4303A (10′ NE, mag. 13) and NGC 4292 (12′ NW, mag. 12.2).

NGC 4314

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 22.5 m, +29° 54′	April 21
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		4.2′×3.7′	10.5

This is thought to be part of the NGC 4274 galaxy group (see NGC 4274). It is nearly face-on (with an inclination angle of 23°). Professional telescopes find a ring of star formation around the nucleus with a diameter of about 16″. This ring is the only place star formation is currently occurring in this galaxy, and has been going on for a few tens of millions of years. The ring is believed to be related to the presence of a nuclear bar (with an oval shape and a diameter of 8″ in professional telescopic studies). This bar is thought to have driven gas from the disk inward into a ring situated between two so-called “inner Lindblad resonances” (where the speed of density waves resonantly amplifies oscillations in the orbits of matter in the disk).

NGC 4321 (M100)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 22.9 m, +15° 49′	April 22
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		7.5′×6.1′	9.3

This is part of the Virgo galaxy cluster (see M49/NGC 4472), being the brightest and largest spiral galaxy in the Virgo cluster. It is a “grand-design spiral,” meaning that it has two symmetrically placed spiral arms that extend over most of its visible disk in professional telescopic images. Resonance associated with the bar and the “Lindblad resonances” (where the speed of density waves resonantly amplifies oscillations in the orbits of matter in the disk) are thought to be triggering a ring of star formation (a “starburst”) in the central region of M100. This ring has a radius of 7.5″–20″ and its stars vary in age progressively around the ring from less than 10 million years old to several hundred million years old, formed in a succession of a few intense periodic star formation episodes. M100 has a mass of about 200 billion suns and an optical diameter of about 120,000 light years.

NGC 4346

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Barred lenticular galaxy	12 h 23.5 m, +47° 00′	April 21
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		3.2′ × 1.3′	11.3
This is part of the Ursa Major galaxy cluster (see M109/NGC 3992) and is alternately considered also part of the NGC 4051 galaxy group (see NGC 4051) or its own NGC 4346 galaxy group of about five galaxies.			

NGC 4350

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Lenticular galaxy	12 h 24.0 m, +16° 42′	April 21
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		2.9′ × 1.6′	11.0
This is thought to contain a supermassive central black hole with a mass of several hundred million suns. The disk of this galaxy accounts for a little more than a quarter of the light it emits, while its diffuse ellipsoidal part accounts for a little less than three-quarters of its light. The mass of this galaxy is about 50 billion suns. It is part of the M87 clump of the Virgo galaxy cluster (see M49/NGC 4472).			

NGC 4361

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Corvus	Planetary nebula	12 h 24.5 m, −18° 47′	April 21
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years		2.1′	10.9

Professional telescopic studies suggest that this nebula has a quadrapolar structure i.e. it has two pairs of bipolar lobes, one pair at position angles of 105° and 285° with a diameter of 68″, while the other pair is at position angles of 25° and 225° and a diameter of 90″. These lobes may have been produced by two separate mass ejection events (about a thousand years apart) with each event producing one of the bipolar lobes by the same mechanism that produces the more common bipolar planetary nebulae. The bipolar lobes may have different orientations because the circumstellar toroidal ring of material that leads to the formation of the jets was oriented in different directions (possibly due to precession of this ring due to the presence of a secondary star, i.e., the central star may be a binary star). These lobes (which are about 5,000 years old) are thought to be embedded in a spheroidal shell with a diameter of about 50″ (that is about 10,000 years old), all of which is surrounded by a filamentary outer halo (nearly 2′ in diameter) that has regions of high expansion velocity (70 km/s). The magnitude 13 central star is visible in amateur scopes and is thought to be a Population II star (i.e., it formed from the original, very old, material in our galaxy).

NGC 4365

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 24.5 m, +07° 19′	April 21
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		6.5′×5.0′	9.6

This is one of about 10 % of elliptical and lenticular galaxies within about 100 million light year radius that has a "kinematically decoupled core," meaning that the core of the galaxy appears to rotate about a different axis than the rest of the galaxy. In this galaxy, the inner core (within radii of 2″–3″) rotates about the minor axis of the elliptical shape that this galaxy makes in the sky, while the rest of the galaxy appears to rotate about the major axis (i.e., at right angles to the rotation axis of the inner core). Although it remains uncertain, such orbital behavior could be the result of one or more galaxy mergers, with a minor merger having occurred perhaps as recently as a few billion years ago. Professional telescopic studies indicate this galaxy contains more than 6,400 globular clusters. It is thought to contain a central supermassive black hole mass of a few hundred million suns. This galaxy lies beyond the main Virgo galaxy cluster (see M49/NGC 4472).

NGC 4371

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred lenticular galaxy	12 h 24.9 m, +11° 42′	April 21
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		4.0′×2.3′	11.0

This is part of the Virgo galaxy cluster (see M49/NGC 4472). The nucleus of this galaxy is not active and has a ring (21″ in diameter) around it in professional telescopic studies.

NGC 4374 (M84)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 25.1 m, +12° 53′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		6.5′×5.6′	9.2

This is part of the Virgo galaxy cluster (see M49/NGC 4472) and a physically close companion to M86. M84 lies at one end of the "Markarian Chain" of galaxies that lies along a "chain" NE of M84 and includes eight galaxies: M84 (NGC 4374), M86 (NGC 4406), NGC 4435, NGC 4438, NGC 4461, NGC 4458, NGC 4473 and NGC 4477. These galaxies are moving like a rigid, tumbling chain thrown away from Earth at several hundred km/s with the chain tumbling so that the W side of the chain (M84) is actually moving toward us while the E side (NGC 4477) is moving doubly fast away from us. The nucleus of M84 is an AGN (or "active galactic nucleus"), in which energetic emission is caused by accretion onto a massive central object, which for M84 is thought to be a black hole with a mass of around a billion suns. This AGN powers the two jets and associated lobes that are evident in the nuclear region (the inner few arcseconds) in professional telescopes at radio wavelengths, the radio waves being due to synchrotron emission of high-speed electrons gyrating wildly in a magnetic field. This galaxy contains about 1,800 globular clusters.

NGC 4382 (M85)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Elliptical galaxy	12 h 25.4 m, +18° 11′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		7.1′×5.5′	9.1

M85 is at the northern edge of the Virgo galaxy cluster (see M49/NGC 4472) and a close physical companion to NGC 4394 (7′ ENE). It is viewed nearly face-on and is unusual for an elliptical galaxy because it contains young stars (i.e., less than a few billion years old) in its inner regions, which may have arisen from a past merger with another galaxy or because of interaction with nearby NGC 4394. It is thought to have an eccentric stellar disk in its nucleus, that gives it the appearance of a double nucleus (with 0.25″ separation) in professional telescopes.

NGC 4388

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Spiral galaxy	12 h 25.8 m, +12° 40′	April 21
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		5.6′×1.5′	11.0

This is part of the Virgo galaxy cluster (see M49/NGC 4472), lying near the center of this cluster. It has a mass of about 90 billion suns and an optical diameter of about 90,000 light years. It is a Seyfert galaxy in which emission from the nucleus is thought to occur due to accretion of matter onto a massive central black hole with a mass of perhaps nearly 10 million suns. The galaxy is nearly edge-on (with an inclination angle of 72°). It has a tail of atomic hydrogen (HI) gas extending out hundreds of millions of light years from the disk in professional telescopes and having a mass of several hundred million suns. This gas is thought to have been stripped from the galaxy's disk by the "ram pressure" of the hot intracluster medium that occurs because of this galaxy's velocity relative to this medium. This removal of gas from this galaxy's disk is thought to have occurred a couple hundred million years ago and ended star formation in this galaxy.

NGC 4394

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 25.9 m, +18° 13′	April 22
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		3.4′×3.2′	10.9

This is part of the M87 clump of the Virgo cluster (see M49/NGC 4472), as is nearby M85 (7′ W – see M85/NGC 4382). It lies at the northern boundary of the Virgo cluster. NGC 4394 is a LINER ("low-ionization nuclear emission region") galaxy (see M81/NGC 3031). It has a diameter of about 50,000 light years and is nearly face-on (its inclination angle is about 22°, meaning that it rotates about an axis that is tilted from our line-of-sight by about 22°).

NGC 4406 (M86)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 26.2 m, +12° 57′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		8.9′×5.8′	8.9
This is part of the Virgo galaxy cluster (see M49/NGC 4472) and may anchor one of three subgroups in this cluster, the other two larger subgroups being associated with M87 (NGC 4486) and M49 (NGC 4472). Along with its close physical companion M84, it is part of the "Markarian Chain" of galaxies (see M84/NGC 4374). M86 is moving rapidly toward us compared to the rest of the Virgo cluster, resulting in M86 having a high speed (over 1,000 km/s) relative to the material between galaxies in the cluster (the "intracluster medium"). This galaxy's high-speed supersonic movement through the intracluster medium is thought to have caused gas to be stripped from the galaxy (so-called "ram-pressure stripping"), resulting in a tail of gas extending out from this galaxy more than a million light years and having a mass of about a billion suns. Professional telescopes have found several thousand globular clusters in this galaxy. It is thought to have undergone a collision with NGC 4438 (see NGC 4438) in the past.			

NGC 4414

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Spiral galaxy	12 h 26.5 m, +31° 13′	April 22
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		4.4′×3.0′	10.3
This is a flocculent spiral galaxy (see NGC 3521 for explanation). It contains an unusually large surface density of neutral gas in its disk (about ten times that of the Milky Way), which would normally give intense star formation if gravitationally disturbed by interaction with another galaxy. The relative isolation of NGC 4414 is thought to have kept this from occurring to date.			

NGC 4419

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 26.9 m, +15° 03′	April 22
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		3.3′ × 1.2′	11.2
This is part of the M87 clump of the Virgo cluster (see M49/NGC 4472). This is a LINER galaxy (see M81/NGC 3031) with active star formation thought to be occurring in the nucleus and circumnuclear disk. Like many of the spirals in the Virgo cluster, this galaxy has much less atomic hydrogen gas than average for spirals in general. This is thought to be caused by stripping of this gas from the outer regions of the galaxy due to the galaxy's extreme speed (1,300 km/s for this galaxy) relative to the material between galaxies in the cluster (the "intracluster medium"). The galaxy has a dynamical mass of about 90 billion suns, an optical diameter of about 50,000 light years, and an inclination angle of about 70° (i.e., it is nearly edge-on).			

NGC 4429

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Lenticular galaxy	12 h 27.4 m, +11° 06′	April 22
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		5.8′ × 2.8′	10.2
This is part of the Virgo galaxy cluster (see M49/NGC 4472). This is a LINER galaxy (see M81/NGC 3031). It has an optical diameter of about 90,000 light years and an inclination angle of about 75°. Professional telescopic studies find that the nucleus of this galaxy (radius of 1″) is a few billion years younger and chemically distinct from the remainder of the galaxy, in addition to having a nuclear ring (radius 4″–6″) from a previous starburst ring. These structures may have been caused by orbital resonant interactions, but this remains uncertain.			

NGC 4435

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred lenticular galaxy	12 h 27.7 m, +13° 05′	April 22
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		3.0′×2.2′	10.8
It has been suggested that NGC 4435 was involved in a high-speed collision with nearby NGC 4438 (4′ SSE – see NGC 4438), but M86 (NGC 4406) is now thought to have been the one involved with NGC 4438. NGC 4435 is edge-on (with an inclination angle of 90°) and has a mass of about 80 billion suns. It is part of the "Markarian Chain" of galaxies (see NGC 4473).			

NGC 4438

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Lenticular galaxy	12 h 27.8 m, +13° 01′	April 22
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		8.5′×3.0′	10.0
This is the most disrupted galaxy in the Virgo galaxy cluster. This disruption is thought to be the result of a collision with M86 (NGC 4406) some 100 million years ago. Filaments of interstellar material that were extruded in this collision extend between M86 and NGC 4438. NGC 4438 has a mass of about 400 billion suns and is a LINER galaxy (see M81/NGC 3031) with this emission perhaps powered by an active galactic nucleus (AGN) containing a supermassive central black hole with a mass of around a hundred million suns. It is part of the "Markarian Chain" of galaxies (see NGC 4473). It is thought to be undergoing ram pressure stripping of its gas due to its motion through the intracluster medium.			

NGC 4442

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred lenticular galaxy	12 h 28.1 m, +09° 48′	April 22
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		4.5′ × 1.8′	10.4
This is part of the Virgo cluster (see M49/NGC 4472) as well as the NGC 4442 galaxy group of five galaxies, the brightest of which are NGC 4469 (1° 6′ SSE, mag. 11.5) and IC 3521 (3° SSE, mag. 13.5). It has a mass of about 50 billion suns and is nearly edge-on (with an inclination angle of about 70°).			

NGC 4448

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 28.3 m, +28° 37′	April 22
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		3.9′ × 1.4′	11.2
This is nearly edge-on (with an inclination angle of about 70°). It has an optical diameter of about 100,000 light years and has an outer ring. Outer rings require a galaxy to avoid tidal interactions with other galaxies (since such interactions destroy these rings). As a result, galaxies with rings do not usually belong to a gravitationally bound group, and this galaxy is no exception.			

NGC 4449

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Irregular barred galaxy	12 h 28.2 m, +44° 06′	April 22
Distance	**Age**	**Apparent size**	**Magnitude**
12 million light years		6.2′×4.4′	9.4

This has an optical diameter of about 20,000 light years and a stellar mass of 3 billion suns. Active star formation is occurring along its bar and it has a starburst nucleus. The nucleus contains a star cluster with several hundred thousand hot, young stars that are a few million years old. It contains over 250 giant ionized hydrogen (HII) regions (star-forming regions like M42). Several of these HII regions are visible as bright knots in large amateur telescopes. Professional telescopes find it has a large atomic hydrogen (HI) region outside the optically visible region, that extends out about ten times the optical diameter of this galaxy and has a mass of about a billion suns. The origin of this HI gas is not known, but it may be the result of a close encounter with M94 (NGC 4736, 5° ESE) several billion years ago that left a 100,000 light year diameter disk of HI gas around NGC 4449. Since then, interaction with nearby UGC 7577 (irregular dwarf galaxy, mag. 12, 37′ S) has redistributed this gas into its current lopsided arm, streamers, and disk. In professional telescopes, a tidal stellar stream with a stellar mass of more than 10 million Suns extends out several tens of thousands of light years to the southeast of NGC 4449. This stream is thought to be a tidally distorted colliding dwarf galaxy, and this accretion event may have been the trigger for NGC 4449's recent star formation that began about half a billion years ago. It contains perhaps nearly 70 globular clusters. One of its most massive globular clusters, with a mass of nearly 2 million suns, may be the nuclear remnants of another previously accreted dwarf galaxy.

NGC 4450

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Spiral galaxy	12 h 28.5 m, +17° 05′	April 22
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		5.4′×4.1′	10.1
This is part of the Virgo galaxy cluster (see M49/NGC 4472). It is a LINER (low-ionization nuclear emission region) galaxy (see M81/NGC 3031), which in this case is thought to be caused by photoionization due to accretion onto a supermassive central black hole. This galaxy has an optical diameter of about 90,000 light years.			

NGC 4459

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Lenticular galaxy	12 h 29.0 m, +13° 59′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		3.5′×2.7′	10.4
This galaxy is thought to contain a supermassive central black hole with a mass of about a billion suns. It is part of the M87 clump of the Virgo galaxy cluster (see M49/NGC 4472).			

NGC 4472 (M49)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 29.8 m, +08° 00′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		10.2′ × 8.3′	8.3

This is a giant elliptical galaxy and the brightest member of the Virgo galaxy cluster, which is the nearest galaxy cluster to us. The Virgo galaxy cluster may contain nearly 2,000 galaxies, which are bunched into several subclusters with M87 and M49 being principal members of the two main subclusters. M49 lies perhaps a few million light years closer than M87. Occupying a roughly rectangular shape in the sky (8° E-W × 16° N-S), the major concentration of the Virgo cluster extends several tens of millions of light years around the cluster center near M87 (but, for simplicity, all its members are listed herein as being at the same distance). M49 is thought to be falling toward the center of the Virgo cluster at about a thousand km/s. Much of the mass in the Virgo cluster is dark matter, with the total mass of the Virgo cluster being many hundreds of trillions of solar masses. The Virgo cluster lies at the center of the Virgo supercluster, an even larger gathering of galaxies with a diameter of about 100 million light years that includes our own Local Group. M49 contains about 6,000 globular cluster, which are mostly old (10 billion years). The center of M49 is thought to contain a supermassive black hole with a mass of about a half billion suns. The stellar mass of M49 is perhaps 200 billion suns, but its total mass (including dark matter in its halo) is more than a trillion suns. Its optical diameter is about 150,000 light years.

NGC 4473

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Elliptical galaxy	12 h 29.8 m, +13° 26′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		4.5′×2.5′	10.2
This contains a massive central black hole with a mass of about 100 million suns. The inner 45″ radius of this galaxy has a mass of about 50 billion suns. This galaxy is rotating slowly (60 km/s), with the west side approaching and the east side receding with respect to the galaxy's center. It is part of the M87 clump of the Virgo galaxy cluster (see M49/NGC 4472), as well as being part of the "Markarian Chain" of galaxies that lies along a "chain" NE of M84 that includes eight galaxies: M84 (NGC 4374), M86 (NGC 4406), NGC 4435, NGC 4438, NGC 4461, NGC 4458, NGC 4473 and NGC 4477. These galaxies are moving like a rigid, tumbling chain thrown away from Earth at several hundred km/s with the chain tumbling so that the W side of the chain (M84) is actually moving toward us while the E side (NGC 4477) is moving doubly fast away from us.			

NGC 4477

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred lenticular galaxy	12 h 30.0 m, +13° 38′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		3.7′×3.3′	10.4
This is part of the M87 clump of the Virgo galaxy cluster (see M49/NGC 4472), as well as the "Markarian Chain" of galaxies (see NGC 4473) of which it forms the eastern end. It is a Seyfert galaxy (where a supermassive object in this galaxy's center accumulates nearby material and causes strong nuclear emission).			

NGC 4478

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 30.3 m, +12° 20′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		1.8′ × 1.5′	11.4

This galaxy is part of the Virgo galaxy cluster (see M49/NGC 4472) and is thought to be a companion of M87 (see M87/NGC 4486, 8′ ENE), as is its neighbor NGC 4476 (4.5′ WNW). NGC 4478 has suffered in its companionship with M87 though, since it has lost material to M87, with some of the many globular clusters in M87 believed to have been stolen from NGC 4478. NGC 4478 has a nearly edge-on nuclear stellar disk in its inner arc second possibly created from gas accreted in a merger which then formed stars.

NGC 4485

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Irregular barred galaxy	12 h 30.5 m, +41° 42′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		2.4′ × 1.8′	11.7

This galaxy is interacting with nearby NGC 4490 (4′ SSE – see NGC 4490), with their closest approach a few hundred million years ago. Indeed, much of the interstellar medium in NGC 4485 is thought to have been stripped out of NGC 4485 because this galaxy has been passing through the atomic hydrogen (HI) gas halo of NGC 4490 (so-called "ram-pressure" stripping). Professional telescopes find a large HI cloud SW of NGC 4485 (extending in a bridge between the two galaxies due to their tidal interaction) and that probably used to be part of NGC 4485, but was blown out of this galaxy by ram-pressure stripping. NGC 4485 has a diameter of about 20,000 light years and is about eight times less massive than NGC 4490. NGC 4485 is part of the NGC 4490 galaxy group of about eight galaxies, which is also part of the Canes Venatici II galaxy group of 22 galaxies anchored by M106/NGC 4258.

NGC 4486 (M87)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 30.8 m, +12° 23′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		8.3′×6.6′	8.6

Lying near the center of the Virgo galaxy cluster (see M49/NGC 4472), this is a heavyweight in the world of galaxies. Its mass is several trillion solar masses (although more than 90 % of this is dark matter, with less than a trillion suns due to stellar mass). This is many hundreds of times more massive than the average galaxy. M87 lies at the heart of the largest of the two major subclusters within the Virgo cluster (the other being associated with M49/NGC 4472), while a third smaller clump may be associated with M86/NGC 4406. The M87 clump of the Virgo cluster has a mass of several hundred trillion suns. The center of M87 is thought to contain a supermassive black hole with a mass of several billion suns. This black hole is believed to be what drives the active galactic nucleus (in which energetic emission is caused by accretion onto the massive central black hole) that gives rise to the optically one-sided jet in M87. This jet is the major part of the radio source known as Virgo A, the radio waves being due to synchrotron emission of high-speed electrons gyrating wildly in a magnetic field. This jet extends for thousands of light years (its brightest parts extending out about 25″), with material in the jet traveling at significant fractions of the speed of light. M87 has one of the largest numbers of globular clusters of any galaxy, with more than perhaps 16,000 (compare to the Milky Way's 150 or so). The optical diameter of M87 is about 130,000 light years (which is more than twice the diameter of the average galaxy), but it extends out several times this distance in professional telescopic studies.

NGC 4490

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Barred spiral galaxy	12 h 30.6 m, +41° 39′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		6.4′×3.2′	9.5

Intense star formation (nearly five new suns per year) is occurring throughout the disk of NGC 4490, an unusual situation, since such starbursts are normally confined to the nuclear regions of galaxies. The atomic hydrogen (HI) envelope (visible in professional telescopic studies) surrounding this galaxy and nearby NGC 4485 (4′ NNW – see NGC 4485) is one of the largest known, extending out nearly ten times the optical diameter of NGC 4490 and having a mass of nearly 20 billion suns. This gas may have been driven from the disk by supernovae associated with this galaxy's highly active star formation. NGC 4490 is part of the NGC 4490 galaxy group of about eight galaxies, which is also part of the Canes Venatici II galaxy group of 22 galaxies anchored by M106/NGC 4258.

NGC 4494

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Elliptical galaxy	12 h 31.4 m, +24° 47′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		4.8′×3.5′	9.7

Dark matter makes up perhaps around half of the mass of this galaxy. It has a stellar mass of about 100 billion suns. It may be part of a gravitationally bound galaxy group of perhaps eleven galaxies with NGC 4565 (1° 07′ E – see NGC 4565) and NGC 4562 (barred spiral, 57′ E, mag. 13.5). It is a LINER ("low-ionization nuclear emission region") galaxy (see M81/NGC 3031). It has a central stellar disk and dust ring, as well as kinematically decoupled core (meaning it rotates independently of the rest of the galaxy), which all may be the result of a major merger with another galaxy several billion years ago.

NGC 4501 (M88)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Spiral galaxy	12 h 32.0 m, +14° 25′	April 24
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		6.8′ × 3.7′	9.4
M88 is part of the Virgo galaxy cluster (see M49/NGC 4472) and is a Seyfert galaxy (where a black hole in this galaxy's center, in this case with a mass of 80 billion suns, accumulates nearby gas resulting in strong emission from the nucleus). It has an optical diameter of about 110,000 light years. The nucleus of this galaxy (within a radius of about 4″) has a different chemical makeup than the rest of the galaxy. The galaxy is a "flocculent" spiral, meaning that it lacks any obvious azimuthally symmetric spiral arm pattern (see NGC 3521). It traveling through the Virgo cluster's intracluster medium, which causes "ram pressure" compression of its western side and removal of its atomic hydrogen gas.			

NGC 4517

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Spiral galaxy	12 h 32.8 m, +00° 07′	April 23
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		10.5′ × 1.5′	10.5
This is part of the Virgo galaxy cluster (see M49/NGC 4472), thought to be lying toward the near side of this cluster. It is nearly edge-on. NGC 4437 is a duplicate entry of NGC 4517.			

NGC 4526

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred lenticular galaxy	12 h 34.0 m, +07° 42′	April 24
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		7.0′×2.5′	9.6

This galaxy is part of the Virgo galaxy cluster (see M49/NGC 4472) and lies near the core of the cluster. It is nearly edge-on, with an inclination angle of 79°. It hosts a supermassive central black hole with a mass of a half billion suns. It has a central stellar disk that rotates independently of the rest of the galaxy.

NGC 4527

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 34.1 m, +02° 39′	April 24
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		6.2′×2.1′	10.5

This galaxy is part of the Virgo galaxy cluster (see M49/NGC 4227), and lies toward the closer side of this cluster. A massive dark core is present in this galaxy, with nearly 10 billion solar masses present in the inner 10″ radius (corresponding to a radius of about 3,000 light years). Most of the galaxy rotates at about 200 km/s about an axis that is inclined 69° from our line-of-sight. This galaxy has an optical diameter of about 90,000 light years. Its central region may be just entering a period of greatly increased star formation, i.e., it may be an incipient starburst galaxy.

NGC 4535

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 34.3 m, +08° 12′	April 24
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		7.1′×5.0′	9.8

This is part of the Virgo galaxy cluster (see M49/NGC 4472). It has an optical diameter of about 110,000 light years. Its rotation axis is inclined at 47° from our line-of-sight. It is a LINER galaxy (see M81/NGC 3031).

NGC 4536

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 34.4 m, +02° 11′	April 24
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		7.6′×3.2′	10.3

This is part of the Virgo galaxy cluster (see M49/NGC 4427). This galaxy is nearly edge-on (with an inclination angle of about 70°). It is a starburst galaxy, meaning that intense star formation is occurring in its central regions, in this case in a 20″×30″ region. However, star formation has come to an end in its very inner nucleus although it continues in a circumnuclear ring (about 7″ in diameter). It may contain a supermassive central black hole that gives rise to its low-luminosity active galactic nuclei (LLAGN) with nuclear emission powered by accretion onto its central black hole.

NGC 4546

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred lenticular galaxy	12 h 35.5 m, –03° 48′	April 24
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		3.3′ × 1.6′	10.3

This galaxy is unusual in that it contains a gas disk that counter-rotates (at several hundred km/s) relative to the stars in the disk. The gas disk has a radius of about 25,000 light years and contains several hundred million solar masses. The gas is thought to be left over from an accreted gas-rich dwarf galaxy. The remains of the nucleus of the accreted galaxy is thought to lie about 20″ NW of the center of NGC 4546 (mag. 17.6) and has a stellar mass of about 34 million suns. The accreted dwarf galaxy is only a few billion years old, much younger than the 11-billion-year old NGC 4546. It is thought to have had a mass about 1/10 that of NGC 4546's mass of 30 billion suns. NGC 4546 is nearly edge-on (inclination angle of about 70°). Its diameter is about 60,000 light years.

NGC 4548 (M91)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 35.4 m, +14° 30′	April 24
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		5.2′ × 4.2′	10.1

This galaxy is part of the M87 clump of the Virgo galaxy cluster (see M49/NGC 4472). It is a LINER galaxy (see M81/NGC 3031). Like many spirals in galaxy clusters, this galaxy has much less atomic hydrogen gas than average for spirals in general. This is thought to be caused by stripping of this gas (so-called "ram-pressure stripping") from the galaxy due to the galaxy's motion relative to the material between galaxies in the cluster (the "intracluster medium"). Most of this galaxy rotates at about 250 km/s about an axis inclined to our line-of-sight by about 35°. It has a low star formation rate for a spiral galaxy. Stars in its nucleus have much higher "metal" content, meaning they are abundant in elements heavier than hydrogen and helium, than the rest of this galaxy.

NGC 4550

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred lenticular galaxy	12 h 35.5 m, +12° 13′	April 24
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		3.3′×0.9′	11.5

This is part of the Virgo galaxy cluster (see M49/NGC 4472). This galaxy has a stellar mass of about 20 billion suns. It is one of only about 10 % of lenticular galaxies that consists of two counter-rotating stellar disks, with only about 2 % of elliptical and lenticular galaxies within about 100 million light year radius having two stellar disks of nearly equal mass like NGC 4550. In NGC 4550 the two disks may be the result of one of two possibilities: counter-rotating gas was accreted into a galaxy that subsequently formed stars in a counter-rotating disk, or alternatively, two galaxies with opposite directions of rotation merged to form one galaxy. Whichever of these two events caused NGC 4550's present state, this event is thought to have occurred more than several billion years ago.

NGC 4552 (M89)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 35.7 m, +12° 33′	April 24
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		3.5′×3.5′	9.9

This is part of the Virgo galaxy cluster (see M49/NGC 4472). A supermassive object in this galaxy's center (thought to be a black hole with a mass of many hundreds of millions of suns) accumulates nearby gas resulting in emission from the nucleus as a LINER ("low-ionization nuclear emission region" – see M81/NGC 3031) galaxy. The galaxy's supersonic motion relative to the Virgo intracluster medium has resulted in ram pressure stripping of gas from this galaxy. A recent nuclear outburst, perhaps in the past couple million years, is thought to have produced a powerful shock wave that is causing X-ray emission in two ring-shaped regions within the center of this galaxy, with diameters of a few thousand light years in diameter. It contains 1,400 globular clusters within a radius of 10′ from its center. It has a complex structure of plumes, tails and shells in its outer regions that may be remnants from one or more past galaxy mergers or accretions.

NGC 4559

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 36.0 m, +27° 58′	April 24
Distance	**Age**	**Apparent size**	**Magnitude**
35 million light years		10.7′×4.4′	9.6

This galaxy is near the North Galactic Pole, meaning that there is little foreground extinction of its light from gas and dust in our galaxy (since its direction lies perpendicular to the disk of our galaxy). This is also why there are so many distant objects (i.e., galaxies) visible in the constellations surrounding this area. In professional telescopic studies, NGC 4559 contains many ionized hydrogen (HII) regions like M42. One of these in the western part of this galaxy contains an ultra-luminous X-ray source (ULX) whose emission may be due to mass accretion onto a black hole, with a mass of many tens of suns, from a companion blue supergiant with a mass of tens of suns. Collision of a dwarf galaxy with the disk of NGC 4559 several tens of millions of years ago may have triggered the star formation region that contains this ULX. This galaxy has a mass of about 50 billion suns. Its inclination angle is about 70° (meaning it rotates about an axis that is inclined at 70° from our line-of-sight).

NGC 4565

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Spiral galaxy	12 h 36.3 m, +25° 59′	April 25
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		15.8′×2.1′	9.5

With an inclination angle of 87°, this galaxy is virtually edge-on. It has an optical diameter of about 180,000 light years. More than 200 globular clusters are known in this galaxy from professional telescopic studies. This galaxy is thought to be a Seyfert galaxy (see NGC 3227). It is part of a gravitationally bound galaxy group of perhaps 11 galaxies including NGC 4562 (barred spiral, 12′ SW, mag. 13.5) and NGC 4494 (see NGC 4494, 1° 07′ W), as well as nearby IC 1371 (mag. 16.9), with a bridge of material between IC 1371 and NGC 4565. With our edge-on view, in professional telescopes NGC 4565's neutral hydrogen (HI) is found to have a twisted ("integral sign") shape, with the twist mostly outside the optically visible portion of the galaxy. Such twists (also called warps, depending on the orientation of our view of the galaxy) occur in the HI distribution of about half of all galactic disks. This galaxy is near the North Galactic Pole, meaning that there is little foreground extinction of its light from gas and dust in our Galaxy (since its direction lies perpendicular to the disk of our galaxy). This is also why there are so many distant objects (i.e. galaxies) visible in the constellations surrounding this area.

NGC 4567

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Spiral galaxy	12 h 36.5 m, +11° 15′	April 25
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		3.1′×2.2′	11.3

Together with nearby NGC 4568 the two galaxies are nicknamed the "Siamese Twins." They are believed to be interacting. Both belong to the Virgo galaxy cluster (see M49/NGC 4472). NGC 4567 is deficient in atomic hydrogen (HI) because of ram pressure stripping resulting from the galaxy's motion relative to the intra-cluster medium.

NGC 4569 (M90)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 36.8 m, +13° 10′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		9.5′×4.4′	9.5

This is part of the Virgo cluster (see M49/NGC 4472). It is a LINER galaxy ("low-ionization nuclear emission region" – see M81/NGC 3031), but its nuclear emission is thought to be dominated by intense star formation and supernovae (i.e., a starburst, see M82/NGC 3034), rather than by accretion onto a central black hole. About two new stars form every year in this galaxy (about the same as form yearly in the Milky Way). The galaxy rotates about an axis that is inclined to our line-of-sight by about 64° with the western edge of the galaxy closest to us. Although the galaxy IC 3583 (6′ NNW) is nearby in the sky and is also a Virgo cluster member, the two are not thought to be interacting strongly. Because of M90's high speed relative to the Virgo cluster (over a thousand km/s, which is locally supersonic), it is thought to have lost 90 % of its atomic hydrogen (HI) gas to "ram-pressure stripping" (see M91/NGC 4548) that peaked about 300 million years ago.

NGC 4570

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Lenticular galaxy	12 h 36.9 m, +07° 15′	April 25
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		3.7′×1.2′	10.8

This is part of the Virgo galaxy cluster (see M49/NGC 4472). NGC 4570 has a total luminous mass of about 60 billion suns and is nearly edge-on. Professional telescopes show it has an outer disk (at radius greater than 7″), two stellar rings (at radii of 1.7″ and 4.5″), and an inner nuclear disk (inside the rings). This complex structure is thought to have been caused by a nuclear bar (which has since faded) that drove gas into the central regions of this galaxy. Some of this material formed into the present-day rings via resonant interactions (where density waves are in resonance with the local speed of epicycle oscillations in the orbits of matter in the disk, including the so-called Lindblad resonances). About 120 globular clusters have been detected to date in this galaxy.

NGC 4579 (M58)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 37.7 m, +11° 49′	April 25
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		6.0′×4.8′	9.6

This is part of the Virgo galaxy cluster (see M49/NGC 4472). M58 has a mass of about 300 million suns. It is a LINER galaxy (see M81) in which emission from the nucleus is thought to occur due to accretion of matter onto a supermassive central black hole with a mass of about 50 million suns. It has a nuclear ring with a diameter less than 1,000 light years. Its optical diameter is about 100,000 light years.

NGC 4590 (M68)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hydra	Globular cluster	12 h 39.5 m, −26° 45′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
34,000 light years	10–14 billion years	11′	7.3

This has a mass of a few hundred thousand suns. Its size of 11′ corresponds to a diameter of over 100 light years. Like most globular clusters, it does not orbit our galaxy with the galactic disk as we do. Instead it follows an orbit that takes it out as far as about 170,000 light years from the galactic center and then back in as close as about 30,000 light years on an elliptical path (with eccentricity 0.5) inclined to the galactic disk (by about 30°), taking about half a billion years to make one revolution around our galaxy. It is very "metal-poor" (meaning it is sparse in elements heavier than helium), being among the 25 most metal poor globular clusters in our galaxy.

NGC 4594 (M104)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Spiral galaxy	12 h 40.0 m, −11″ 37′	April 25
Distance	**Age**	**Apparent size**	**Magnitude**
30 million light years		8.6′×4.2′	8.3

This is nicknamed the "Sombrero Galaxy." The well-known dust lane, which actually has a ring-shape (like Saturn's rings), contains a mass of about 16 million suns of dust grains that are submicron in size. The dust lane may owe its existence to the gravitational interaction of a now-defunct bar with the interstellar medium. The disk in this galaxy is about a quarter as massive as this galaxy's large spheroidal bulge (whereas in our galaxy the disk has a mass about seven times that of the bulge). This galaxy has a stellar mass of about a quarter trillion suns. It harbors a central black hole with a mass of many hundreds of millions of suns, onto which a few percent of a solar mass is accreted every year. It is a LINER (see M81/NGC 3031) galaxy, is nearly edge-on (inclination angle of 84°) and contains nearly 2,000 globular clusters. An ultra-compact dwarf galaxy similar to a globular cluster, but with a mass of about 30 million suns, orbits M104.

NGC 4596

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred lenticular galaxy	12 h 39.9 m, +10° 11′	April 25
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		4.0′×3.0′	10.5

This is part of the Virgo galaxy cluster (see M49/NGC 4472). Its bar takes about 20 million years to make one rotation and accounts for almost half the luminosity of this galaxy. The central bulge in this galaxy accounts for about 30 % of its luminosity. The remaining 25 % of the luminosity comes from the convex-lens-shaped remaining portion of this galaxy (whence comes the name "lenticular," meaning lens-shaped).

NGC 4605

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred spiral galaxy	12 h 40.0 m, +61° 37′	April 25
Distance	**Age**	**Apparent size**	**Magnitude**
15 million light years		5.9′×2.4′	10.1
This is a dwarf spiral galaxy with an optical diameter of about 25,000 light years (similar to the diameter of the Large Magellanic Cloud). It is close to edge-on (with an inclination angle of 69°).			

NGC 4618

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Barred Magellanic galaxy	12 h 41.6 m, +41° 09′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		4.2′×3.4′	10.6
This is a classic example of a barred Magellanic galaxy (named after the Large Magellanic Cloud). This galaxy type (which is the "latest" type of spiral galaxy in Hubble's classification scheme before the irregular class) is characterized in professional telescopes by having essentially only one spiral arm, with a bar that is offset from the center of the galaxy. About half of the light from NGC 4618 comes from its disk, while about a quarter comes from the one spiral arm and about one-seventh comes from the bar. The remaining tenth or so comes from isolated star-forming regions (containing bright, hot young stars and ionized hydrogen – some of these regions are visible as knots in large amateur telescopes). NGC 4625 is nearby (8′ NNE, mag. 12.3), which is also a barred Magellanic spiral. However, the two are not thought to be interacting. Both are part of the Canes Venatici II galaxy group of 22 galaxies anchored by M106 (NGC 4258).			

NGC 4621 (M59)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 42.0 m, +11° 39′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		5.4′ × 3.7′	9.7
This is part of the Virgo galaxy cluster (see M49/NGC 4472). The inner core of this galaxy is unusual because it is thought to be counter-rotating from the rest of the galaxy as well as having a different chemical makeup from, and being younger than, the rest of the galaxy, perhaps due to dynamics driven by a bar, or else by a past accretion event. This inner core has a diameter of several hundred light years and apparent size of about an arcsecond. Professional telescopes find M59 has a disk that emits about 16 % of the light from this galaxy. M59 also has a circumnuclear disk (diameter of 5″–7″) in professional telescopic studies. The center of this galaxy is believed to contain a supermassive black hole (with a mass of about 300 million suns). M59 contains about 2,000 globular clusters.			

NGC 4631

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Barred spiral galaxy	12 h 42.1 m, +32° 33′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		15.2′ × 2.8′	9.0
This galaxy is nearly edge-on (with an inclination angle of about 80°) and has an optical diameter of about 110,000 light years. It is interacting with its nearby neighbors (NGC 4627 and NGC 4656 – see NGC 4656). The gravitational distortions from these interactions are thought to be triggering intense star formation that is seen throughout the disk of NGC 4631 (as patchy, bright regions in large amateur telescopes). These regions are less than about 10 million years old and together contain about 25 million solar masses. Supernovae and stellar winds from these star-forming regions are thought to be the source of the hot (million degree) corona of gas that surrounds this galaxy. Gravitational interactions between NGC 4631 and NGC 4656 may have also spawned a nearby tidal dwarf galaxy. It belongs to a galaxy group of perhaps 28 gravitationally bound galaxies.			

NGC 4636

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 42.8 m, +02° 41′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		10.4′ × 5.9′	9.4
It is part of the Virgo galaxy cluster (see M49/NGC 4472), lying at the southern edge of this cluster. This galaxy harbors a supermassive central black hole with a mass of about 80 million suns (compare this to the 4 million solar mass black hole at the center of our galaxy). Like many such black holes in elliptical galaxies, this one emits unexpectedly little radiation due to accretion, for reasons that remain unclear. One explanation is that the accretion disk is truncated at a certain, inner radius by a jet that extracts energy from the disk and truncates the disk's emission. This galaxy contains nearly 4,000 globular clusters, which is slightly richer in globulars than most ellipticals in the Virgo cluster.			

NGC 4643

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred lenticular galaxy	12 h 43.3 m, +01° 59′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		3.1′ × 2.5′	10.8
This is a LINER galaxy (see M81/NGC 3031). It is the namesake member of the NGC 4643 group of perhaps nine gravitationally bound galaxies.			

NGC 4649 (M60)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 43.7 m, +11° 33′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		7.6′ × 6.2′	8.8

This is a giant elliptical galaxy. It is part of the Virgo galaxy cluster (see M49/NGC 4472). M60 is thought to contain a supermassive central black hole (with a mass of perhaps 4.5 billion suns). Its nearby companion galaxy NGC 4647 (barred spiral galaxy, 2.5′ NW, mag. 11.4) is possibly a few million light years away from M60, and not thought to have interacted significantly with M60 yet. M60 contains perhaps 15,000 globular clusters (about 100 times as many as in our galaxy).

NGC 4654

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 43.9 m, +13° 08′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		5.0′ × 3.1′	10.4

This is part of the Virgo galaxy cluster (see M49/NGC 4472). Professional telescopic studies find that the neutral hydrogen in this galaxy is distributed asymmetrically, with a large tail off the SE edge that may have been blown out (by so-called "ram pressure") because of this galaxy's Frisbee-like relative motion through the intracluster medium (the material between galaxies in this cluster). In professional telescopes, the northern of its two spiral arms is much stronger, perhaps caused by a tidal interaction with NGC 4639 about 0.5 billion years ago. Its optical diameter is about 80,000 light years.

NGC 4656

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Irregular galaxy	12 h 44.0 m, +32° 10′	April 26
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		15.3′×2.4′	10.1

This is nearly edge-on (with an inclination angle of about 80°) and has an optical diameter of about 110,000 light years. It is part of the NGC 4631 galaxy group (see NGC 4631). Its interaction with nearby NGC 4631 is thought to have triggered star formation in NGC 4656. This starburst activity has blown out chimney-like ionized filaments, the largest of which is a double filament with a mass of several tens of millions of suns that extends perpendicular to the disk for thousands of light years in professional telescopes. A bridge of neutral hydrogen (with a mass of several billions suns) extends between NGC 4656 and NGC 4631, and gravitational interactions between the two galaxies may have also spawned a nearby tidal dwarf galaxy.

NGC 4660

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 44.5 m, +11° 11′	April 27
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		2.1′×1.7′	11.2

This contains a supermassive black hole with a mass of several hundred million suns. It is part of the Virgo galaxy cluster (see M49/NGC 4472). It is an unusual elliptical galaxy since it contains a disk structure (inclined at about 66° from our line-of-sight) that emits a third of the light from this galaxy. It may form a galaxy pair with M59 (NGC 4621).

NGC 4665

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred lenticular galaxy	12 h 45.1 m, +03° 03′	April 27
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		3.5′×3.5′	10.3
This galaxy is part of the Virgo galaxy cluster (see M49/NGC 4472). About 20 % of all disk galaxies are lopsided (i.e., not azimuthally symmetric), and this is one such galaxy. NGC 4624 and NGC 4664 are repeat entries of NGC 4665.			

NGC 4666

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 45.1 m, −00° 28′	April 27
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		4.5′×1.4′	10.8
This is nearly edge-on (having an inclination angle of 70°) with the SE edge toward us and the NW edge on the far side of the galaxy. It has a mass of a couple hundred billion suns. Intense star formation (i.e., a "starburst") is occurring in this galaxy, particularly within the central 1′ radius of its disk, with about 100 luminous HII (ionized hydrogen) star-forming regions spread over its disk in professional telescopic images. Stellar winds and supernovae from star-formation have strewn gas out tens of thousands of light years perpendicular to the disk in a cone-shaped "superwind" that is thought to have been ionized mainly by shock waves. Star formation farther out in the disk of the galaxy is thought to have blown gas into an extended gaseous halo that surrounds this galaxy. Tidal disturbances caused by nearby NGC 4668 (7′ SE) and a nearby dwarf galaxy may be responsible for triggering the starburst in NGC 4666. These galaxies along with another nearby dwarf galaxy and NGC 4632 (45′ WNW) form a gravitationally bound group. While nuclear emission from NGC 4666 is strongly dominated by its starburst, about 15 % of its central X-ray emission is thought to be due to an active galactic nucleus (AGN) in which energetic emission is caused by accretion onto a massive central object.			

NGC 4689

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Spiral galaxy	12 h 47.8 m, +13″ 46′	April 27
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		4.3′×3.5′	10.7
This is part of the Virgo galaxy cluster (see M49/NGC 4472), lying at its eastern edge. As with many of the spirals in the Virgo cluster, much of the gas from this galaxy has been stripped away by interaction with the intracluster medium (see NGC 4419).			

NGC 4697

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	12 h 48.6 m, −05° 48′	April 28
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		7.2′×4.7′	9.2
This has a total mass of about 200 billion suns, with a central black hole mass of perhaps 200 million suns. Professional telescopic studies find more than 500 planetary nebulae in this galaxy (about the same number as in our galaxy). It is part of the NGC 4697 group of perhaps 37 gravitationally bound galaxies that includes nearby NGC 4731 (51′ SE), NGC 4775 (1.5° ESE), NGC 4941 (4° E), NGC 4951 (4° E), NGC 4948 (4.5° ESE), and NGC 4958 (4.8° ESE).			

NGC 4698

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Spiral galaxy	12 h 48.4 m, +08° 29′	April 28
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		4.0′ × 2.5′	10.7

This is part of the Virgo galaxy cluster (see M49/NGC 4472), lying at the northeastern boundary of this cluster. This is a Seyfert galaxy (see NGC 3227). It has an unusual nuclear disk that rotates about an axis that is perpendicular to the axis of rotation of the rest of the galaxy and thought to be the result of accretion in its past. Its bulge is also elongated perpendicular to the main disk, rather than being elongated within the disk as is the case with all but a handful of spiral galaxies.

NGC 4699

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 49.0 m, −08° 40′	April 28
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		3.8′ × 2.8′	9.6

It has an optical diameter of about 65,000 light years and an inclination angle of about 40°. It is the namesake member of the NGC 4699 galaxy group of 14 gravitationally bound galaxies that includes NGC 4802 (3° 46′ SSE), NGC 4722 (4° 41′ S), NGC 4700 (2° 45′ S), NGC 4742 (2° SSE), NGC 4781 (2° 18′ SE), and NGC 4790 (2° SE).

NGC 4725

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Barred spiral galaxy	12 h 50.4 m, +25° 30′	April 28
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		10.7′ × 7.6′	9.3

This galaxy is near the North Galactic Pole, meaning that there is little foreground extinction of its light from gas and dust in our galaxy (since its direction lies perpendicular to the disk of our galaxy). This is also why there are so many distant objects (i.e., galaxies) visible in the constellations surrounding this area. This is a Seyfert galaxy (see NGC 3227). It has a mass of 100 billion suns within a radius of 3′ of its center. Its optical diameter is 120,000 light years and rotates about an axis inclined at about 42° from our line-of-sight. Like about one-third of barred galaxies, it is double-barred, having both an inner and an outer bar. It has an inner ring with a diameter of 4.5′ in professional telescopes (not to be confused with the incomplete pseudo-ring of its spiral arms at a diameter of 10′ that is visible in large amateur telescopes). The inner ring is thought to be expanding at about 50 km/s and rotating at just over 200 km/s, and is undergoing active star formation. This galaxy is interacting with nearby NGC 4747 (25′ NE), the latter being about 1/20 the mass of NGC 4725. The galaxy NGC 4712 (11′ W) is a background object.

NGC 4736 (M94)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Barred spiral galaxy	12 h 50.9 m, +41° 07′	April 29
Distance	**Age**	**Apparent size**	**Magnitude**
15 million light years		14.4′ × 12.1′	8.1

This has a mass of perhaps 30–40 billion suns, an optical diameter of about 70,000 light years, and contains a central black hole with a mass of about 7 million suns. Professional telescopes find M94 has an inner ring (between 35″ and 48″ in radius) that is undergoing intense star formation (i.e., it is a "starburst" ring) and is the result of ring-bar dynamics. Star formation is also occurring in its outer disk. About one new star is formed every year in M94. Most of the galaxy rotates at approximately 150 km/s about an axis inclined to our line-of-sight by about 40°. M94 is a LINER galaxy (see M81/NGC 3031) and is part of the M94 group (also called the Canes Venatici I galaxy group) of perhaps 40 gravitationally associated galaxies. A counter-rotating component found in this galaxy may be the result of a past merger event.

NGC 4753

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Lenticular galaxy	12 h 52.4 m, −01° 12′	April 28
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		6.0 ′×2.8′	9.9

This is part of the Virgo galaxy cluster (see M49/NGC 4472). Professional telescopic studies find this galaxy has a complicated set of dust lanes that are thought to be the result of a nearly edge-on view of this galaxy's "twisted disk" (meaning the plane of the disk varies with radius). The dust in this galaxy has a mass of several hundred thousand Suns. The twisted disk is thought to be due to the accretion of a gas-rich dwarf galaxy that occurred at least a half billion years ago. It is part of the NGC 4653 galaxy group of perhaps 23 gravitationally bound galaxies.

NGC 4754

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred lenticular galaxy	12 h 52.3 m, +11° 19′	April 28
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		4.4′×2.4′	10.5

This contains just over 100 globular clusters. It is part of the Virgo galaxy cluster (see M49/NGC 4472), as are nearby NGC 4733 and NGC 4762 (see NGC 4762). These three galaxies lie at the eastern boundary of the Virgo cluster.

NGC 4762

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred lenticular galaxy	12 h 52.9 m, +11° 14′	April 29
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		8.7′ × 1.7′	10.1

This contains nearly 300 globular clusters. It is part of the Virgo galaxy cluster (see M49/NGC 4472), lying at its eastern edge along with NGC 4733 and NGC 4754. It contains a nuclear disk of gas (3″ in radius) that is rotating more rapidly than the stars there, at a speed of over 100 km/s at its outer edge. This galaxy's mass out to a radius of 1′ from the center is about 35 billion suns. The galaxy is perfectly edge-on. It is a LINER galaxy (see M81/NGC 3031). Like the majority of barred lenticular galaxies, an outer ring is seen (at a diameter of 8.3′) in professional telescopes.

NGC 4755

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Crux	Open cluster	12 h 53.7 m, −60° 21′	April 29
Distance	**Age**	**Apparent size**	**Magnitude**
8,000 light years	11 million years	10′	4.2

Professional telescopes count more than 5,000 stars in this region, of which only about a thousand are actual members of this young cluster, the rest being field stars (see M39). The extensive field star contamination is the result of the cluster's relatively large distance from us. About a third of its members are pre-main sequence stars that have not yet started undergoing hydrogen fusion but instead are still undergoing gravitational contraction, indicating that its stars did not all form at the same time. Indeed, its most massive stars formed during its early collapse (like the orange-colored luminous supergiant κ Crucis, which has already evolved off the main sequence), followed by lower mass star formation. It is nicknamed the Jewel Box Cluster or the κ Crucis cluster.

NGC 4781

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	12 h 54.4 m, −10° 32′	April 29
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		3.4′ × 1.4′	11.1
This is part of the NGC 4699 galaxy group (see NGC 4699), to which nearby NGC 4742 and NGC 4790 also belong. NGC 4760 (19′ W) is a background object and several times farther away.			

NGC 4800

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Spiral galaxy	12 h 54.6 m, +46° 32′	April 29
Distance	**Age**	**Apparent size**	**Magnitude**
55 million light years		1.6′ × 1.2′	11.6
This rotates about an axis that is inclined at about 40° from our line-of-sight. Its central region contains two unusual ultracompact nuclear rings, with radii of 100 and 420 light years that are perhaps associated with inner Lindblad resonances, where the speed of density waves resonantly amplifies oscillations in the orbits of matter in the disk.			

NGC 4826 (M64)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Spiral galaxy	12 h 56.7 m, +21° 41′	April 30
Distance	**Age**	**Apparent size**	**Magnitude**
15 million light years		10.0′×5.4′	8.5
Nicknamed the “Black-Eye Galaxy” (because of a dark arc-shaped dust region on its NE side, which is a challenge to discern in amateur telescopes), this has an optical diameter of about 50,000 light years. The nucleus of this galaxy is chemically different from the rest of the galaxy (and is said to be “chemically decoupled”). In addition, the gas in the outer disk (radii >about 1′ and containing 100 million solar masses) counter-rotates from rest of the galaxy, including the stars (which all rotate the same way). This highly unusual situation may have its origin in the past accretion of a gas-rich dwarf satellite galaxy. The dust that gives the galaxy its “black eye” rotates with the stars. M64 is thought to be a LINER galaxy driven by a starburst in its nucleus (see M81/NGC 3031 for explanation).			

NGC 4845

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Spiral galaxy	12 h 58.0 m, +01° 35′	April 29
Distance	**Age**	**Apparent size**	**Magnitude**
45 million light years		4.9′×1.3′	11.3
This is nearly edge-on (with an inclination angle of 78°). Its central bulge is thought to rotate about an axis that is not aligned with either the major or minor axes of its elliptical shape (so the bulge is said to be “triaxial”). It has a number of HII (ionized hydrogen) star-forming regions and is part of the NGC 4643 galaxy group (see NGC 4643). It is a Seyfert galaxy (see NGC 3227), with a central black hole mass of a few hundred thousand suns.			

NGC 4856

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred lenticular galaxy	12 h 59.4 m, −15° 03′	April 30
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		4.3′ × 1.2′	10.6
This is nearly edge-on (having an inclination angle of about 70°) with an optical diameter of about 80,000 light years and a position angle of 35°.			

NGC 4866

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Lenticular galaxy	12 h 59.5 m, +14° 10′	April 30
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		6.4′ × 1.5′	11.1
This is a LINER galaxy (see M81/NGC 3031).			

NGC 4900

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	13 h 00.7 m, +02° 30′	May 1
Distance	**Age**	**Apparent size**	**Magnitude**
45 million light years		2.2′ × 2.1′	11.3
This is associated with the Virgo cluster and is part of the NGC 4900 galaxy group of perhaps eight gravitationally bound galaxies. It is nearly face-on (with an inclination angle of about 5°). Along its bar are many young star formation bursts that are 5–8 million years old. It contains a dusty nuclear bar that is perpendicular to the large scale bar.			

NGC 4958

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred lenticular galaxy	13 h 05.8 m, –08° 01′	May 2
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		3.9′ × 1.4′	10.7

This is part of the NGC 4697 galaxy group (see NGC 4697), as is its nearby neighbor NGC 4948. It has an optical diameter of about 50,000 light years.

NGC 4995

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	13 h 09.7 m, –07° 50′	May 3
Distance	**Age**	**Apparent size**	**Magnitude**
90 million light years		2.4′ × 1.7′	11.2

This is a Seyfert galaxy (see NGC 3227). It has many HII (ionized hydrogen, star-forming) regions in its disk. It is the namesake member of the NGC 4995 group of perhaps four gravitationally bound galaxies, the brightest of which are NGC 4928 (1° 41′ W) and NGC 4981 (1° NNW). Nearby NGC 4958 and NGC 4928 are part of the much closer NGC 4697 galaxy group (see NGC 4697).

NGC 5005

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Barred spiral galaxy	13 h 10.9 m, +37° 04′	May 3
Distance	**Age**	**Apparent size**	**Magnitude**
65 million light years		5.8′ × 2.9′	9.8

This has a mass of several hundred billion suns. It is alternately classed as a LINER galaxy (see M81/NGC 3031) or a Seyfert galaxy (see NGC 3227). It is the namesake member of the NGC 5005 group of 13 galaxies that includes nearby NGC 5033 (40′ SE – see NGC 5033), NGC 5002 (26′ S), NGC 5014 (47′ S), IC 4213 (1° 24′ S), NGC 4861 (3° 15′, SW), NGC 5107 (2° 33′ NE), NGC 5112 (2° 45′ NE), IC 4182 (1° 09′ WNW).

NGC 5024 (M53)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Coma Berenices	Globular cluster	13 h 12.9 m, +18° 10′	May 4
Distance	**Age**	**Apparent size**	**Magnitude**
60,000 light years	10–14 billion years	13′	7.7

The mass of this cluster is about half a million suns. It lies nearly directly "above" us from the galactic central plane in the halo of our galaxy (see M2/NGC 7089 for the meaning of "halo"). Its orbit keeps it out in the halo, with a period of close to a billion years. It follows a path that takes it well over 100,000 light years from the galactic center and never closer than about 35,000 light years to the galactic center. Its orbit is highly inclined (by about 60°) to the disk of our galaxy. M53's apparent size corresponds to a diameter of about 230 light years. The nearby globular cluster NGC 5053 (1° ESE) lies nearly directly "below" M53 in three-dimensional space, being a 1,600 light years closer to us (in a direction nearly perpendicular to the disk of our galaxy).

NGC 5033

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Spiral galaxy	13 h 13.5 m, +36° 36′	May 4
Distance	**Age**	**Apparent size**	**Magnitude**
65 million light years		10.7′×5.0′	10.0

This has a total dynamical mass of about a quarter trillion suns. It is thought to have been perturbed in the past by weak interaction with other galaxies, perhaps dwarf galaxies that lie nearby (as the Milky Way has been perturbed by the Magellanic Clouds). It is part of the NGC 5005 galaxy group (see NGC 5005). It is a Seyfert galaxy (see NGC 3227), in which emission from the nucleus is thought to occur due to accretion of matter onto a massive central black hole. Its Seyfert active galactic nucleus is offset from the galaxy's mass centroid, perhaps because of a past merger event. A nuclear starburst lasting perhaps 10 million years may be contributing the majority of the radio and far infrared emission from its nucleus. It may have a small nuclear bar with a length <30″.

NGC 5054

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Spiral galaxy	13 h 17.0 m, −16° 38′	May 5
Distance	**Age**	**Apparent size**	**Magnitude**
90 million light years		5.1′×2.8′	10.9

It has a mass of about 140 billion suns and an optical diameter of 130,000 light years. It is the namesake member of the NGC 5054 group of perhaps seven galaxies, and is associated with the NGC 5044 galaxy group that covers roughly 2 square degrees centered on NGC 5044 and whose associated NGC members include NGC 5017, 5030, 5031, 5035, 5037, 5038, 5044, 5046, 5047, 5049 and 5054 itself, among over 150 much dimmer galaxies that lie in this region.

(NGC 5055) M63

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Spiral galaxy	13 h 15.8 m, +42° 02′	May 4
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		12.6′×7.2′	8.5

This is nicknamed the "Sunflower Galaxy." It is part of a gravitationally bound group of perhaps nine galaxies that includes M51 (NGC 5194) and NGC 5023 (spiral galaxy, mag. 12.1, 2° NNW). M63 is a so-called "flocculent" spiral galaxy, meaning that it lacks any obvious azimuthally symmetric spiral arm pattern (see NGC 3521 for further explanation). It has a mass of a couple hundred billion suns and is a "low-ionization nuclear emission region" galaxy (or "LINER" – see M81/NGC 3031 for explanation). It has an optical diameter of a little over 90,000 light years. Beyond its optically visible regions the galaxy consists of a neutral hydrogen (HI) disk (not visible in amateur telescopes) that is "warped" so that the far outer edge of its HI disk lies in a plane that is skewed by perhaps about 20° from the rest of the galaxy. Warps occur in the HI distribution of most galaxies that have significant HI extending beyond their optical disks, perhaps because of misalignment, relative to the disk, of the angular momentum of accreted material. Professional telescopes also find a giant loop extending out 14′ on the eastern side of this galaxy, which is thought to be a stellar tidal stream created by the accretion, within the past few billion years ago, of a dwarf galaxy with a mass of a few hundred thousand suns.

NGC 5128

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Centaurus	Elliptical galaxy	13 h 25.5 m, −43° 01′	May 7
Distance	**Age**	**Apparent size**	**Magnitude**
12 million light years		18.2′	7.0

This is thought to consist of a giant elliptical galaxy that merged with a small spiral galaxy within perhaps the past few hundred million years. This merger is thought to have produced the galaxy's current thin warped disk with an inclination angle of about 70° to our line of sight that appears as a prominent gas and dust lane. Intense star formation is occurring in this disk in many ionized hydrogen (HII) regions. This galaxy is the central member of the Centaurus A galaxy group, containing about 30 members, which includes NGC 4945 (7° SW) and NGC 5102 (6.5° NW), and that may be paired with the M83 galaxy group (see M83/NGC 5326). It is the fifth brightest galaxy in the sky, after M31, M33, and the two Magellanic clouds. It has a mass of about 400 billion suns. It is also called Centaurus A, after its moniker as a strong radio source, having a diameter of several degrees in the sky. This wide area radio emission may stem from the past merge that led to its thin disk. A series of optical and neutral hydrogen (HI) shells suggest this galaxy may have also accreted a number of small satellite galaxies. Nearly 1,500 globular clusters have been identified in this galaxy in professional telescopes. It contains a low-luminosity active galactic nucleus, powered by a supermassive black hole with mass of about 50 million suns.

NGC 5139

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Centaurus	Globular cluster	13 h 26.8 m, −47° 29′	May 7
Distance	**Age**	**Apparent size**	**Magnitude**
18,000 light years	10–14 billion years	55′	3.9

This is also called ω Centauri. With a mass of about 4 million suns, it is the most massive and brightest globular cluster in the Milky Way. It is thought to be the remnant nucleus of a previously accreted dwarf galaxy. Unlike most globular clusters, its stars have exceptional variations in their chemical abundances, which may be the result of an unusually extended star formation period. It has a retrograde, high eccentricity orbit with a period of about 120 million years that takes it within a few thousand lights of the galactic center and out to a distance of about 20,000 light years. Instead of being almost spherical like most globular clusters, it has an unusually high rotation rate that flattens it so that its aspect ratio of minor to major axis is about 0.87.

NGC 5189

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Musca	Planetary nebula	13 h 33.5 m, −65° 58′	May 9
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years		2.3′	10.3

The complicated structure here may be the result of multiple mass loss events from the central star whose main outflow direction may precess due to an unseen companion star, perhaps dominated by two sets of bipolar lobe-creating events. Its central star (mag. 14) is a carbon rich WC Wolf-Rayet star (see NGC 40) with an extreme temperature of 135,000 K and is about to become a white dwarf after ending its asymptotic giant branch (AGB) stay on the color-magnitude diagram. It also pulsates as a GW Virginus variable star with a period of 690 s due to the so-called κ mechanism, whereby the stellar atmosphere opacity increases with temperature so that radially inward mass movements suffer increased opacity and result in increased pressure pushing such disturbances outward, after which they repeat the process in a periodic manner. It is nicknamed the “Spiral Planetary Nebula.”

NGC 5194 (M51)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Spiral galaxy	13 h 29.9 m, +47° 12′	May 8
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		11.2′×6.9′	8.1

Nicknamed the "Whirlpool Galaxy," this is a grand-design spiral, meaning that it has two symmetrically placed spiral arms that extend over most its visible disk in professional telescopic images. What appears as a bridge connecting M51 to its nearby companion galaxy NGC 5195 (4′ NNE – see NGC 5195) is actually an optical illusion – a spiral arm of M51 is superimposed on NGC 5195 with NGC 5195 actually lying on the far side of M51 (by perhaps a half million light years), although the two galaxies have had perhaps two recent close encounters in the past (see NGC 5195). These gravitational interactions with NGC 5195 are thought to have triggered star formation in M51, with two peaks in star cluster formation occurring a few hundred million years ago, in addition to a recent peak a few million years ago. Almost 20,000 ionized hydrogen (HII) star-forming regions have been identified in M51, with diameters averaging about 30 light years and having masses up to several thousand Suns. A number of these HII regions can be seen as bright knots in amateur telescopes. M51 is a Seyfert galaxy (see NGC 3372 for explanation) and has an optical diameter of about 80,000 light years. It is part of the M51 galaxy group of perhaps nine gravitationally bound galaxies.

NGC 5195

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Barred lenticular galaxy	13 h 30.7 m, +47° 16′	May 8
Distance	**Age**	**Apparent size**	**Magnitude**
25 million light years		5.9′×4.6′	9.6

This is the companion galaxy with which M51 is interacting (see M51/NGC 5194). This interaction is thought to be responsible for triggering star formation in the arms of M51, and has had a strong effect on the location and strength of M51's star formation. NGC 5195 is on the far side of M51 from us (by perhaps half a million light years) and thought to be several times less massive than M51. Models suggest that NGC 5195 has had two close encounters with M51 over the past few hundred million years, but its orbit is decaying so that it may merge with M51 (perhaps in less than a few hundred million years). NGC 5195 is thought to have had a nuclear starburst in its past, which has since ceased but whose evolved stars still yield considerable emission from the nucleus of this galaxy. Indeed, it is a LINER galaxy (see M81/NGC 3031). It has an optical diameter of about 40,000 light years.

NGC 5236 (M83)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hydra	Barred spiral galaxy	13 h 37.0 m, −29° 52′	May 11
Distance	**Age**	**Apparent size**	**Magnitude**
15 million light years		12.9′ × 11.5′	7.5

This is a grand design spiral, meaning that it has two symmetrically placed spiral arms that extend over most of its visible disk in professional telescopic images. It is also a starburst galaxy (meaning it has intense star formation occurring – see M82/NGC 3034) with the star formation concentrated in a half-ringlet occupying the region 3″–7″ from the galaxy center that contains hundreds of star clusters. About 30 of these star clusters have masses of more than 20,000 suns and are less than 10 million years old. An extremely massive star cluster, with a mass of about 10 million suns formed about 100 million years ago from a previous starburst and lies just a few arc seconds away from the kinematical center of this galaxy, giving the galaxy the appearance of a double nucleus in professional telescopes. M83 is part of a gravitationally bound group of galaxies that includes nearby NGC 5264 (1° E) and NGC 5253 (1° 53′ SSE), the latter having its closest approach to M83 1 or 2 billion years ago. M83 has an optical diameter of about 60,000 light years and is nearly face-on (with an inclination angle of 24°, i.e., it rotates about an axis that is inclined from our line-of-sight by 24°). It contains more than a thousand massive Wolf-Rayet stars (see NGC 2403 for explanation).

NGC 5248

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Bootes	Barred spiral galaxy	13 h 37.5 m, +08° 53′	May 10
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		6.2′ × 4.5′	10.1

This is a grand-design spiral (meaning that it has two symmetrically placed spiral arms that extend over most of its visible disk in professional telescopic images). Professional telescopic studies find two circumnuclear rings of star formation, an inner one with a diameter of 3″ and an outer one with diameter 12″. These rings may have formed due to dynamics associated with two nested bars that are thought to be present in this galaxy. NGC 5248 has a mass of about 140 billion suns and an optical diameter of about 70,000 light years. The NE side of this galaxy is the side closest to us.

NGC 5272 (M3)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Globular cluster	13 h 42.2 m, +28° 23′	May 11
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	18′	6.3

The mass here is about a half million suns. The size of 18′ corresponds to a diameter of about 160 light years. It orbits the galaxy on a precessing elliptical path that is highly inclined with the plane of our galaxy and quite eccentric (minor axis to major axis ratio of 0.4). It takes about 300 million years to make one revolution of the galaxy, never straying farther than about 60,000 light years from the galactic center. (We are about 27,000 light years from the galactic center, although we stay in the disk of our galaxy and M3 does not.) M3 never approaches closer than about 10,000 light years from the galactic center, making it an inner halo cluster (so called since it doesn′t travel too far out in the halo – see M2 for the meaning of "halo"). It is considered intermediate in its richness of "metals" (elements heavier than helium), ranking just out of the top third in metallicity for globular clusters in our galaxy.

NGC 5273

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Canes Venatici	Lenticular galaxy	13 h 42.1 m, +35° 39′	May 11
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		2.8′×2.5′	11.5

This is a Seyfert galaxy (where a supermassive object in this galaxy's center accumulates nearby material resulting in strong emission from the nucleus). It has an optical diameter of about 40,000 light years, which is a little below the average diameter of 60,000 light years for nearby galaxies (i.e., those within 150 million light years).

NGC 5286

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Centaurs	Globular cluster	13 h 46.4 m, −51° 22′	May 12
Distance	**Age**	**Apparent size**	**Magnitude**
38,000 light years	10–14 billion years	11′	7.3
Some have suggested this once belonged to the now accreted Canis Major dwarf spheroidal galaxy. It has a mass of about 700,000 suns. It has not been well studied in professional telescopes. It is about 150 times further away from us than the nearby positioned bright star, M Centauri (mag. 4.6) that is about 260 light years distant.			

NGC 5322

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Elliptical galaxy	13 h 49.2 m, +60° 11′	May 13
Distance	**Age**	**Apparent size**	**Magnitude**
90 million light years		6.0′×4.1′	10.1
This is a Seyfert galaxy (see NGC 3372). It has a central core within a radius of 10″ that counter-rotates relative to the rest of the galaxy, which is thought to be the result of a merger of two galaxies several billion years ago. It is the namesake member of the NGC 5322 galaxy group, which contains perhaps 21 gravitationally bound galaxies including 5342, 5372, 5376, 5379, and 5389.			

NGC 5363

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Lenticular galaxy	13 h 56.1 m, +05° 15′	May 15
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		4.1′×2.6′	10.5

Professional telescopic studies find a neutral hydrogen (HI) disk surrounding this galaxy that is falling into the galaxy at several tens of km/s, resulting in accretion of a few percent of a solar mass/year into the inner regions of the galaxy. It contains a dust lane, and is unusual for its galaxy type in that it contains ionized hydrogen (HII) regions in a barred spiral disk. Young stars in these regions are thought to have formed upon accretion of material in a past merger event. It is a LINER ("low-ionization nuclear emission region") galaxy (see M81/NGC 3031) and is part of the NGC 5364 galaxy group (see NGC 5364).

NGC 5364

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Spiral galaxy	13 h 56.2 m, +05° 01′	May 15
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		6.8′×4.4′	10.4

Professional telescopes find this galaxy has an amazingly regular spiral appearance – its arms can be traced for well over a complete revolution from their origin. Significant HII (ionized hydrogen) star-forming regions are present. It is the namesake member of the NGC 5364 galaxy group of seven gravitationally bound galaxies that includes nearby NGC 5363 (14′ N – see NGC 5363), NGC 5356, NGC 5348, NGC 5338 and NGC 5300. One degree north is the NGC 5374 galaxy group, which is more than twice as far away as NGC 5364 and includes NGC 5374 and 5382.

NGC 5457 (M101)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	14 h 03.2 m, +54° 21′	May 17
Distance	**Age**	**Apparent size**	**Magnitude**
20–25 million light years		28.8′×26.9′	7.5

This galaxy is nearly face-on. It has a diameter of almost 200,000 light years. Many ionized hydrogen (HII) star-forming regions are present in M101, some of which can be seen as bright knots in amateur telescopes. Several of these knots have their own NGC numbers, e.g., NGC 5461, 5462, 5471, the latter of which is a hundred times larger and brighter than any HII region in our galaxy. Some of these supersized HII regions have masses of tens of millions of suns (e.g., NGC 5461 and 5471), and although they appear as a single knot in amateur telescopes, they are made up of many individual giant molecular clouds (GMCs) that have masses of several hundred thousands of suns (similar to the masses of GMCs in our galaxy). M101 is the namesake member of the M101 group of gravitationally bound galaxies that includes NGC 5474 (44′ SSE), NGC 5585 (3° 21′ NE), NGC 5204 (6° NW) and NGC 5477 (22′ ENE) and Holmberg IV (UGC 8837, 1° 19′ WSW). Tidal interactions with several group members in the past few hundred million years (perhaps including NGC 5477, NGC 5474 and Holmberg IV) are thought to have distorted M101. These interactions may have induced the formation of some of the HII regions, e.g., NGC 5471.

NGC 5466

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Bootes	Globular cluster	14 h 05.5 m, +28″ 32′	May 17
Distance	**Age**	**Apparent size**	**Magnitude**
50,000 light years	12–14 billion years	9.2′	9.2

This cluster orbits the galaxy with a period of about a billion years, never getting any closer than about 15,000 light years to the galactic center, but wandering out perhaps over 200,000 light years at its most distant orbital position. This cluster has an orbit that shares dynamical properties with that of NGC 6934 (see NGC 6934), and it has been suggested that both are left over from a disrupted satellite galaxy of the Milky Way. NGC 5466 has a diameter of about 130 light years and a mass of about 100,000 suns. It has leading and trailing tidal tails caused by its interaction with the Milky Way's gravitational potential, mostly when it crosses the disk and during its closest approach to the galactic center. In professional telescopes, the tidal stream of these tails subtends a 45° arc on the sky. Although binary stars are rare in globular clusters, professional telescopes find this cluster contains three eclipsing binaries (two of which are "contact binaries," meaning they are so close to each other that they are immersed in a common envelope of gas). Its ranks below the tenth percentile in its fraction of elements heavier than helium, i.e., it is "metal" poor among Milky Way globular clusters.

NGC 5473

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Barred lenticular galaxy	14 h 04.7 m, +54° 54′	May 17
Distance	**Age**	**Apparent size**	**Magnitude**
110 million light years		2.2′ × 1.7′	11.4

This is part of the NGC 5485 galaxy group of seven gravitationally bound galaxies that includes nearby NGC 5422, NGC 5443, NGC 5475, NGC 5485 and NGC 5486. Nearby M101 (35′ SSW) is a foreground object, with NGC 5473 being about five times further away.

NGC 5474

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Spiral galaxy	14 h 05.0 m, +53° 40′	May 17
Distance	**Age**	**Apparent size**	**Magnitude**
20 million light years		4.7′×4.7′	10.6

This has a mass of several billion suns. It is nearly face-on (with an inclination angle of about 20°). Professional telescopes find that the disk of this galaxy is warped at its outer edges (in its neutral hydrogen disk beyond the optically visible region), becoming increasingly less face-on at larger radii (reaching inclination angles of 30°–40°). Warps occur in the HI distribution of most galaxies that have significant HI extending beyond their optical disks, perhaps because of misalignment, relative to the disk, of the angular momentum of accreted material. This galaxy has interacted recently with its much larger neighbor, M101, which is thought to have caused asymmetry in both galaxies. It is part of the M101 galaxy group (see M101/NGC 5457).

NGC 5557

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Bootes	Elliptical galaxy	14 h 18.4 m, +36° 30′	May 21
Distance	**Age**	**Apparent size**	**Magnitude**
130 million light years		2.4′×1.9′	10.9

Several distinct atomic hydrogen (HI) clouds lie along tidal tails extending out as far as half a billion light years and thought to be the result of a gas rich major merger in the past few billion years. Three tidal dwarf galaxies may have been spawned in this collisional debris. It forms a gravitationally bound group of perhaps 20 galaxies, that includes the pair NGC 5590 (1° 29′ SSE) and NGC 5589 (1° 24′ SSE).

NGC 5566

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	14 h 20.3 m, +03° 56′	May 21
Distance	**Age**	**Apparent size**	**Magnitude**
75 million light years		6.6′ × 2.3′	10.7

This has a circumnuclear disk with its own mini-spiral pattern nested inside the large scale bar. It is inclined at about 64°. It is the namesake member of the NGC 5566 group of perhaps twelve gravitationally bound galaxies that includes nearby NGC 5560 (5′ NW), 5574 (43′ SSE), 5576 (42′ SSE – see NGC 5576) and 5577 (33′ SSE) as well as the dimmer NGC 5569 (4′ NE). This group may be associated with the much larger NGC 5846 group (see NGC 5846). It is a LINER galaxy (LINER stands for "low-ionization nuclear emission region" – see M81/NGC 3031).

NGC 5576

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	14 h 21.1 m, +03° 16′	May 21
Distance	**Age**	**Apparent size**	**Magnitude**
75 million light years		3.8′ × 2.7′	10.8

This is part of the NGC 5566 galaxy group (see NGC 5566). The stars in its nucleus are unusually rich in iron, perhaps due to multiple starbursts. It has undergone recent star formation. It has a central black hole with a mass of 180 million suns. NGC 5576 may be interacting with nearby NGC 5574 (3′ SSW), with a 7′ long tidal tail extending SSW beyond NGC 5574 with a luminosity that is several percent of the luminosity of NGC 5576.

NGC 5631

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Major	Lenticular galaxy	14 h 26.6 m, +56° 35′	May 23
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		1.7′ × 1.7′	11.4

This is a Seyfert galaxy (where a supermassive object in this galaxy's center accumulates nearby material resulting in strong emission from the nucleus). A minor merger with a gas rich dwarf galaxy is thought to be responsible for a full-size counter-rotating disk of ionized gas, inclined at an angle of 35° from the stellar disk, that is present in this galaxy.

NGC 5634

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Globular cluster	14 h 29.6 m, −05° 59′	May 23
Distance	**Age**	**Apparent size**	**Magnitude**
80,000 light years	10–14 billion years	5.5′	9.5

This has a mass of nearly 300,000 suns and a diameter of about 90 light years. It lies well off the galactic plane (by about 60,000 light years). It is thought to have once belonged to the Sagittarius dwarf elliptical galaxy (see M54/NGC 6715) but was stripped away by gravitational interactions with our galaxy billions of years ago.

NGC 5676

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Bootes	Spiral galaxy	14 h 32.8 m, +49° 27′	May 24
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		3.9′ × 1.8′	11.1
This has a mass of about 200 billion suns. It is the namesake member of the NGC 5676 group of galaxies that includes perhaps 17 gravitationally bound galaxies, the brightest of which include NGC 5660, NGC 5689 (see NGC 5689), NGC 5673, and IC 1029, all within 1° of NGC 5676, as well as NGC 5707 (2° NNE) and NGC 5633 (3.5° SSW).			

NGC 5689

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Bootes	Barred lenticular galaxy	14 h 35.5 m, +48° 45′	May 26
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		3.3′ × 1.0′	11.9
This is part of the NGC 5676 group of galaxies (see NGC 5676) that also includes the much dimmer NGC 5682 (mag. 13.9), and NGC 5693 (mag. 13.6).			

NGC 5694

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hydra	Globular cluster	14 h 39.6 m, −26° 32′	May 26
Distance	**Age**	**Apparent size**	**Magnitude**
110,000 light years	10–14 billion years	4.3′	10.2

This has a mass of about 300,000 suns and a diameter of about 140 light years. It has an unusually low abundance of elements heavier than helium (i.e., it is "metal-poor"), lying near the tenth percentile in its fraction of elements heavier than helium. It lies in the halo (see NGC 7006) of our galaxy, one of only 13 outer halo globular clusters (that lie more than 80,000 light years from the galactic center). It may have formed in a dwarf spheroidal galaxy and been subsequently accreted by the Milky Way.

NGC 5746

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Barred spiral galaxy	14 h 44.9 m, +01° 57′	May 27
Distance	**Age**	**Apparent size**	**Magnitude**
90 million light years		7.4′ × 1.3′	10.5

This has an optical diameter of about 180,000 light years and is nearly edge-on (with an inclination angle of 84°). It is the namesake member of the NGC 5746 galaxy group of perhaps 39 gravitationally bound galaxies, among which are the following nearby readily visible NGC galaxies: 5690, 5740, 5746, 5691, 5705, 5713, 5719, and 5750. It shows no signs of having undergone a major merger event in its past.

NGC 5846

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Virgo	Elliptical galaxy	15 h 06.5 m, +01° 36′	June 2
Distance	**Age**	**Apparent size**	**Magnitude**
90 million light years		4.0′ × 3.7′	10.1

This is a large galaxy with a mass of several trillion suns. Its central black hole has a mass of about a billion suns. It is the namesake member of the large NGC 5846 group of perhaps several hundred galaxies that all lie at approximately the same distance, and which includes all the readily visible NGC galaxies within a 3° × 3° square, most of which are "early-type" galaxies (i.e., ellipticals, lenticulars and early-type spirals). Indeed, it is the third most massive group of early-type galaxies within a 100 million light year radius, after the Virgo and Fornax clusters. The NGC 5846 group includes many dwarf galaxies, accounting for perhaps 80 % of the galaxies in this group, a situation similar to the Virgo Cluster. Dust found in the central region of NGC 5846 in professional telescopic studies is thought to be from a past accretion of a small, gas-rich galaxy. A high-speed encounter with NGC 5850 is thought to have left the latter with a disturbed morphology.

NGC 5866 (M102)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Draco	Lenticular galaxy	15 h 06.5 m, +55° 46′	June 2
Distance	**Age**	**Apparent size**	**Magnitude**
40 million light years		6.5′ × 3.1′	9.9

This is a lenticular galaxy (given the label S0 in classification schemes), meaning it has a disk and central bulge like a spiral galaxy, but lacks the spiral arms. Lenticulars usually contain very little gas, dust, or young stars, consisting almost entirely of old stars. It contains about 340 globular clusters. This galaxy is sometimes called the "Spindle Galaxy," although NGC 3115 also has this nickname. It is nearly edge-on (inclination angle of 86°, meaning it rotates about an axis that is inclined at 86° from our line-of-sight) with about 60 % of its light coming from its bulge and 40 % from its disk. It has an optical diameter of 80,000 light years (the diameter of our galaxy is about 100,000 light years). It is the namesake member of the NGC 5866 group of perhaps five galaxies that includes nearby NGC 5907 and NGC 5879, which are within several million light years of NGC 5866. Messier's original M102 is believed to be a duplicate entry of M101 (NGC 5457) rather than being NGC 5866, but in order to have 110 different objects in the Messier list, many amateur astronomers informally attach the label M102 to NGC 5866.

NGC 5897

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Libra	Globular cluster	15 h 17.4 m, −21° 01′	June 4
Distance	**Age**	**Apparent size**	**Magnitude**
40,000 light years	10–14 billion years	11′	8.4

This has a mass of about 100,000 suns and a diameter of about 130 light years. It is "metal-poor" (meaning it contains relatively low amounts of elements heavier than helium) even for a globular cluster, being in the bottom 15th percentile for metallicity among Milky Way globular clusters. It contains about 40 "blue stragglers," which are stars that are paradoxically far more blue and luminous than expected perhaps because of mass transfer between or coalescence of stars (see NGC 6633). This cluster is relatively elliptical in shape, with a minor to major axis ratio of 0.7. Two tidal stellar streams emanate from this globular, one to the north and the other to the south, resulting from its motion through the Milky Way gravitational field.

NGC 5904 (M5)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Serpens Caput	Globular cluster	15 h 18.6 m, +02° 05′	June 5
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	23′	5.7
This has a mass of about 600,000 suns and its diameter is about 160 light years. Like most globular clusters, it does not orbit our galaxy with the galactic disk as we do. Instead it follows an orbit that takes it out as far as 180,000 light years from the galactic center and then back in as close as a few thousand light years, on a path highly inclined to the galactic disk, taking almost a billion years to make one revolution around our galaxy (compare to the quarter billion years our Sun takes to make one galactic revolution). M5 currently sits about 20,000 light years from the galactic center, which is much closer than its average orbital distance since it is about to reach its closest approach to the galactic center.			

NGC 5907

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Draco	Spiral galaxy	15 h 15.9 m, +56° 20′	June 5
Distance	**Age**	**Apparent size**	**Magnitude**
45 million light years		12.6′ × 1.4′	10.4
The nearly edge-on size of 12.6′ gives this galaxy an optical diameter of about 165,000 light years. The mass of its stars and gas is about 85 billion suns, with gas making up 23 % of this mass. Although not visible in amateur telescopes, it has two faint loops and an extended halo which may be the remains of a merger event. Both its stellar and gas disks are quite warped, perhaps related to its past merger. It is part of the NGC 5866 galaxy group (see M102/NGC 5866).			

NGC 5982

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Draco	Elliptical galaxy	15 h 38.7 m, +59° 21′	June 11
Distance	**Age**	**Apparent size**	**Magnitude**
130 million light years		3.0′×2.1′	11.1

This has a mass of about a half billion suns, and contains about 1,500 globular clusters. As with about 30 % of elliptical galaxies, the core of this galaxy rotates independently of its outer regions, a feature that may result from the merging of two galaxies. In such mergers, the central part retains the angular momentum of one of the merged galaxies, while the outer parts retain the angular momentum of the other galaxy. A recent minor merger, in the past couple billion years, is thought to have created a series of shells in the envelope of this galaxy. It is part the namesake member of the NGC 5982 group of perhaps 16 gravitationally bound galaxies that includes NGC 5985 (7′ E, a Seyfert galaxy – see NGC 3227), as well as NGC 5987 (1° 17′ S) and NGC 5989 (32′ NE). Nearby NGC 5981 (6′ WNW) is not considered part of this group and instead lies somewhat closer to us.

NGC 6025

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Triangulum Australis	Open cluster	16 h 03.3 m, −60° 26′	June 16
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	80 million years	15′	5.1

Professional telescopes count about 60 member stars brighter than mag. 11.3. It has a diameter of about 13 light years. It currently lies about 250 light years below the galactic plane but oscillates above and below the galactic plane so that it crosses it a half a dozen times or so in its 200-million-year period orbit around the galaxy center. It has not been well studied by professional astronomers.

NGC 6093 (M80)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scorpius	Globular cluster	16 h 17.0 m, −22° 58′	June 21
Distance	**Age**	**Apparent size**	**Magnitude**
33,000 light years	10–14 billion years	10′	7.3
This has a mass of about 300,000 suns and a diameter of about 100 light years. It was the first globular cluster to have a nova discovered in it. M80 is a bulge cluster (meaning it orbits inside the central bulge of our galaxy – see M9/NGC 6333) and has one of the shortest orbital periods of the globular clusters in our galaxy. Indeed, it only takes about 70 million years to complete one revolution about the galaxy, in an orbit that is highly inclined to the galactic central plane.			

NGC 6118

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Serpens Caput	Spiral galaxy	16 h 21.8 m, −02° 17′	June 21
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		4.7′ × 1.9′	11.7
This has a mass of about 100 billion suns, an optical diameter of about 100,000 light years, and an inclination angle of about 60° (meaning its disk rotates about an axis that is inclined at about 60° from our line-of-sight).			

NGC 6121 (M4)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scorpius	Globular cluster	16 h 23.6 m, −26° 31′	June 21
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	10–14 billion years	36′	5.4

This is the nearest globular cluster to us. Its size of 36′ corresponds to a diameter of about 70 light years. It has a mass of about 100,000 suns. It has two distinct stellar populations, which are thought to represent two different generations of stars that formed at different times in this cluster. The cluster lies toward the galactic center, within roughly 2,000 light years of the galactic central plane, so that interstellar material in the disk of our galaxy blocks out some of its light and makes it dimmer (by a few magnitudes) than it would otherwise appear. It follows an orbit that takes it in as close as 1,000 light years and out as far as 30,000 light years from the galactic center over a period of about 120 million years.

NGC 6144

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scorpius	Globular cluster	16 h 27.2 m, −26° 01′	June 22
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	7.4 ′	9.0

This has a mass of about 100,000 suns. Its size of 7.4′ gives it a diameter of about 60 light years. It lies behind the ρ Ophiuchi dust cloud which, along with other interstellar material between us and the cluster, dims our view of the stars in this cluster. It is a bulge cluster (i.e., it orbits in the central ball-like bulge of our galaxy) and is metal-poor (i.e., it contains low amounts of elements heavier than helium), being in the bottom 20th percentile for metallicity of Milky Way globular clusters.

NGC 6171 (M107)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	16 h 32.5 m, −13° 03′	June 23
Distance	**Age**	**Apparent size**	**Magnitude**
20,000 light years	10–14 billion years	13′	7.8
This has a mass of about 100,000 suns and a diameter of about 80 light years. It is a bulge cluster (i.e., it orbits in the central ball-like bulge of our galaxy) with a period of about 100 million years. Its orbital path is inclined by about 45° to the galactic disk and is a very flattened ellipse. It was not noted by Messier, but instead is a recent (1947) addition to the Messier catalog suggested by H. S. Hogg.			

NGC 6205 (M13)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hercules	Globular cluster	16 h 41.7 m, +36° 28′	June 26
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	20′	5.8
This is nicknamed the "Hercules Cluster." Its 20′ size corresponds to a diameter of about 130 light years. It has a mass of about 500,000 suns. It orbits the galaxy independently of the material in the galactic disk on an inclined orbit that travels out to beyond 100,000 light years from the galactic center but approaches within 15,000 light years of the galactic center, taking half a billion or so years to complete one revolution.			

NGC 6207

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hercules	Spiral galaxy	16 h 43.1 m, +36° 50′	June 26
Distance	**Age**	**Apparent size**	**Magnitude**
65 million light years		3.0′ × 1.2′	11.4
This has an optical diameter of about 55,000 light years and a mass of about 15 billion suns. A foreground star 6″ N of the nucleus is partly responsible for the star-like appearance of the nucleus. It rotates about an axis inclined at 64° from our line-of-sight.			

NGC 6210

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hercules	Planetary nebula	16 h 44.5 m, +23° 48′	June 27
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years		21″	8.8
The three-dimensional structure of this nebula is complex, with professional telescopic studies finding extensions in several directions that are thought to be jets ejected from the nucleus, in addition to expanding shell structures. The central star (mag. 12.7) has a surface temperature of about 70,000 K and can be seen in large amateur telescopes. Its radius is about 35 % that of our Sun. The nebula is perhaps a few thousand years old.			

NGC 6217

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ursa Minor	Barred spiral galaxy	16 h 32.6 m, +78° 12′	June 24
Distance	**Age**	**Apparent size**	**Magnitude**
70 million light years		3.0′×2.5′	11.0
This is a Seyfert galaxy (see NGC 3227) with a nuclear starburst (i.e., intense nuclear star formation). It has one of the largest (apparent size) one-sided X-ray jets, extending 2.7′ SW from its nucleus in professional telescopic studies, presumably associated with accretion onto a supermassive central object. The rotation axis of the galaxy has an inclination angle of about 33° to our line-of-sight.			

NGC 6218 (M12)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	16 h 47.2 m, −01° 57′	June 27
Distance	**Age**	**Apparent size**	**Magnitude**
15,000 light years	10–14 billion years	16′	6.1
This clusters size of 16′ corresponds to a diameter of about 70 light years. Like M3 and M10, this is an inner halo cluster, so called since it doesn't travel too far out in the halo – see M2 for the meaning of "halo." M12 never strays farther than about 20,000 light years from the galactic center on an orbit inclined to the galactic central plane by 33° or so. M12 takes about 130 million years to complete one revolution around the galaxy, having just crossed the galactic central plane a few million years ago (lying 2,000 light years below it) on its way to a maximum excursion of 10,000–15,000 light years below the galactic plane. Its mass is about 100,000 suns, which is perhaps a fifth of its original mass, having been tidally stripped of stars by interactions with the Milky Way's gravitational potential over its lifetime, losing a mass of perhaps 5,000 suns each time it orbits our galaxy.			

NGC 6229

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hercules	Globular cluster	16 h 47.0 m, +47° 32′	June 27
Distance	**Age**	**Apparent size**	**Magnitude**
100,000 light years	10–14 billion years	4.5′	9.4

This has a mass of about half a million suns. Its size of 4.5′ gives it a diameter of about 130 light years. It lies in the outer halo of our galaxy (see NGC 7006 for explanation of "halo"), 65,000 light years above the galactic central plane and about 100,000 light years from the galactic center. Such "outer halo" globular clusters are uncommon – only 19 of the 150 or so globulars in our galaxy are farther than 80,000 light years from the galactic center, with the only other outer halo NGC globular clusters being NGC 2419 (see NGC 2419), NGC 5694 (see NGC 5694), NGC 5824, NGC 7006 (see NGC 7006), and NGC 7492.

NGC 6231

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scorpius	Open cluster	16 h 54.2 m, −41° 49′	June 29
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	4 million years	14′	2.6

This is a rich, young cluster. It is also known as the "False Comet Cluster," or the "Northern Jewel Box." It has a mass of about 2,600 suns and is at the center of the 1°×2° Scorpius OB1 association of stars that also includes Collinder 316. The globular cluster NGC 6397 (see NGC 6397) is thought to have passed through the galactic disk 4 million years ago at the location of the natal cloud from which NGC 6231 formed. This may have triggered the star formation that led to NGC 6231. It contains the blue hypergiant ζ^1 Sco (HD 152236, mag. 4.8), which is a blue super-supergiant with Balmer emission lines, of which only 16 such stars have been identified in the galaxy; its mass is about 40 suns. The star HD 153919 (mag. 6.6, 4.5° NE) is thought to have once been part of NGC 6231 but was ejected when its companion star exploded in a supernova.

NGC 6235

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	16 h 53.4 m, −22° 11′	June 29
Distance	**Age**	**Apparent size**	**Magnitude**
40,000–45,000 light years	10–14 billion years	5′	8.9
This has a mass of nearly 200,000 suns. It has a diameter of about 60 light years. It lies on the other side of the galactic center from us (14,000 light years from the galactic center), about 9,000 light years above the galactic central plane. It is a bulge cluster (i.e., it lies in the central ball-like bulge of our galaxy).			

NGC 6254 (M10)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	16 h 57.1 m, −04° 06′	June 30
Distance	**Age**	**Apparent size**	**Magnitude**
15,000 light years		20′	6.6
The mass here is 100,000–200,000 suns. Its size of 20′ corresponds to a diameter of about 80 light years. This cluster stays within several thousand light years of the galactic central plane and has a velocity close to that of the material in the galactic disk. This is quite unusual for a moderately “metal-poor” cluster like this one (“metal-poor” meaning it has low amounts of elements heavier than helium), since stars in the galactic disk tend to have “metal” that was scattered by previous supernovae. Only a few percent of its stars are binaries, which is much lower than that seen on average in the Milky Way, but is expected given the high density of stars and resulting dynamical interactions between stars. 120 blue stragglers are known in this cluster, which are stars that are paradoxically far more blue and luminous than expected perhaps because of mass transfer between or coalescence of stars (see NGC 6633).			

NGC 6266 (M62)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 01.2 m, −30° 07′	July 1
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	15′	6.4

This has a mass of almost a million suns. Its size of 15′ corresponds to a diameter of about 110 light years. It lies on the edge of the galactic disk, in the direction of the galactic center from us and is a “bulge cluster” (meaning it spends its time orbiting within the central 15,000 light year diameter bulge of our galaxy). It is one of only a few Milky Way globular clusters that might host a black hole, in this case with an intermediate mass of at most a couple thousands of suns. The core of M62 is thought to be “collapsed” (see NGC 6284 for explanation).

NGC 6273 (M19)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 02.6 m, −26″ 16′	July 1
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	17 ′	6.8

With a mass of about 1.2 million suns, this emits the tenth most visible light of all the globular clusters in our galaxy. It belongs to the central bulge of our galaxy (i.e., the central, spherically shaped region), lying a few thousand light years nearly directly above the galactic center. It is a metal-poor bulge cluster (metal-poor meaning it has a low abundance of elements heavier than helium), being close to the bottom 20th percentile in metallicity for Milky Way globular clusters.

NGC 6284

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 04.5 m, −24° 46′	July 1
Distance	**Age**	**Apparent size**	**Magnitude**
50,000 light years	10–14 billion years	6.2′	8.9

This object has a mass of about 200,000 suns. Its size of 6.2′ gives it a diameter of about 90 light years. It lies well on the other side of the galactic center from us (24,000 light years from the galactic center), about 8,000 light years above the galactic central plane. The core of this cluster has "collapsed," a process that results from an instability that causes stars near the cluster center to confine themselves to an inordinately small region of space (with interstellar spacings as low as the distance between the Sun and Pluto), like a swarm of angry bees suddenly placed into a small container. Less than 15 % of globular clusters in our galaxy have collapsed cores.

NGC 6287

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 05.2 m, −22° 42′	July 2
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	4.8′	9.3

This has a mass of about 100,000 suns. This is a very metal-poor cluster (meaning it contains very low amounts of elements heavier than helium, i.e., "metals"), being in the bottom seventh percentile for metallicity of Milky Way globular clusters. It lies in the inner halo of our galaxy.

NGC 6293

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 10.2 m, −26° 35′	July 3
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	8.2′	8.3
This has a mass of about 200,000 suns and a diameter of about 30 light years. It lies in the inner halo of our galaxy and is a very metal-poor cluster (i.e., it contains very low amounts of elements heavier than helium), being in the bottom ninth percentile for metallicity of Milky Way globular clusters. This is a core-collapsed cluster (see NGC 6284 for explanation).			

NGC 6304

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 14.5 m, −29° 28′	July 3
Distance	**Age**	**Apparent size**	**Magnitude**
20,000 light years	10–14 billion years	8′	8.3
This lies on our side of the galactic center, close to the galactic central plane. It has a mass of about 200,000 suns. It is a bulge cluster and is “metal-rich” (meaning it has significant amounts of elements heavier than helium) and so may have formed somewhat later than nearby metal-poor bulge clusters. It lies in a window of low foreground extinction, like Baade’s window (see NGC 6522), that allows us to peer farther through space here than in other nearby areas of the sky because of reduced amounts of interstellar material. It has a mass of about 150,000 suns.			

NGC 6316

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 16.6 m, −28° 08′	July 4
Distance	**Age**	**Apparent size**	**Magnitude**
35,000 light years	10–14 billion years	5.4′	8.1
This has a mass of nearly 400,000 suns and a diameter of about 55 light years. It lies in the central bulge of our galaxy, on the other side of the galactic center from us, a few thousand light years above the galactic central plane. It is a “metal-rich” cluster (meaning it has larger amounts of elements heavier than helium), being in the top 15th percentile for metallicity of Milky Way globular clusters.			

NGC 6333 (M9)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 19.2 m, −18° 31′	July 5
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	12′	7.8
The mass here is about 300,000 suns. Its size of 12′ gives it a diameter of about 90 light years. It belongs to the central bulge of our galaxy (i.e., the central, spherically shaped region within about 15,000 light years of the galactic center) and lies a few thousand light years nearly directly above the galactic center. This is a metal-poor bulge cluster (metal-poor meaning it has a low abundance of elements heavier than helium), being in the bottom 20th percentile for metallicity of Milky Way globular clusters.			

NGC 6341 (M92)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Hercules	Globular cluster	17 h 17.1 m, +43° 08′	July 6
Distance	**Age**	**Apparent size**	**Magnitude**
27,000 light years	10–14 billion years	12′	6.4

This is one of the oldest globular clusters known and is the second most metal-poor Milky Way globular cluster, after M15/NGC 7078. It has a mass of about 200,000–300,000 suns. Its size of 12′ corresponds to a diameter of about 100 light years. It orbits the galaxy on a path that is somewhat inclined to the disk (by a little more than 20°) that takes it a maximum of about 25,000 light years away from the galactic central plane, traveling between typically a few thousand and 40,000 light years from the galactic center. It completes one revolution around the galaxy about once every 200 million years.

NGC 6342

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 21.2 m, −19° 35′	July 6
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	4.4′	9.5

This has a mass of about 200,000 Suns and a diameter of about 35 light years. It lies in the central bulge of our galaxy and is metal-rich, being above the 80th percentile in metallicity of Milky Way globular clusters. This is a core-collapsed cluster (see NGC 6284 for explanation).

NGC 6355

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 24.0 m, −26° 21′	July 6
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	4.2′	8.6
This has a mass of almost 400,000 suns and a diameter of about 40 light years. It is a bulge cluster (i.e., it lies in the central ball-like bulge of our galaxy). This is a core-collapsed cluster (see NGC 6284 for explanation). It lies behind a dark nebula, LDN 1792, that is about 400 light years away, which gives rise to considerable reddening of this cluster in professional telescopes.			

NGC 6356

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 23.6 m, −17° 49′	July 6
Distance	**Age**	**Apparent size**	**Magnitude**
50,000 light years	10–14 billion years	10′	8.2
This has a mass of about 800,000 suns and its size of 10′ gives it a diameter of about 150 light years. It lies on the other side of the galactic center from us in the central bulge of our galaxy. It is a “metal-rich” cluster (meaning it has significant amounts of elements heavier than helium), being in the 87th percentile for metallicity of Milky Way globular clusters. It completes an orbit of the galaxy every few hundred million years, having crossed the galactic central plane a few tens of millions of years ago.			

NGC 6369

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Planetary nebula	17 h 29.3 m, −23° 46′	July 8
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years		38″	11.4

This is nicknamed the "Little Ghost Nebula." Its central star (mag. 15.6) is a Wolf-Rayet star (see NGC 40 for explanation) with a mass of about 65 % that of our Sun and a temperature of about 70,000 K. The nebula's structure is thought to consist of an inner shell that has a barrel shape with two extending lobes capping the barrel on the east side and one capping lobe on the west side. The barrel's axis is inclined at an angle of about 50° from our line of sight. The barrel may have appeared a couple thousand years ago, while its capping lobes appeared perhaps several thousand years ago. A faint extended filamentary envelope surrounds this inner shell.

NGC 6397

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ara	Globular cluster	17 h 40.7 m, −53° 40′	July 11
Distance	**Age**	**Apparent size**	**Magnitude**
8,000 light years	10–14 billion years	31′	5.7

This has a mass of about 40,000–80,000 suns and is thought to have crossed the galactic disk only about 4 million years ago. This crossing may have triggered the formation of the open cluster NGC 6231 (see NGC 6231). It is the second closest globular cluster to us (after M4/NGC 6121). It has a collapsed core (see NGC 6284). Professional telescopic searches detect no planets orbiting its stars. It has the 13th lowest abundance of metals (elements heavier than helium) of the approximately 150 known globular clusters in the Milky Way.

NGC 6401

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 38.6 m, −23° 55′	July 10
Distance	**Age**	**Apparent size**	**Magnitude**
35,000 light years	10–14 billion years	4.8′	7.4
This contains over a million suns and its size of 4.8′ gives it a diameter of about 50 light years. It is a bulge cluster (i.e., it lies in the central ball-like bulge of our galaxy), lying on the far side of the bulge from us.			

NGC 6402 (M14)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 37.6 m, −03° 15′	July 10
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	11′	7.6
The mass here is about 1.2 million times that of our Sun. Its size of 6.7′ corresponds to a diameter of about 100 light years. It is located in the central bulge of our galaxy (i.e., the central, spherically shaped region) and is relatively lacking in elements heavier than helium (i.e., “metals”), so that it may have formed in one of the earliest star-forming periods of our galaxy. It lies about 8,000 light years above the galactic central plane about 13,000 light years from the galactic center. It was only the second globular cluster (after M80) to have a nova discovered in it. It may have an extragalactic origin and been accreted by the Milky Way.			

NGC 6405 (M6)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scorpius	Open cluster	17 h 40.3 m, −32° 15′	July 10
Distance	**Age**	**Apparent size**	**Magnitude**
1,600 light years	95 million years	33′	4.2

This is nicknamed the “Butterfly Cluster” due to the shape of its apparent outline. It contains several chemically peculiar stars (“CP2” stars – see NGC 2169 for explanation). It lies in the direction of the center of our galaxy, less than 20 light years below the galactic central plane. Its size of 33′ corresponds to a diameter of about 15 light years. Professional telescopic studies have counted over 300 stars belonging to this cluster (only a small fraction of which are visible in amateur telescopes).

NGC 6426

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	17 h 44.9 m, +03° 10′	July 12
Distance	**Age**	**Apparent size**	**Magnitude**
70,000 light years	10–14 billion years	4.2′	10.9

This lies 16,000 light years from the galactic plane, and 37,000 light years from the galactic center. Its apparent diameter of 4.2′ gives it a diameter of 80 light years. It has a mass of nearly 100,000 suns. Among the 150 or so Milky Way globular clusters, it is among the top ten most “metal-poor” globular clusters (meaning it has lower than usual amounts of elements heavier than helium). Along with ω Centauri and NGC 6402, it is one of only a few Milky Way globular clusters known to contain a CH carbon star, which are thought to be atypical carbon stars where carbon-rich material was previously accreted from a companion star that has since become a white dwarf.

NGC 6440

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	17 h 48.9 m, −20° 22′	July 14
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	4.4′	9.3

This is one of 20 or so of the most massive globular clusters in our galaxy, containing nearly 600,000 solar masses. It contains a couple transient X-ray sources, thought to be caused by interacting binary stars (i.e., a neutron star and a low-mass companion), in addition to several millisecond radio pulsars. Its size of 4.4′ gives it a diameter of about 35 light years. It is a bulge cluster (meaning it lies in the central bulge of our galaxy) and is "metal-rich" (meaning it has significant amounts of elements heavier than helium), being in the top 12th percentile for metallicity of Milky Way globular clusters. Its horizontal branch, composed of stars immediately following their red giant stage, has an unusual split into two branches that differ in luminosity, possibly indicating different chemical compositions or ages of the two branches.

NGC 6445

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Planetary nebula	17 h 49.3 m, −20° 01′	July 14
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years		44″	11.2

This nebula is believed to have evolved from a progenitor star with a mass >3 solar masses. It is one of only about 14 % of planetary nebulae that are not classified as round or elliptical. It is instead bipolar, meaning it has a three-dimensional "bowtie" shape in professional telescopes. It was discovered in 1882 by Pickering and is about 1.5 light years in diameter.

NGC 6451

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scorpius	Open cluster	17 h 50.7 m, −30° 13′	July 15
Distance	**Age**	**Apparent size**	**Magnitude**
9,000 light years	200 million years	8′	8.2

An apparent diameter of 7′ gives this an actual diameter of 20 light years. It was discovered in 1784 by William Herschel. It is known to contain one so-called “chemically peculiar” star, meaning this star has somewhat unusual amounts of elements heavier than helium in regions near its photosphere (NGC 2169).

NGC 6475 (M7)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scorpius	Open cluster	17 h 53.8 m, −34° 48′	July 14
Distance	**Age**	**Apparent size**	**Magnitude**
1,000 light years	300 million years	75′	3.3

First mentioned by Ptolemy over 2,000 years ago, this has a diameter of about 20 light years. Professional telescopic studies find that nearly 100 % of the stars in M7 are binary stars, an inordinately high frequency of binaries compared to the galactic field (where >50 % of main-sequence stars are binaries). It has a mass of about 700 suns. Like all open clusters, a good number of the stars in the field of this cluster (called “field stars”) do not belong to the cluster. Instead, they just happen to lie in the line-of-sight of the cluster but are actually much closer or farther away from us than the cluster. This “contamination” by field stars can be seen in Fig. 3.7. (See M39 for further discussion of this.)

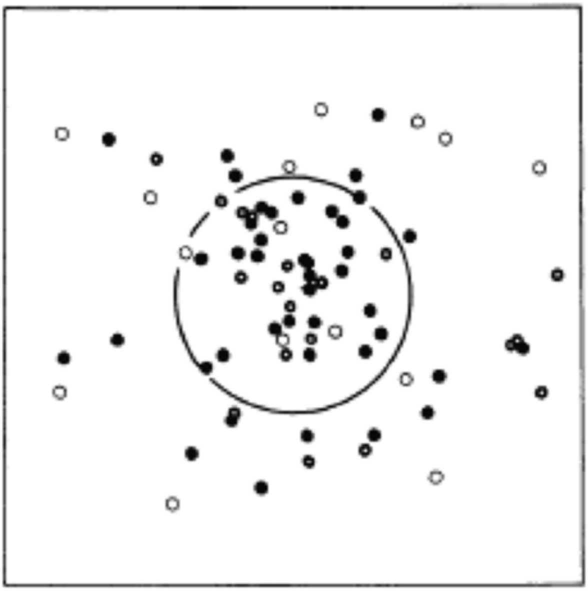

Fig. 3.7 The brighter stars (<mag. 10) in the region of M7 are shown. The *large circle* is shown to give a length scale and has a diameter of 60′. Stars shown by a *solid circle* can be considered as belonging to M7 since they have a greater than 90 % chance of belonging to the cluster. However, stars represented by *open circles* probably do not belong to M7, since they have a less than 20 % change of belonging to the cluster. *Half filled circles* may or may not belong to the cluster, since they have a membership probability between 20 and 90 %. (Reprinted from Gieseking, Astron. Astrophys. Suppl. Ser. 61:75–81, 1985. With permission.)

NGC 6494 (M23)

Constellation	**Object type**	**RA, Dec**	**Approx. transit date at local midnight**
Sagittarius	Open cluster	17 h 57.1 m, −18° 59′	July 15
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years	300 million years	25′	5.5
The size of 25′ corresponds to a diameter of about 15 light years. This has a mass of nearly 600 suns.			

NGC 6503

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Draco	Spiral galaxy	17 h 49.5 m, +70″ 09′	July 13
Distance	**Age**	**Apparent size**	**Magnitude**
17 million light years		7.0′×2.5′	10.2
This is nearly edge-on (with an inclination angle of 74°). It is an unusually isolated galaxy, lying in the so-called "Local Void," a 15 million light year radius region containing few galaxies. It is thought to contain an inner star-forming ring with an end-on bar inside it, as well as a nuclear spiral.			

NGC 6514 (M20)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Emission and reflection neb	18 h 02.7 m, −22° 58′	July 16
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	300,000 years	20′	6.3
Light from very young stars that formed out of the surrounding gas ionize hydrogen in the nebula causing it to glow (making the nebula a so-called HII region, although other elements are present, in particular oxygen, since the nebula benefits from a filter that lets in light from doubly ionized oxygen, i.e., OIII). This nebula is thought to be in a "pre-Orion-nebula" state, where young stars are violently ejecting matter, and protostars with jets are interacting with the nebula. The nebula is "lit up" mostly by the bright star in the middle of the nebula (HD 164492 or ADS 10991, mag. 7). ADS 10991 is a multiple star whose two brightest components have a separation of 10.6″ and position angle of 212°. It is found to consist of seven stars in professional telescopic studies. Dust grains are also present in the nebula (in the northern regions near the bright mag. 7.5 star there) which scatter the starlight, so that this nebula consists of both a reflection nebula (in the north) and an emission nebula (in the south). The nickname "Trifid Nebula" refers to the emission nebula and is derived from Latin (trifidus, meaning "split into three"), which refers to its three lobes, which are separated by lanes of dust grains in the nebula that block its light from us. The entire nebula's size of 20′ corresponds to a diameter of about 30 light years.			

NGC 6517

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Globular cluster	18 h 01.8 m, −08° 58′	July 16
Distance	**Age**	**Apparent size**	**Magnitude**
35,000 light years	10–14 billion years	4.0′	10.1
This lies on the far side of our galaxy, within the central bulge of our galaxy (being about 14,000 light years from the galactic center). Its size of 4.0′ gives it a diameter of about 40 light years. It has a mass of nearly 200,000 suns. It is one of about 30 globular clusters known to contain one or more pulsars, most of which are millisecond pulsars whose rotational speed may have been increased to its current high speed by angular momentum enhancement associated with mass transfer from a nearby companion star.			

NGC 6520

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Open cluster	18 h 03.4 m, −27° 53′	July 16
Distance	**Age**	**Apparent size**	**Magnitude**
6,000 light years	150 million years	2.0′	7.6
The size of 6′ gives it a diameter of about 4 light years. It has a mass of about 350 suns. The dark cloud to the west is Barnard 86 (i.e., B86), or the "Inkspot Nebula," a dense cloud of dust grains between us and the rich background of old Milky Way stars. The mass of B86 is about 600 suns.			

NGC 6522

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 03.6 m, −30° 02′	July 16
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	9.4′	9.9
This is one of the less massive globular clusters, with a mass of only a few tens of thousands of suns. It lies just below (2,000 light years below) the center of our galaxy in Baade’s window. This is a “window” near the center of our galaxy where there is less obscuring dust, allowing us to see objects much closer to the center of our galaxy in this window than in other regions. NGC 6522 is believed to have passed through the central galactic plane about 2 million years ago. Its galactic orbit, with a period of 10 million years or so, never takes it far from the galactic center (always staying within on average about 20,000 light years of it). It has a diameter of about 70 light years. It is an old globular cluster and may have formed in the earliest star-forming period of our galaxy. It also has a collapsed core (see NGC 6284 for explanation).			

NGC 6523 (M8)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Emission nebula	18 h 03.7 m, −24° 23′	July 16
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years		45′ × 30′	5.0
This is nicknamed the “Lagoon Nebula.” The open cluster NGC 6530, with more than 1,000 member stars, is embedded within this nebula. The stars in this cluster formed from the nebula in the past couple million years. It contains many pre-main sequence stars that are still contracting and have not yet begun burning hydrogen. The nebula itself is a large ionized hydrogen (or HII) region, within which young O and B-type stars associated with the cluster are thought to still be triggering star formation. M8 is actually only a small “blister” on the surface of a giant molecular gas cloud that lies behind M8. The nebula is ionized (and thus made visible) largely by just three stars (primarily 9 Sgr, but also the binary HD 165052, and the multiple star Herschel 36) as shown in Fig. 3.8. Herschel 36 may be a triple star system, perhaps consisting of a close binary pair that orbits a primary star whose mass is similar to that of the orbiting binary pair and is >20 suns. It is responsible for ionizing the brightest part of the nebula, a 15″ × 30″ patch in the center of the nebula. This patch is called the “Hourglass.” The Hourglass is on the backside of the nebula, right on the edge of the giant molecular cloud from which NGC 6530 has formed.			

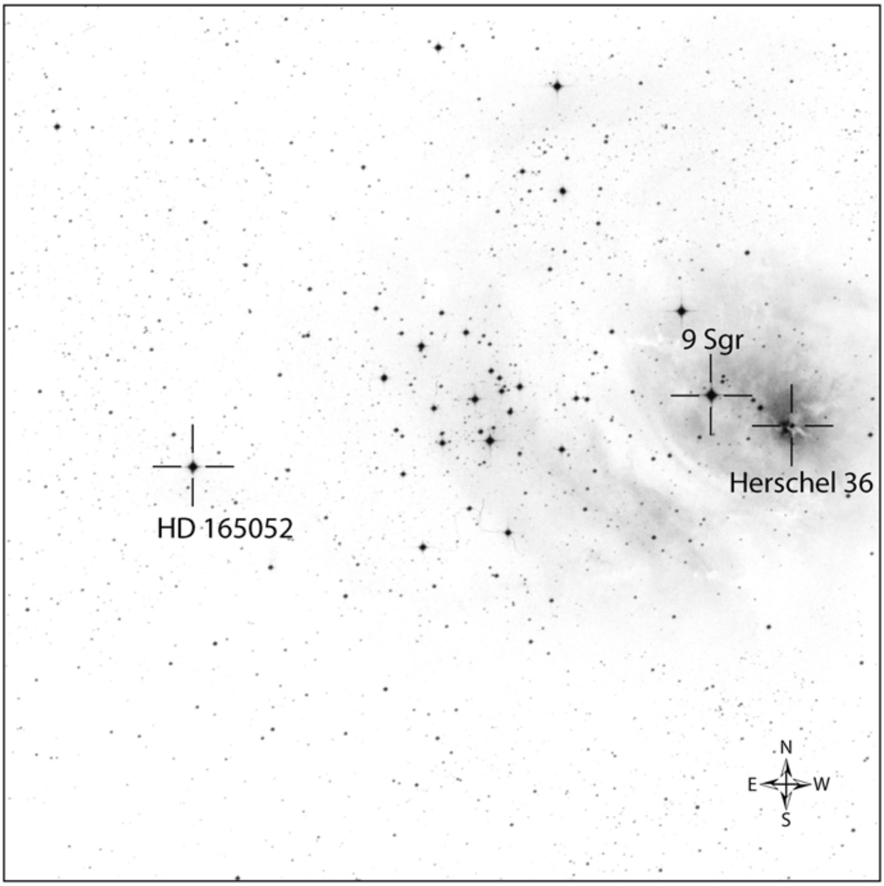

Fig. 3.8 The region east of and including the emission nebula M8 (NGC 6523) is shown (with the open cluster NGC 6530 in the middle of the figure), with the three stars responsible for ionizing M8 marked with *crosshairs*. The area shown is 30′×30′. (From the Digitized Sky Survey, Space Telescope Science Institute, based on photographic data of the National Geographic Society, Palomar Observatory Sky Survey, POSS I.)

NGC 6528

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 04.8 m, −30° 03′	July 18
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	5′	9.6
This has a diameter of about 40 light years and a mass of a couple hundred thousand suns. It lies close to NGC 6522, both apparently (being 16′ E of NGC 6522), and in actuality (lying 1,000 light years away from NGC 6522), although it is several times more massive than NGC 6522 and contains much more "metal" (i.e., elements heavier than helium), being in the top ninth percentile for metallicity of Milky Way globular clusters. Like NGC 6522, NGC 6528 lies in Baade's window. (See NGC 6522 for explanation.) It belongs to the central bulge of our galaxy (whose properties are somewhat like those of elliptical galaxies) rather than the disk.			

NGC 6531 (M21)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Open cluster	18 h 04.2 m, −22″ 29′	July 16
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	5–10 million years	16′	5.9
This cluster lies very close to the galactic central plane (being a few tens of light years below it). It has a mass of perhaps 800 suns. Of the 1,500 or so open clusters in our galaxy this is one of many that have not been well studied by professional telescopes.			

NGC 6540

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 06.1 m, −27° 46′	July 17
Distance	**Age**	**Apparent size**	**Magnitude**
10,000 light years	10–14 billion years	1.5′	10

This lies toward the center of our galaxy in a smaller version of "Baade's window" (see NGC 6522 for explanation). Originally classified as an open cluster, it was reclassified as a globular cluster in the 1980s, making it the most recent addition to the list of NGC/IC globular clusters. It is a collapsed-core cluster. (See NGC 6284 for explanation.)

NGC 6541

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Corona Australis	Globular cluster	18 h 08.0 m, −43° 42′	July 18
Distance	**Age**	**Apparent size**	**Magnitude**
23,000 light years	10–14 billion years	15′	6.3

This is located in the inner halo in the central region of our galaxy and is the third most metal-poor globular cluster (i.e., lacking in elements heavier than helium) within 10,000 light years of the galaxy center. It is a core collapsed cluster (see NGC 6284). It is the 21st most luminous of the approximately 150 globular clusters in our galaxy. It has a diameter of about 100 light years.

NGC 6543

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Draco	Planetary nebula	17 h 58.6 m, +66° 38′	July 15
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	1,000 years	20″	8.1

This is nicknamed the "Cat's Eye Nebula." Its central star (mag. 10.9) is a Wolf-Rayet star. (See NGC 40 for explanation.) Professional telescopes find a very complex geometry to this nebula, consisting of a core (the bright region seen in amateur telescopes, about 20″–25″ in diameter) made of two expanding elliptical bubbles that are oriented perpendicular to each other, surrounded by nine concentric rings that are actually spherical shells thought to represent separate mass ejection events/shocks ejected over the past 5,000–20,000 years at intervals of 1,000–2,000 years. The edges of the core are pierced by fast-moving, low-ionization emission regions ("FLIERS" – see NGC 7662), placed symmetrically at the two ends of the major axis of the core. The inner nebula is surrounded by an outer halo (diameter 5.5′) with an irregular outer edge and a large knot 1.7′ west of the center of inner nebula. The sequence of events that created such an intricate structure to this nebula is not fully understood.

NGC 6544

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 07.3 m, −25° 00′	July 17
Distance	**Age**	**Apparent size**	**Magnitude**
10,000 light years	10–14 billion years	9.2′	7.5

This is the third closest and one of the most concentrated globular clusters known. It has a diameter of about 25 light years. It contains 130,000 solar masses. It is one of relatively few (<30) globular clusters that is known to contain a pulsar, in this case containing two pulsars. One of these pulsars has a companion of planetary mass (ten times the mass of Jupiter), which is the least massive globular cluster pulsar companion identified to date. The companion orbits the pulsar with a period of less than 2 h, which is the third shortest period known for a binary pulsar. The other pulsar's companion is the most massive globular cluster pulsar companion known of nearly 150 identified to date, with a mass of about 1.5 suns and a period of 10 days. This is a collapsed-core cluster. (See NGC 6284 for explanation.)

NGC 6553

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 09.3 m, −25° 54′	July 19
Distance	**Age**	**Apparent size**	**Magnitude**
20,000 light years	10–14 billion years	9.2′	8.3
This has a mass of about a quarter million suns and a diameter of about 20 light years. It lies in the central bulge of our galaxy, where it is patchily obscured by dust and gas that interferes with accurate study of this cluster. It is “metal-rich” (meaning it has significant amounts of elements heavier than helium), being in the top ninth percentile for metallicity of Milky Way globular clusters.			

NGC 6568

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Open cluster	18 h 12.7 m, −21° 36′	July 20
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	500 million years	12′	8.6
This was discovered in 1786 by William Herschel. Like most open clusters, it lies near the central plane of our galaxy. It has a mass of about 150 suns. It has not been well studied in professional telescopes.			

NGC 6569

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 13.6 m, −31° 50′	July 19
Distance	**Age**	**Apparent size**	**Magnitude**
35,000 light years	10–14 billion years	6.4′	8.4
This lies in the central bulge of our galaxy, on the other side and slightly below (by several thousand light years) the center of our galaxy. It has a mass of about 400,000 suns and a diameter of nearly 50 light years. Its horizontal branch, composed of stars immediately following their red giant stage, has an unusual split into two branches that differ in luminosity, possibly indicating different chemical compositions or ages of the two branches.			

NGC 6572

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Planetary nebula	18 h 12.1 m, +06° 51′	July 20
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years		15″	8.1
In professional telescopic studies, the elliptical shell of this nebula has disruptions that are thought to be due to more recent collimated mass ejections that are bipolar (i.e., the mass was ejected from the center of the nebula in opposite directions at the same time). Its size of 15″ corresponds to a diameter of about 0.3 light years.			

NGC 6583

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Open cluster	18 h 15.8 m, −22° 08′	July 21
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	1 billion years	2′	10.0

This was discovered in 1786 by William Herschel. It lies only a few hundred light years below the galactic central plane and follows a circular orbit with a radius of about 20,000 light years.

NGC 6611 (M16)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Serpens Cauda	Open cluster with nebulosity	18 h 18.8 m, −13° 48′	July 20
Distance	**Age**	**Apparent size**	**Magnitude**
6,000 light years	1–3 million years	8′	6.0

The stellar mass of this open cluster is thought to be about 20,000 suns. The cluster's size of 8′ corresponds to a diameter of about 14 light years. It is embedded in a gas cloud from which the cluster formed and in which star formation is still going on. Young, hot stars in the cluster are ionizing the surrounding hydrogen gas cloud (making it a so-called HII region), thereby making it fluoresce as the emission nebula IC 4703 which is nicknamed the "Eagle Nebula" or the "Star Queen Nebula" after the appearance of part of this nebula in professional telescopic images and photographs. This namesake region is well known from the Hubble Space Telescope's "Pillars of Creation" photo of a 2′×2′ or so portion of it (which lies just SE of the open cluster's most concentrated area). This photo shows three large pillars (looking like "elephant trunks" or hoodoos) aligned in a SE-NW direction. The pillars are regions of dark molecular gas and dust that are being "eroded" by intense radiation from stars to their NW. Stars in NGC 6611 are thought to progress in age from younger (1 million years) in the northwest to older (3 million years) in the southeast, possibly because star formation in this region was progressively triggered by an encounter starting in the southeast several million years ago with a giant molecular shell created earlier by supernovae explosions.

NGC 6613 (M18)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Open cluster	18 h 20.0 m, −17° 06′	July 21
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	30 million years	7′	6.9
This sparse cluster has a diameter of about 10 light years and has not been well studied. It has a mass of perhaps a little less than a couple hundred suns.			

NGC 6618 (M17)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Emission nebula + open cluster	18 h 20.8 m, −16° 10′	July 21
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	1 million years	20′ × 15′	6.0
The appearance of this nebula in amateur telescopes leads to its various nicknames (“Swan Nebula,” “Omega Nebula,” among others). Its size of 20′ corresponds to a diameter of about 40 light years. Like M8 and M16, the nebula fluoresces due to an embedded open cluster, in this case containing thousands of stars that formed from the nebula. However, the stars in the open cluster are so heavily obscured by intervening gas and dust that only five of them have magnitudes brighter than 14 (with only two brighter than magnitude 10), making its appearance as a true “cluster” of stars essentially nonexistent in the eyepiece of an amateur telescope. Professional telescopes find many pre-main sequence stars in this cluster that are only a few hundred thousand years old. These young stars are still collapsing and have not yet begun nuclear fusion. Ongoing star formation is thought to be occurring, triggered by already formed large bright O-type stars which are irradiating the molecular cloud from which they formed.			

NGC 6624

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 23.7 m, −30° 22′	July 23
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	8.8′	7.6

This has a mass of just over 300,000 suns. It lies just below the center of our galaxy in the central galactic bulge. It is "metal-rich" (meaning it has significant amounts of elements heavier than helium), being in the top 15th percentile for metallicity of Milky Way globular clusters. It has a diameter of about 65 light years. It contains an X-ray source caused by gas flowing from a white dwarf onto a neutron star (with mass of 1.6 suns and a radius of 9 km) that revolve around each other every 11 min at a separation of less than half the Earth-Moon distance! It is a collapsed-core cluster. (See NGC 6284 for explanation.)

NGC 6626 (M28)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 24.5 m, −24° 52′	July 22
Distance	**Age**	**Apparent size**	**Magnitude**
20,000 light years		13′	6.9

The mass is about 300,000 suns. Like M10 (NGC 6254), this cluster spends its time within a few thousand light years of the galactic central plane. This is quite unusual for a "metal-poor" cluster like this one ("metal-poor" meaning it has low amounts of elements heavier than helium), since stars in the galactic disk tend to have "metal" that was scattered by previous supernovae. The origin of this cluster is thus uncertain. Its elliptical orbit takes it in as close as 2,000 light years (at perigalacticon) and out as far as 20,000 light years (at apogalacticon) from the galactic center with an orbital period of about 50 million years. It is currently near apogalacticon. Interactions with the Milky Way's gravitational potential have resulted in mass loss and perhaps two tidal tails, one of which may be due to its last passage about 4 million years ago through the galactic central plane.

NGC 6629

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Planetary nebula	18 h 25.7 m, −23° 12′	July 22
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years		16″	11.3
This has a diameter of a few tenths of a light year. It is expanding outward at about 10 km/s. The central star is a mag. 12.9 Wolf-Rayet star. (See NGC 40 for explanation of "Wolf-Rayet star") with a mass of 0.6 suns and a temperature of perhaps 46,000 K. Its movement through the interstellar medium is believed to be causing one-sided ram-pressure stripping and compression, leading to a somewhat asymmetric halo in professional telescopes.			

NGC 6633

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Ophiuchus	Open cluster	18 h 27.3 m, +06° 31′	July 24
Distance	**Age**	**Apparent size**	**Magnitude**
1,000 light years	600 million years	4.6	20′
This was discovered in 1783 by Caroline Herschel (William Herschel's sister). It has a mass of about a hundred suns. It has a width of about 8 light years. It contains several "blue stragglers," which are stars that are paradoxically far more blue and luminous than expected perhaps because of mass transfer between or coalescence of stars. The two blue stragglers HD 170054 (mag. 8.2, 7′ SW of the cluster center) and HD 169959 (mag. 7.7, 15′ SW of the cluster center) are readily visible in amateur telescopes (see Fig. 3.9), or even binoculars.			

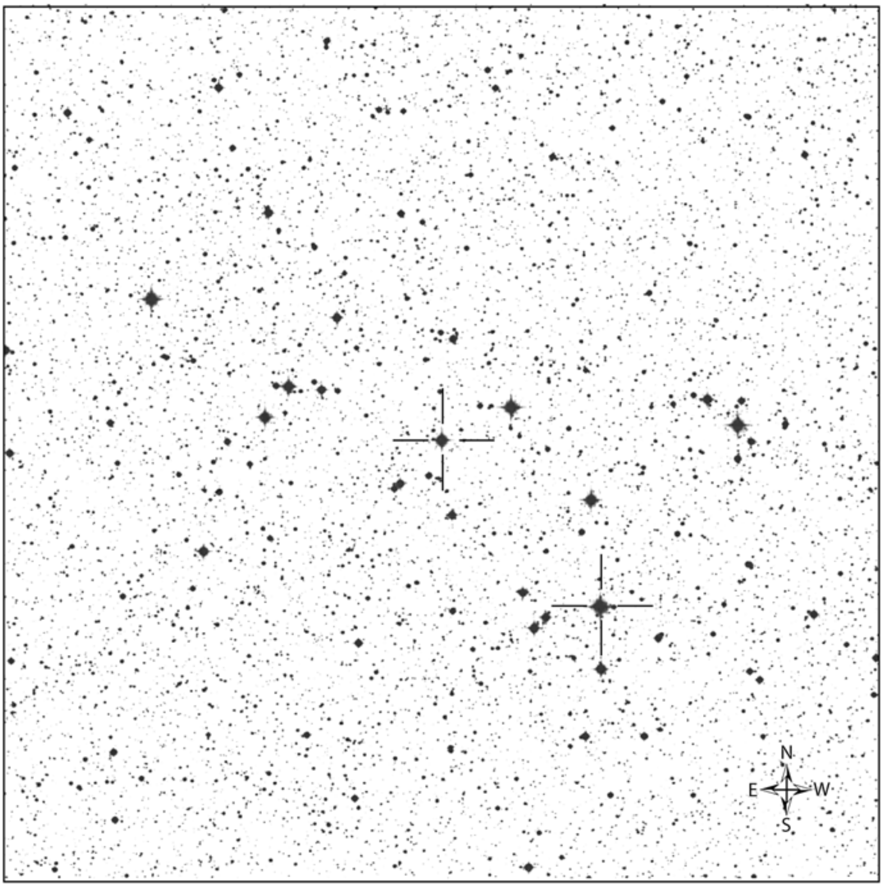

Fig. 3.9 The SW portion of the open cluster NGC 6633 is shown with the two blue stragglers HD 170054 (mag. 8.2, 7′ SW of the cluster center) and HD 169959 (mag. 7.7, 15′ SW of the cluster center) marked by the *crosshairs*. The area shown is 30′×30′. (From the Digitized Sky Survey, Space Telescope Science Institute, based on photographic data of the National Geographic Society, Palomar Observatory Sky Survey, POSS I.)

NGC 6637 (M69)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 31.4 m, −32° 21′	July 24
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	7.1′	8.3

This lies almost directly below the galactic center (about 5,000 light years below the galactic central plane), about 3,000 light years on the other side of the galactic center from us. It has a mass of about 300,000 suns and its size corresponds to a diameter of about 60 light years. It is thought to be a "bulge cluster" (meaning it spends its time orbiting within the central, ball-like, 15,000-light-year diameter bulge of our galaxy). It is a "metal-rich" cluster (meaning it contains significant amounts of elements heavier than helium). About a quarter of the globular clusters in our galaxy are considered metal-rich, and NGC 6637 is just within the top 25th percentile for metallicity of Milky Way globular clusters.

NGC 6638

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 30.9 m, −25° 30′	July 24
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	7.3′	9.2

This is a bulge cluster, meaning it spends its time orbiting within the central, ball-like, 15,000 light year diameter bulge of our galaxy. It is a medium-sized globular cluster of about 100,000 solar masses. Its size of 7.3′ gives it an actual diameter of about 65 light years.

NGC 6642

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 31.9 m, −23° 29′	July 25
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	5.8′	8.9

This lies close (in actual space) to NGC 6638, the two being about 4,000 light years apart. Its size of 5.8′ gives it a diameter of about 40 light years. It has a mass of about 130,000 suns. Its core is thought to have “collapsed,” the result of an instability that causes the stars in its core to confine themselves to an unusually small region (see NGC 6284). About 30 blue stragglers have been found in the center of this cluster, which are stars that are paradoxically far more blue and luminous than expected perhaps because of mass transfer between or coalescence of stars. It is a bulge cluster, meaning it spends its time orbiting within the bulge of our galaxy – see M69/NGC 6637. It sits only 5,000 light years from the center of the galaxy and is near perigalacticon (its closest approach to the galactic center). It is an old globular cluster and may be one of oldest relics in our galaxy.

NGC 6645

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Open cluster	18 h 32.6 m, −16° 53′	July 24
Distance	**Age**	**Apparent size**	**Magnitude**
3,000–4,000 light years		15′	8.5

This was discovered in 1786 by William Herschel. Large discrepancies exist in the age of this cluster determined by different studies, ranging from 400 million years to nearly 10 billion years. The latter would make it one of the oldest known open clusters.

NGC 6656 (M22)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 36.4 m, −23° 54′	July 25
Distance	**Age**	**Apparent size**	**Magnitude**
10,000 light years	10–14 billion years	32′	5.2
Its mass is a few hundred thousand suns. It is the third brightest globular cluster in our night sky, after 47 Tuc (NGC 104) and ω Centauri (NGC 5139). It is also the third closest globular cluster to us (after M4 and NGC 6397). Along with M15, this is one of only four globular clusters that contains a planetary nebula, labeled GJJC 1. However, at mag. 15 and lying near the core of the cluster, finding GJJC 1 in an amateur telescope is exceptionally challenging (the one in M15 is easier to find – see M15). M22 never strays too far from the galactic disk in its orbit, staying within about 15,000 light years of the galactic central plane between about 50,000 and 10,000 light years from the galactic center, orbiting the galaxy once every 200 million years or so. It has two distinct stellar populations with unusually different abundances of heavy elements, the origin of which remains uncertain but may either be simply two generations of stars as occurs in most globular clusters, or more unusually, an extragalactic origin of this cluster.			

NGC 6664

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scutum	Open cluster	18 h 36.6 m, −08° 13′	July 26
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	15 million years	12′	7.8
This has a diameter of about 15 light years. It contains EV Sct (mag. 10), a spectroscopic binary that is one of only two known binary stars in our galaxy that consists of two Cepheid variable stars (the other being CE Cas, which unlike EV Sct, can be split into its two component stars in amateur telescopes – see NGC 7790).			

NGC 6681 (M70)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 43.2 m, −32° 17′	July 27
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	8.0′	7.8
This has a mass of about 200,000 suns and a diameter of about 70 light years. Like its neighbor M69, this is thought to be a "bulge cluster" (meaning it spends its time orbiting within the bulge of our galaxy – see M69/NGC 6637). Its core is thought to have "collapsed," the result of an instability that causes the stars in its core to confine themselves to an unusually small region (see NGC 6284).			

NGC 6694 (M26)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scutum	Open cluster	18 h 45.3 m, −09° 23′	July 27
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	100–200 million years	10′	8.0
This has a diameter of about 15 light years. It lies about 250 light years below the galactic central plane, which happens to be about the furthest extent our Sun travels from the galactic central plane (although the Sun currently sits within about 100 light years above the galactic central plane). In professional telescopes it has a mass of 300–400 suns.			

NGC 6705 (M11)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scutum	Open cluster	18 h 51.1 m, –06° 16′	July 29
Distance	**Age**	**Apparent size**	**Magnitude**
6,000–7,000 light years	200 million years	11′	5.8

This is nicknamed the "Wild Duck Cluster" after the V-shaped outline (pointed east) that some of its brighter members make. Its mass is several thousand suns, with 500 members brighter than mag. 14. Its size of 14′ corresponds to a diameter of about 25 light years. A person in the middle would see a night sky with several hundred first mag. stars, each separated by <1 light year. This is nearly as dense as some globular clusters. A significant number of field stars are present as foreground/background stars (see M39).

NGC 6712

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Scutum	Globular cluster	18 h 53.1 m, –08″ 42′	July 29
Distance	**Age**	**Apparent size**	**Magnitude**
22,000 light years	10–14 billion years	9.8′	8.1

This is one of about 150 globular clusters in our galaxy. It passed through the galactic plane a few million years ago. Numerous such previous interactions with the galactic disk are thought to have stripped away many of its lighter stars, leaving them behind in the Milky Way's halo (which is the large spherical region around the flat, spiral central galactic plane). Indeed, perhaps 99 % of its original mass has been stripped away in this manner, so that it is now but a remnant of what was once one of the most massive globular clusters in our galaxy. It once had a mass of millions of suns, but now contains only 100,000–200,000 solar masses. It is one of only a dozen or so globular clusters in our galaxy that is a bright X-ray source, thought to be caused by interacting binary stars (i.e., a neutron star and a low-mass companion).

NGC 6715 (M54)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 55.1 m, −30° 29′	July 30
Distance	**Age**	**Apparent size**	**Magnitude**
85,000 light years	10–14 billion years	12′	7.7

This globular cluster is not part of our galaxy but instead belongs to a nearby satellite galaxy (that goes by the cumbersome name "Sagittarius dwarf elliptical galaxy") embedded in its nucleus. This companion galaxy is in the process of being gravitationally disrupted by our galaxy. Models predict that it, along with M54, will collide with the disk of our galaxy in several tens of millions of years, having had a past such collision about 200 million years ago. M54 is the second most massive known Milky Way globular cluster (after ω Centauri/NGC 5139) with a mass of about 1.5 million suns (which is about 1/40 the mass of the galaxy it belongs to). Its size of 12′ corresponds to a diameter of about 300 light years.

NGC 6720 (M57)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Lyra	Planetary nebula	18 h 53.6 m, +33° 02′	July 29
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years		3.0′×2.4′	8.8

This is nicknamed the "Ring Nebula." This planetary nebula is thought to have been created a few thousand years ago when an old star blew off its outer layers. In professional telescopes the nebula extends out to nearly 4′ in diameter (with its outer halo 5,000 times dimmer in surface brightness than the ring). Its three-dimensional structure is thought to consist of an ellipsoidal shell (like the skin of an air-ship/dirigible as in the Hindenburg or the Goodyear blimp) that we are looking at nearly end-on. This shell is thought to be encircled at its midsection (half-way along the "dirigible") by a torus of material so that the ring we see is merely a donut of denser material at the mid-section of the ellipsoidal shell. The denseness of the ring is thought to be a relic of the preferential ejection of mass by the central star in its equatorial plane (in a "superwind" – see M27). The shell is expanding outward at a few tens of km/s. Invisible (UV) radiation from the hot central star ionizes the atoms in the shell, and electrons recombining with these ionized atoms cause optical photons to be emitted that make the nebula visible to us.

NGC 6723

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	18 h 59.6 m, −36° 38′	July 31
Distance	**Age**	**Apparent size**	**Magnitude**
28,000 light years	10–14 billion years	13′	6.8
This currently lies in the bulge region of our galaxy, but its orbit is highly inclined (82°) from the galactic plane and it is likely a halo cluster. It is the most metal-poor (i.e., lacking in elements heavier than helium) of all inner halo globular clusters. It has a mass of about 200,000 suns.			

NGC 6752

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pavo	Globular cluster	19 h 10.9 m, −59° 59′	August 3
Distance	**Age**	**Apparent size**	**Magnitude**
12,000 light years	10–14 billion years	29′	5.3
This has a mass of about 100,000–200,000 suns and is a halo cluster. It is thought to have crossed the galactic disk about 30 million years ago. Five-millisecond pulsars have been identified within this cluster. It is the seventh nearest globular cluster and the fourth brightest in our sky (after ω Centauri/NGC 5139, M22/NGC 6656, and 47 Tucanae/NGC 104).			

NGC 6755

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aquila	Open cluster	19 h 07.8 m, +04° 16′	August 3
Distance	**Age**	**Apparent size**	**Magnitude**
5,000–7,000 light years	50 million years	7.5	15′

The diameter of this cluster is about 20–30 light years. Of more than nearly 17,000 stars in the field of this cluster down to mag. 23, most of which are field stars (see M39/NGC 7092), professional telescopes have identified 71 variable stars to date. It was discovered in 1785 by William Herschel. The open cluster Czernik 39 lies about 7′ NNW.

NGC 6756

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aquila	Open cluster	19 h 08.7 m, +04° 42′	August 3
Distance	**Age**	**Apparent size**	**Magnitude**
11,000 light years	100–200 million years	4.0′	10.6

This has a diameter of about 13 light years and was discovered in 1791 by William Herschel. Two Be stars are known in this cluster, which are B-type stars that are peculiar because of hydrogen Balmer emission lines in their spectra, due to material expelled by high rotational velocities into a circumstellar disk in the equatorial plane of the star – see M47/NGC 2422.

NGC 6779 (M56)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Lyra	Globular cluster	19 h 16.6 m, +30° 11′	August 4
Distance	**Age**	**Apparent size**	**Magnitude**
30,000 light years	10–14 billion years	8.8′	8.4

This has a mass of about 200,000 suns and a diameter of about 80 light years. Although its orbit is roughly circular and lies nearly in the galactic disk (inclined by only about 15° to the central plane), like almost all globular clusters in our galaxy, it does not orbit with the disk material at a constant radius from the galactic center. Instead its path is thought to take it out as far as about 50,000 light years away from the galactic center and within a few thousand light years of the galactic center, although it takes about the same amount of time to complete an orbit as our sun (i.e., about a quarter billion years). It is a metal-poor halo cluster, meaning it contains lower amounts of compounds heavier than helium (i.e., “metals”), being near the bottom tenth percentile in metallicity of Milky Way globular clusters.

NGC 6781

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aquila	Planetary nebula	19 h 18.4 m, +06° 32′	August 4
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years		11.4	1.9′

This is about 2 light years in diameter and is probably a few tens of thousands of years old. Its central star has a mass of 0.6 suns, while its progenitor star had a mass of 1.5 suns before it blew off its outer layers to create this nebula. It is thought to have an hourglass shape that we are viewing nearly end-on. It is expanding at several tens of km/s.

NGC 6802

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Vulpecula	Open cluster	19 h 30.6 m, +20° 16′	August 9
Distance	**Age**	**Apparent size**	**Magnitude**
6,000 light years	1 billion years	3.3′	8.8
This is a relatively old open star cluster. With a diameter of a little over 3 light years, it also is one of the smallest open clusters. Old age causes clusters like this one to disintegrate as gravitational forces tear stars away from it over time.			

NGC 6809 (M55)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	19 h 40.0 m, −30° 58′	August 10
Distance	**Age**	**Apparent size**	**Magnitude**
18,000 light years	10–14 billion years	19.0′	6.3
This has a mass of about 100,000–200,000 suns and a diameter of about 100 light years. It takes a little over 100 million years or so to complete an orbit about our galaxy, always staying within about 25,000 light years of the galactic center but swinging within a few thousand light years of the galactic center, all in a path that is highly inclined to the disk of our galaxy. It contains 65 identified "blue stragglers" (see NGC 6633), which are stars that are paradoxically far more blue and luminous than expected perhaps because of mass transfer between or coalescence of stars. It is metal poor, being near the bottom tenth percentile for metallicity of Milky Way globular clusters.			

NGC 6818

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Planetary nebula	19 h 44.0 m, −14° 09′	August 11
Distance	**Age**	**Apparent size**	**Magnitude**
6,000 light years		46″	9.3
Nicknamed the "Little Gem," this has a diameter of a little more than half a light year and consists of two concentric shells. The central star has a temperature of 145,000 K, and a mass of about 0.6 suns, corresponding to a progenitor star of about 1 solar mass. In professional telescopes the central star is a binary star, with separation of 0.09″ and an orbital period of 1,500 years. The nebula is thought to be only a few thousand years old.			

NGC 6819

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Open cluster	19 h 41.3 m, +40° 11′	August 11
Distance	**Age**	**Apparent size**	**Magnitude**
8,000 light years	2.5 billion years	26′	7.3
This is an old cluster and also one of the richest known open clusters in our galaxy, with 2,500 member stars down to mag. 22 in professional telescopic studies. It has a diameter of about 60 light years and a mass of 2,600 suns.			

NGC 6823

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Vulpecula	Open cluster	19 h 43.2 m, +23° 18′	August 12
Distance	**Age**	**Apparent size**	**Magnitude**
6,000–10,000 light years	A few million years	12′	7.1

The remains of the nebulous gas from which this very young cluster formed is barely visible as the emission nebulae NGC 6820 that surrounds this cluster. Professional telescopes find three pillar-like ("elephant trunk") structures in the surrounding nebulosity, associated with star formation. About a hundred young stellar objects (YSOs) have been identified in the cluster region, including pre-main sequence stars that are still collapsing and have not yet begun nuclear fusion. Radiation from the couple dozen confirmed OB stars in NGC 6823 may have triggered the formation of these YSOs. The cluster has a diameter of a little more than 20 light years, while its surrounding nebulosity extends to a visible diameter of about 70 light years.

NGC 6826

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Planetary nebula	19 h 44.8 m, +50° 32′	August 12
Distance	**Age**	**Apparent size**	**Magnitude**
3,000–4,000 light years		25″	8.8

This has a diameter of about half a light year and is thought to be several thousand years old. It is nicknamed the "Blinking Planetary" because the nebula "blinks" (i.e., appears and disappears) when viewed by direct and averted vision in rapid succession. Outside the bright inner nebula, professional telescopes find a large 2′ diameter halo with a brighter outer rim, making this a multiple shell nebula. The central star has a mass of about 0.6 times that of our Sun and has a surface temperature of about 45,000 K. In professional telescopes it is a variable star, of type ZZ Lep (the namesake central star of IC 418), and one of only 14 known variable planetary nebula central stars. Its periodic variations, with a period of 1.2 days, may be set by its rotational period, while irregular hourly variations may be related to its variable stellar wind. At mag. 10.4 this is one of the brightest central stars of all planetary nebulae visible to us.

NGC 6830

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Vulpecula	Open cluster	19 h 51.0 m, +23° 06′	August 12
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	40 million years	6′	7.9
This has a diameter of nearly 10 light years and was discovered in 1784 by William Herschel.			

NGC 6834

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Open cluster	19 h 52.2 m, +29° 24′	August 14
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	80 million years	6′	7.8
This has a diameter of about 10 light years and was discovered in 1784 by William Herschel.			

NGC 6838 (M71)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagitta	Globular cluster	19 h 53.8 m, +18° 47′	August 14
Distance	**Age**	**Apparent size**	**Magnitude**
13,000 light years	10–14 billion years	7.2′	8.4
This is the eighth closest globular cluster to us. With a mass of only a few tens of thousands of duns and a diameter of a little over 25 light years, this is a sparse globular cluster. It has an elliptical shape with an aspect ratio (minor to major axis ratio) of about 0.7, its flattened shape possibly caused by its recent passage through the galactic central plane about 16 million years ago. Its orbit is highly elliptical (with a minor to major axis ratio of 0.2), and it takes about 160 million years to complete one orbit around our galaxy, never straying far from the galactic disk.			

NGC 6853 (M27)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Vulpecula	Planetary nebula	19 h 59.6 m, +22° 43′	August 15
Distance	**Age**	**Apparent size**	**Magnitude**
1,000 light years		5.8′	7.3

This is nicknamed the "Dumbbell Nebula," although a partially eaten apple might be a better description of its actual appearance in amateur telescopes. Planetary nebulae begin when an aging giant star gives off a large amount of gas in a "superwind" (traveling at 10 km/s, emitting 10^{-4} solar masses/year). Once the core of the old star is eventually exposed, a hot, fast wind (1,000 km/s, emitting 10^{-9} solar masses/year) slams into the previously emitted gas. This may explain the complex shapes of some planetary nebulae, but the presence of companion stars and magnetic fields may also play a role in some cases. The nebula is ionized by short-wavelength, nonvisible radiation from the central star, and re-emits this radiation in visible wavelengths. The central star (mag. 13.8) lies at the narrowest part of the "bowtie" shape and has a temperature of about 110,000 K. The nebula is several thousand years old and still expanding (at several tens of km/s). In professional telescopes M27 is found to have an elliptical halo surrounding the main nebula, which itself is elliptical and also contains an internal elliptical shell, so that the structure of this nebula consists of nested shells.

NGC 6864 (M75)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Globular cluster	20 h 06.1 m, −21° 55′	August 17
Distance	**Age**	**Apparent size**	**Magnitude**
70,000 light years	10–14 billion years	6.8′	8.6

This has a mass of about half a million suns and a diameter of about 140 light years. Its horizontal branch (HB), composed of stars immediately following their red giant stage, has two gaps in it, giving three HB populations that differ in temperature. It lies on the other side of the galaxy from us, well below the galactic central plane (about 30,000 light years).

NGC 6866

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Open cluster	20 h 03.9 m, +44° 10′	August 17
Distance	**Age**	**Apparent size**	**Magnitude**
4,000–5,000 light years	500–800 million years	7′	7.6
This has a mass of perhaps 140 suns. It has a diameter of about 10 light years and was discovered in 1793 by Caroline Herschel.			

NGC 6882

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Vulpecula	Open cluster	20 h 12.0 m, +26° 29′	August 18
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years		20′	5.9
Disagreement exists regarding the age, membership and distance of this cluster, with some studies suggesting there are at least two neighboring or overlapping clusters with different distances and ages in this region. NGC 6885 is considered by some to be a duplicate entry of NGC 6882.			

NGC 6885

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Vulpecula	Open cluster	20 h 12.0 m, +26° 29′	August 18
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years		20′	5.9
This is considered here to be a duplicate entry of NGC 6882.			

NGC 6888

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Emission nebula	20 h 12.1 m, +38° 21′	August 18
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years		18′×13′	

This is nicknamed the "Crescent Nebula." Its shape is due to a fast (2,000 km/s) stellar wind from a nearby star (HD 192163, mag. 7.5), plowing previously emitted material from the star (when it was a red supergiant) into an ellipsoidal shell that is hitting a still earlier shell of ejected material. A third, faint shell may surround both these shells and may be due to previously emitted winds from the main sequence progenitor to HD 192163 hitting the surrounding interstellar medium. See Fig. 3.10 for the position of HD 192163. The collision of the two shells breaks them up into clumps. Ionization by UV radiation from the star HD 192163 makes the clumps visible to us. HD 192163 is a Wolf-Rayet star – a massive star now having about 15 times the mass of the Sun, near the end of its life (which will end in a supernova) and losing matter at a prodigious rate (i.e., about an Earth-mass/year) via its fast wind (see NGC 2403 for further explanation of Wolf-Rayet stars). The total mass of this nebula may be about 45 suns, 40 suns worth of which is neutral matter, with only about 5 suns of ionized gas.

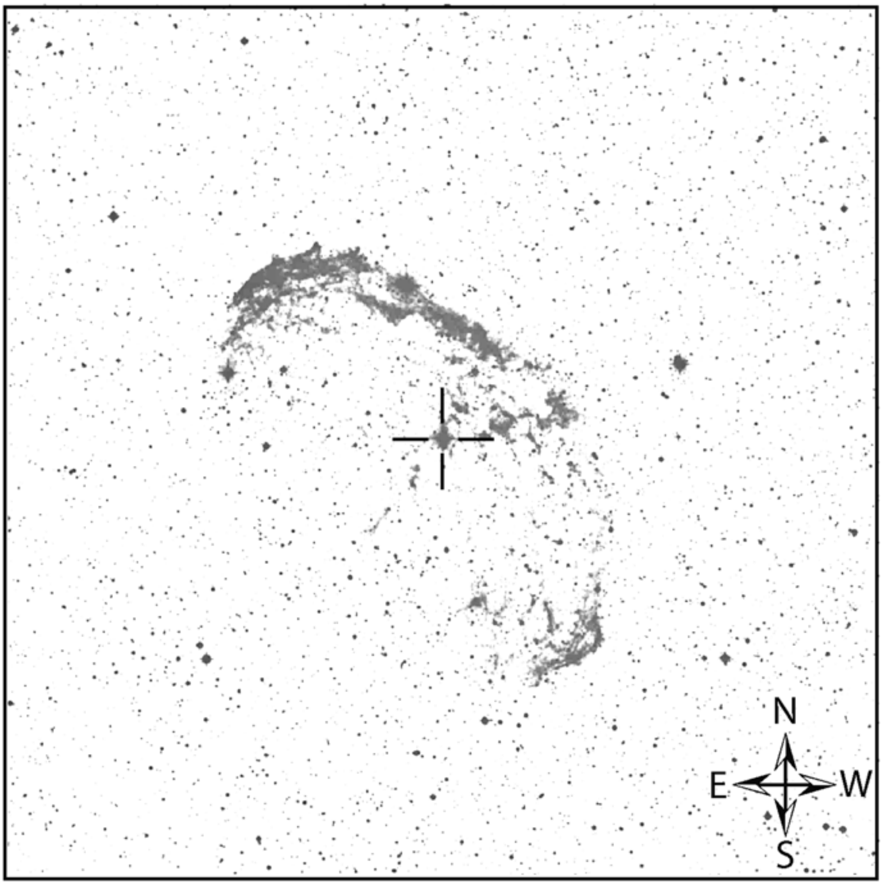

Fig. 3.10 The Wolf-Rayet star responsible for creating the "Crescent Nebula" (NGC 6888) is marked by the *cross-hairs*. The area shown is 30′ × 30′. (From the Digitized Sky Survey, Space Telescope Science Institute, based on photographic data of the National Geographic Society, Palomar Observatory Sky Survey, POSS I.)

NGC 6905

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Delphinus	Planetary nebula	20 h 22.4 m, +20° 06′	August 22
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years		1.2′	11.1

This has a diameter of slightly less than 2 light years and is nicknamed the "Blue Flash Nebula." The central star (mag. 15.5) is a Wolf-Rayet star (see NGC 40 for explanation) with a temperature of about 150,000 K.

NGC 6910

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Open cluster	20 h 23.2 m, +40° 47′	August 22
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	6 million years	10′	7.4
This has a mass of a few hundred suns and a diameter of about 10 light years. It is a very young open cluster. It forms the heart of the Cygnus OB9 association of hot, bright O and B stars, which is itself part of the larger Cygnus X association of OB stars which contains thousands of massive stars within a thousand light year diameter region.			

NGC 6913 (M29)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Open cluster	20 h 23.9 m, +38° 32′	August 21
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	A few million years	10′	6.6
This has a diameter of less than 10 light years. It is heavily obscured by foreground dust that is very patchy (dimming some stars in the cluster by up to five magnitudes, but hardly dimming others). In professional telescopes this cluster is found to contain several hundred stars and a mass close to 1,000 suns.			

NGC 6934

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Delphinus	Globular cluster	20 h 34.2 m, +07° 24′	August 25
Distance	**Age**	**Apparent size**	**Magnitude**
50,000 light years	10–14 billion years	7.1′	8.9
This lies far away and well below (17,000 light years below) the galactic central plane in the halo of our galaxy. It orbits the galaxy with a period of about a billion years, never coming any closer to the galactic center than about 10,000 light years, but wandering out about 180,000 light years from the galactic center at its most distant orbital position, on an orbit that is inclined to the galactic disk by about 50°. This cluster moves in retrograde (i.e., opposite) to our galaxy's rotation. It has an orbit that shares dynamical properties with that of NGC 5466 (see NGC 5466), and it has been suggested that both, perhaps along with NGC 7089/M2 and NGC 6205/M13, are left over from a single disrupted satellite galaxy of the Milky Way. It is also moving toward us at high velocity (400 km/s) compared to the surrounding objects in the halo. A size of 7.1′ gives it an actual diameter of about 100 light years. It has a mass of about 200,000 suns.			

NGC 6939

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cepheus	Open cluster	20 h 31.5 m, +60° 40′	August 24
Distance	**Age**	**Apparent size**	**Magnitude**
6,000 light years	1 billion years	10′	7.8
This is one of the older open clusters visible to amateur astronomers. It has a diameter of about 20 light years. The galaxy NGC 6946 is 38′ SE (see NGC 6946).			

NGC 6940

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Vulpecula	Open cluster	20 h 34.4 m, +28° 17′	August 25
Distance	**Age**	**Apparent size**	**Magnitude**
2,500 light years	700–800 million years	25′	6.3
This has a diameter of about 20 light years. It contains four known X-ray sources, all red giants, three of which are binary stars (which make up half of the six known binaries in this cluster). It has a mass of nearly 600 suns.			

NGC 6946

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Barred spiral galaxy	20 h 34.9 m, +60° 09′	August 25
Distance	**Age**	**Apparent size**	**Magnitude**
20 million light years		11.5′×9.8′	9.0
This has an optical diameter of about 65,000 light years. A starburst (meaning violent, high-mass star formation is occurring there) is present in its central regions. Recent star formation is also present throughout the spiral arms. In fact, one of its spiral arms contains a gargantuan young star cluster (15 million years old) with a mass of 1–2 million suns, which is thought to be a young version of a globular cluster. It is located in the knot 2.7′ W and 2.0′ S of the galaxy nucleus, and appears star-like in large amateur telescopes (see Fig. 3.11). This cluster along with about a dozen or so other nearby young star clusters form a complex that are thought to have blown a bubble-like expanding region of gas that has a diameter of about 2,000 light years. NGC 6946 is the namesake member of a group of perhaps eight galaxies that includes seven dwarf irregular galaxy companions to NGC 6946.			

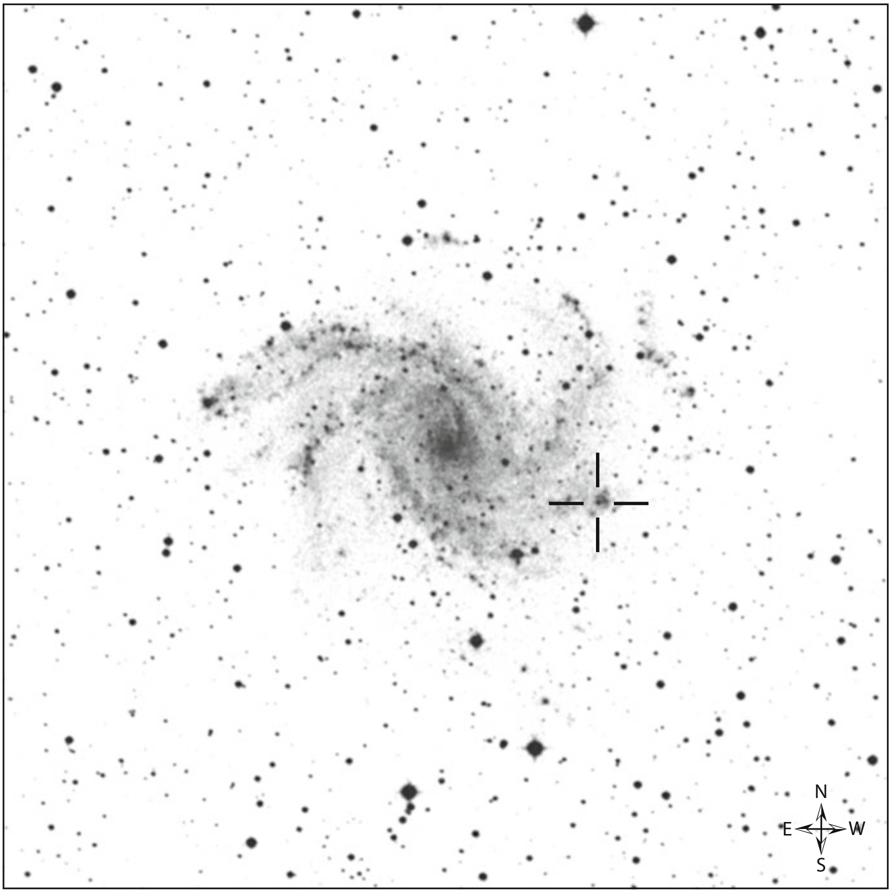

Fig. 3.11 A faint, super star cluster in the galaxy NGC 6946 is marked by the *crosshairs*. The area shown is $15' \times 15'$. (From the Digitized Sky Survey, Space Telescope Science Institute, based on photographic data of the National Geographic Society, Palomar Observatory Sky Survey, POSS I.)

NGC 6960

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Supernova remnant	20 h 45.7 m, +30° 43′	August 27
Distance	**Age**	**Apparent size**	**Magnitude**
1,500 light years		70′ × 6′	7

This is the western portion of the two brightest segments of the "Veil Nebula" (the other, eastern, portion being NGC 6992 + NGC 6995), which are all part of the remains of a supernova that in professional telescopic studies is spread out over a 2.8° × 3.5° region of the sky and called the Cygnus Loop (that also includes the central wisps NGC 6979 and NGC 6974). The nebula is the result of a supernova of a star with perhaps 10–15 times the mass of our Sun that occurred 5,000–10,000 years ago. Prior to the supernova, the stellar winds from the star cleared out a cavity (or "bubble") in the interstellar material. The blast wave of the supernova is only now hitting the wall of this cavity where interstellar material lies. As the blast wave hits the interstellar material, it propagates as shock waves in the interstellar material (with the non-uniform, clumpy nature of the interstellar material causing these shock waves to have an intricate structure). As the shock waves pass through the interstellar material (at about 150 km/s), they heat material in the interstellar clouds to high temperatures. The subsequent cooling of the hot interstellar material (behind the shock wave) gives rise to radiation that we see as the nebula. Regions where a shock wave is propagating nearly parallel to the sky (i.e., viewed edge-on) are brighter (since then we are viewing a sheet of heated material edge-on). In contrast, a shock wave propagating nearly toward or away from us is dimmer (since then we are viewing a sheet of heated material face-on). The 70′ × 6′ apparent size of the nebula corresponds to dimensions of 30 × 2 light years.

NGC 6981 (M72)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aquarius	Globular cluster	20 h 53.5 m, −12° 32′	August 30
Distance	**Age**	**Apparent size**	**Magnitude**
55,000 light years	10–14 billion years	6.6′	9.2

This has a mass of about 200,000 suns and a diameter of about 100 light years. It lies in the halo of our galaxy (see M2 for the meaning of "halo"). It rotates about our galaxy in a retrograde direction (i.e., opposite to the Sun's motion around the galaxy), which has led to the suggestion that it was adopted in a merger with another galaxy.

NGC 6992/6995

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Supernova remnant	20 h 56.4 m, +31° 43′	August 30
Distance	**Age**	**Apparent size**	**Magnitude**
1,500 light years		72′ × 8′	
This is the eastern portion of the Veil Nebula (see NGC 6960).			

NGC 6994 (M73)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aquarius	Asterism	20 h 58.9 m, −12° 38′	August 31
Distance	**Age**	**Apparent size**	**Magnitude**
		1.4′	8.9
The four stars at this location are not a cluster but are simply an asterism (i.e., a pattern of physically unrelated stars on the sky).			

NGC 7000

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Emission nebula	20 h 59.3 m, +44° 31′	August 31
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years		3°×2°	4

This is nicknamed the "North American Nebula" from its apparent shape in low-power amateur telescopes (with a nebula filter) or binoculars. If all its light were emitted by a point source, it would appear as a mag. 4 star in our sky. Of course, in actuality the light from this nebula is spread over several square degrees in the sky, so its brightness is quite dim (and nothing like a magnitude 4 star – see the Introduction for further explanation of the meaning of magnitude). NGC 7000 and the nearby "Pelican Nebula" (IC 5070, whose pelican shape is seen in photographic images) are both part of a single ionized hydrogen (HII) star-forming region (with a mass of about 5,000 suns) that is part of a single dark, giant molecular cloud (with a mass of about 50,000 suns). Part of the giant molecular cloud lies in front of the region between the two nebulae, making it appear as if the two nebulae are separate when in fact they are merely the outlying areas of an underlying emission region. It is the shape of the dark cloud (LDN 935) superposed on the underlying (bright) HII region that produces the namesake appearances of these two nebulae. The underlying HII region is the part of the giant molecular cloud (GMC) that has been ionized by a few hot young stars that formed within the cloud. The nebulae NGC 7000 and IC 5070 are thought to be ionized by a single star magnitude 13.5 star (2MASS J20555125+4352246) that lies just east of the Florida Peninsula area. Professional telescopes have found nine young open clusters embedded in the GMC, mostly obscured in or near dark regions like the Gulf of Mexico area. The dim open cluster NGC 6997 that appears approximately where Lake Superior would be, is actually a background object (about 2 hundred light years behind it) and did not evolve from the North American Nebula. This cluster is sometimes mistakenly labeled as NGC 6996.

NGC 7006

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Delphinus	Globular cluster	21 h 01.5 m, +16° 11′	September 1
Distance	**Age**	**Apparent size**	**Magnitude**
135,000 light years		3.6′	10.6

This lies well out in the halo of our galaxy (the halo is the region outside the spiral disk and bulge of our galaxy, extending out as a sphere with a radius of perhaps six times that of the spiral disk region and containing most of the galaxy's dark matter). Objects in the halo do not rotate with the spiral region, but instead have large, independent velocities. Indeed, NGC 7006 is moving at nearly 300 km/s with respect to the galactic rest frame and has one of the highest relative velocities of all globular clusters, approaching us at nearly 400 km/s. It takes about 2 billion years to complete an orbit about the galaxy, with its closest approach to the galactic center being about 55,000 light years, and its most distant orbital position being over 300,000 light years from the galactic center. It is currently moving toward the galactic center. It has a mass of about 200,000 suns. With a radius of 140 light years, this is a relatively large diameter globular, as is typical of globular clusters that are well out in the halo. It is thought to have formed in a dwarf galaxy similar to the Fornax dwarf galaxy and later been accreted by our galaxy.

NGC 7008

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Planetary nebula	21 h 00.6 m, +54° 33′	August 31
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years		1.4′	10.7

This has a diameter of about a light year. Professional telescopic studies show that the central star is a binary system. The nebula has an odd shape in the eyepiece, having been likened to a horseshoe with the open end to the southeast. In professional telescopes it has an elliptical outer halo with a diameter of 2′ surrounding the brighter inner 1′ diameter portion visible in amateur telescopes.

NGC 7009

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aquarius	Planetary nebula	21 h 04.2 m, −11° 22′	August 31
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years		35″	8.0

This is nicknamed the "Saturn Nebula" after the ansae that extend from the east and west edges in professional and large amateur telescopes. These ansae are thought to be ionization fronts that are expanding supersonically. The nebula is a few thousand years old. The magnitude 12 central star is visible in large amateur telescopes. In three dimensions and ignoring the ansae, the nebula has the shape of an elliptical shell, with a main inner shell nested inside an outer shell. We are looking at the outside of this structure, so we see an oval shape. In professional telescopes, the nebula is contained within a giant halo (with a complex structure) that extends out to a diameter of well over 3′. The total mass of the nebula is a couple tenths of a solar mass. Its size of 0.5′ corresponds to a diameter of about 1/2 light year.

NGC 7027

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Planetary nebula	21 h 07.0 m, +42° 14′	September 2
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years		15″	8.5

This nebula consists of an elliptical shell of ionized gas. In professional telescopic studies, this shell is found to be surrounded by four nested hourglass (bipolar) shells. The inner ionized nebula is about 600 years old, while the outer shells have existed for a few thousand years. Its central star is one of the hottest known stars, with a temperature of 200,000 K.

NGC 7044

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Open cluster	21 h 13.2 m, +42° 30′	September 3
Distance	**Age**	**Apparent size**	**Magnitude**
10,000–12,000 light years	1–2 billion years	7′	12.0
This is one of the older NGC open clusters visible to amateur astronomers. It has a diameter of nearly 20 light years.			

NGC 7062

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Open cluster	21 h 23.5 m, +46° 23′	September 6
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	1 billion years	5′	8.3
This has a diameter of about 10 light years. In professional telescopes it contains a few hundred stars, and a mass of perhaps 1,500 suns. This cluster has at least ten δ Scuti type pulsating variable stars, an uncommonly large number. These stars can be used like Cepheid variables (see NGC 7790) to give accurate estimates of distance based on their period, luminosity and color. The pulsations of δ Scuti variables also give rise to motions at the star surface of a few km/s, which can be used to probe the star's interior structure much like seismic waves on Earth give us information about Earth's interior.			

NGC 7078 (M15)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pegasus	Globular cluster	21 h 30.0 m, +12° 10′	September 7
Distance	**Age**	**Apparent size**	**Magnitude**
34,000 light years	10–14 billion years	18′	6.3

The mass here is nearly a million suns. Its size of 18′ corresponds to a diameter of about 180 light years. It is a halo cluster (see M2 for the meaning of "halo") but never travels farther than about 45,000 light years from the galactic center on a path that is inclined by about 40° from the galactic disk. It revolves once around the galaxy every quarter billion years or so in a prograde orbit (like most globular clusters), meaning it revolves about the galaxy in the same direction as the galaxy's own rotation. The cluster is core collapsed (see NGC 6284 for explanation) and has one of the most concentrated centers (with more than 30 stars per square arcsecond in professional telescopes). M15 contains a planetary nebula (Pease 1, mag. 13), one of only four known globular clusters that share this distinction and the easiest planetary of the four to find in amateur telescopes (but recommended for a 12-in. or larger telescope, and requiring a detailed map of the field, optional nebula filter, and patience to discern Pease 1 among the myriad stars near it). M15 is the most metal poor globular cluster in the Milky Way, meaning it has the least abundance of elements heavier than helium.

NGC 7086

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Open cluster	21 h 30.5 m, +51° 36′	September 8
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	100–200 million years	12′	8.4

This has a diameter of about 10 light years and was discovered in 1788 by William Herschel. NGC 7031, 3.7° W, has been proposed as a twin cluster, but it is about 400 light years closer and 50 million years older and probably did not form from the same giant molecular cloud.

NGC 7089 (M2)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aquarius	Globular cluster	21 h 33.5 m, –00° 49′	September 8
Distance	**Age**	**Apparent size**	**Magnitude**
40,000 light years	10–14 billion years	16′	6.6

The mass here is about 900,000 suns, but many of these stars are more massive than the Sun so that the total number of stars is about 150,000. Its size of 11.7′ gives it a diameter of about 130 light years. It lies in the halo of our galaxy. The halo is the region outside the spiral disk and bulge of our galaxy, extending out as a sphere with a radius of perhaps six times that of the spiral disk region and containing most of the galaxy's dark matter. M2 orbits the galaxy independently of the galactic disk on an inclined orbit that wanders out over 100,000 light years from the galactic center and then approaches within a few tens of thousands of light years of the galactic center, taking the better part of a billion years to complete one revolution around the galaxy. Its color magnitude diagram (CMD) has both a split sub-giant branch, where the two populations differ by a few tenths of magnitude, and a double red giant branch, where the two populations differ somewhat in color. These CMD features may reflect two sequential generations of star formation in this cluster.

NGC 7092 (M39)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Open cluster	21 h 31.7 m, +48° 25′	September 7
Distance	**Age**	**Apparent size**	**Magnitude**
1,000 light years	300–400 million years	31′	4.6

This has a diameter of about 10 light years and a mass of a few hundred suns. This cluster lies in a rich field that is "contaminated" with field stars (i.e., stars that happen to lie along the same line-of-sight but which are foreground or background stars) from the Milky Way. This "contamination" worsens the fainter the stars that are being considered. For example, about 80–90 % of the magnitude 8–10 stars are true cluster members, but only about 20 % of the magnitude 11 stars in this cluster are actual cluster members (the rest being field stars), while fewer than 10 % of the mag. 12 stars are true cluster members. Distinguishing field stars from true open cluster members requires professional telescopic studies, but the fact that one is seeing a mix of field stars and true cluster members should be borne in mind when viewing an open cluster through the eyepiece.

NGC 7099 (M30)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Capricornus	Globular cluster	21 h 40.4 m, −23° 11′	September 9
Distance	**Age**	**Apparent size**	**Magnitude**
25,000 light years	10–14 billion years	12′	6.9
This has a mass of about 100,000–200,000 suns. It orbits the galaxy on a retrograde orbit that is inclined to the galactic disk (by 50°), taking about 160 million years to complete one revolution around the galaxy, never straying farther than about 30,000 light years from the galactic center, but never approaching closer than about 10,000 light years to the galactic center. The core of this cluster has "collapsed" (see NGC 6284), making its central region like a swarm of angry bees suddenly placed into a small container. Its size corresponds to a diameter of about 90 light years. It contains a high concentration of "blue straggler" stars. These are stars that are paradoxically far more blue and luminous than expected perhaps because of mass transfer between or coalescence of stars (see NGC 6633), with almost 50 such stars known in this cluster.			

NGC 7128

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cygnus	Open cluster	21 h 44.0 m, +53° 43′	September 11
Distance	**Age**	**Apparent size**	**Magnitude**
8,000 light years	20 million years	4.0′	9.7
This has a diameter of about 10 light years.			

NGC 7129

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cepheus	Open cluster + reflection nebula	21 h 43.0 m, +66° 07′	September 10
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	3 million years	7′	11
This is a reflection nebula seen against a molecular cloud. It is a star-forming region, and several hot, young stars are visible as an embedded open cluster. In professional telescopes, nearly a hundred young stellar objects have been identified, including pre-main sequence stars that are still collapsing and have not yet begun nuclear fusion.			

NGC 7142

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cepheus	Open cluster	21 h 45.2 m, +65° 46′	September 12
Distance	**Age**	**Apparent size**	**Magnitude**
8,000 light years	3–4 billion years	12′	9.3
This has a diameter of nearly 30 light years and was discovered in 1794 by William Herschel. It is one of the older open clusters visible in amateur telescopes.			

NGC 7160

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cepheus	Open cluster	21 h 53.7 m, +62° 36′	September 14
Distance	**Age**	**Apparent size**	**Magnitude**
3,000 light years	12 million years	5′	6.1
This has a diameter of about 6 light years. It is part of the larger Cepheus OB2 association of stars, which also includes the open cluster Trumpler 37. Massive earlier generation stars in NGC 7160 are thought to be responsible for a large shell of gas known as the Cepheus bubble, visible in professional telescopic studies as a 100-light-year diameter emission region that includes the nebulae Sharpless 2-131 (Sh 2-131), with embedded open cluster IC 1396, and Sharpless 2-140 (Sh 2-140).			

NGC 7209

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Lacerta	Open cluster	22 h 05.1 m, +46° 29′	September 17
Distance	**Age**	**Apparent size**	**Magnitude**
4,000 light years	400 million years	15′	7.7

This has a diameter of almost 30 light years and a mass of about 400 suns. It contains the star SS Lac (mag. 10 – see Fig. 3.12), which was once a variable star of eclipsing Algol type. However, SS Lac is a triple-star system. In such systems, the plane of the orbit of each star can change with time. Indeed, gradual changes in the orientation of the planes of the orbits of the three stars with respect to each other resulted in cessation of the eclipses in the middle of the twentieth century, so that this is no longer a variable star from our line-of-sight. This is only one of four eclipsing variable stars that is known to have stopped varying.

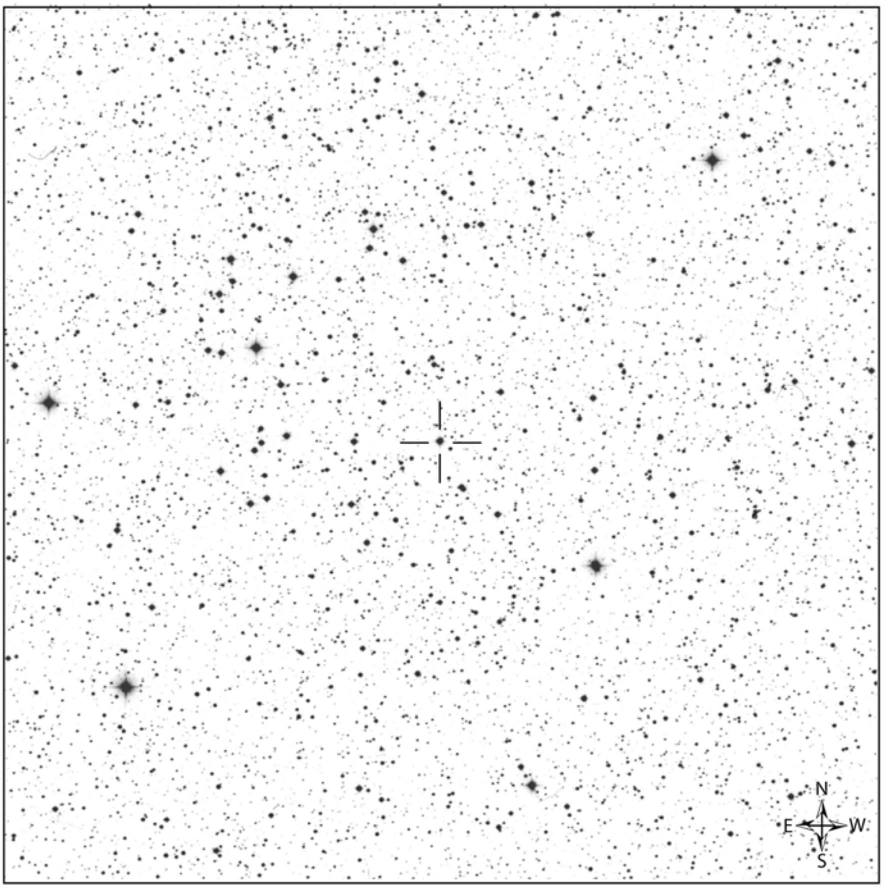

Fig. 3.12 The SW portion of the open cluster NGC 7209 is shown with the star SS Lac marked by *crosshairs*. The area shown is 30′ × 30′. (From the Digitized Sky Survey, Space Telescope Science Institute, based on photographic data of the National Geographic Society, Palomar Observatory Sky Survey, POSS I.)

NGC 7217

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pegasus	Spiral galaxy	22 h 07.9 m, +31° 22′	September 17
Distance	**Age**	**Apparent size**	**Magnitude**
60 million light years		4.0′ × 3.4′	10.2

This is an uncommon spiral in that it has a series of nuclear rings in professional telescopes, which are seen more commonly in galaxies with bars (which this galaxy does not have). It also has an inner circumnuclear disk aligned perpendicular to the main disk. Another unusual feature of this galaxy is that 20–30 % of its stars orbit in the opposite direction to the rest of the stars in the disk. These various features may be the result of one or more past galaxy merging events. It is thought to be part of the NGC 7331 group. (See NGC 7331.)

NGC 7243

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Lacerta	Open cluster	22 h 15.2 m, +49° 54′	September 19
Distance	**Age**	**Apparent size**	**Magnitude**
2,000–3,000 light years	100–300 million years	30′	6.4

This contains about 200 stars down to mag. 15.5 in professional telescopes and has a mass of about 400–500 suns.

NGC 7293

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aquarius	Planetary nebula	22 h 29.6 m, –20° 50′	September 23
Distance	**Age**	**Apparent size**	**Magnitude**
700 light years		17.6′	7.3

This is nicknamed the "Helix Nebula," from its appearance as a helical loop in professional telescopic images. The nebula is thought to have a mass of at least 1.5 suns. In three dimensions the nebula may be a quasi-ellipsoid with a mild hourglass shape (i.e. mildly bipolar), with our view inclined about 37° from the major axis, with a denser torus surrounding the waist of the hourglass. Professional telescopes have found thousands of tadpole-shaped cometary knots of lowly ionized and molecular gas in its inner ring region, as well a 40′ diameter outer halo where the ancient interstellar wind from the asymptotic giant branch (AGB) progenitor star meets the interstellar medium. The mag. 13.5 central star is a hot white dwarf (with a temperature of about 120,000 K, and a mass near that of our Sun) and is visible in amateur telescopes. The star that produced the nebula is thought to have had a mass of perhaps 6.5 times that of our Sun and would have had a visual magnitude of 5.5 in the sky, having lived about 60 million years before creating the nebula a little more than 10,000 years ago (the nebula is thus an old one for a planetary nebula).

NGC 7296

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Lacerta	Open cluster	22 h 28.0 m, +52° 17′	September 23
Distance	**Age**	**Apparent size**	**Magnitude**
7,000–8,000 light years	100–300 million years	6′	9.7

This has a mass of about 300 suns. NGC 7295 is considered a duplicate entry of NGC 7296.

NGC 7331

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pegasus	Spiral galaxy	22 h 37.1 m, +34° 25′	September 25
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years		10.2′×4.2′	9.5

This is about 150,000 light years in diameter. Its stars and gas have a mass of about 160 billion suns. It is thought to contain a supermassive black hole in its nucleus with a mass of a billion suns. In professional telescopes it has a central dust ring that is a site of active star formation. It is part of a sparse group of perhaps nine gravitationally bound major galaxies, including NGC7217 (see NGC 7217), NGC7320, NGC7292, and NGC7457. In addition, NGC 7331 may have four dwarf galaxy companions, as well as a tidal stream off its west side that may be debris from a disrupted ex-companion dwarf galaxy. Several galaxies lie along the same line-of-sight, including NGC 7335 (mag. 13.8), NGC 7336 (mag. 14.6), NGC 7337 (mag. 14.6) and NGC 7340 (mag. 13.9) and appear nearby (within 6′ in an easterly direction), but are much farther away (300–400 million light years) than NGC 7331.

NGC 7380

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cepheus	Open cluster	22 h 47.3 m, +58° 08′	September 26
Distance	**Age**	**Apparent size**	**Magnitude**
7,000–8,000 light years	A few million years	8′	7.2

This has a diameter of about 20 light years. It was discovered in 1787 by Caroline Herschel (William Herschel's sister). It has a mass of a few thousand suns. The remnants of the material from which this young cluster has formed can be seen as the faint nebulosity, labeled as Sharpless 2-142, in which this cluster is embedded and within which active star formation is still occurring. The binary variable star DH Cepheus (mag. 8.6) is thought to be primarily responsible for ionizing Sharpless 2-142, and its ultraviolet radiation is thought to be photo-evaporating the giant molecular cloud (GMC) associated with this nebula as well as triggering star formation by compression of clumps in the GMC.

NGC 7448

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pegasus	Spiral galaxy	23 h 00.1 m, +15° 59′	October 1
Distance	**Age**	**Apparent size**	**Magnitude**
90 million light years		2.6′ × 1.2′	11.4

This has an optical diameter of about 75,000 light years and has more star formation going on than in most spirals. It has a stellar mass of about 24 billion suns. It is the namesake member of the NGC 7448 group of galaxies, which includes NGC 7454 (mag. 11.8), NGC 7463 (mag. 12.9), NGC 7464 (mag. 13.3) and NGC 7465 (mag. 12.3) that can be readily seen within 1/2° nearby, as well as NGC 7437 (mag. 13.3) 1.8° S. Gravitational interactions are likely present in this group, with a tail of atomic hydrogen gas extending from the tight NGC 7463/7464/7465 subgroup toward NGC 7448, and another tail extending off of NGC 7448.

NGC 7479

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pegasus	Barred spiral galaxy	23 h 04.9 m, +12° 19′	October 2
Distance	**Age**	**Apparent size**	**Magnitude**
105 million light years		4.0′ × 3.1′	10.9

This has a mass of a little over 200 billion suns and an optical diameter of about 120,000 light years. The asymmetry in the spiral arms of this galaxy may be due to a minor merger with another galaxy in the recent past. Vigorous star formation is occurring within the central region, in the spiral arms and in the bar, which has a mass of approximately 50 billion suns. It is a Seyfert galaxy (where a supermassive object in this galaxy's center accumulates nearby gas resulting in strong emission from the nucleus).

NGC 7510

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cepheus	Open cluster	23 h 11.1 m, +60° 34′	October 4
Distance	**Age**	**Apparent size**	**Magnitude**
10,000–12,000 light years	6–10 million years	7′	7.9
This has a diameter of about 10 light years and was discovered in 1787 by William Herschel. It lies on the edge of the Perseus arm of our galaxy (which is the next spiral arm outward from us).			

NGC 7606

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aquarius	Spiral galaxy	23 h 19.1 m, –08° 29′	October 5
Distance	**Age**	**Apparent size**	**Magnitude**
100 million light years		5.4′ × 2.1′	10.8
This is one of fewer than about 200 galaxies that have had two or more recorded supernovae.			

NGC 7635

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Emission nebula	23 h 20.8 m, +61° 13′	October 6
Distance	**Age**	**Apparent size**	**Magnitude**
8,000 light years		15′ × 8′	10
This is nicknamed the "Bubble Nebula," after its appearance in professional telescopic images. The "bubble" seen in professional telescopic images is about 3′ in diameter (about 7 light years). It is caused by a fast stellar wind from the hot, young, central star (SAO 20575, mag. 8.7, lying offset from the center of the bubble) that is clearing out a roughly spherical cavity in the surrounding ionized hydrogen (HII) region. NGC 7635 is part of the much larger Sharpless 162 emission region (and which has a diameter of about 30′). Like other emission nebulae, such as M8 and M42, NGC 7635 is a small "blister" on a larger cloud of gas (with only the part that is ionized by the central star being visible). The amount of ionized gas in NGC 7635 is thought to be several solar masses.			

NGC 7654 (M52)

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Cassiopeia</td><td>Open cluster</td><td>23 h 24.8 m, +61° 36′</td><td>October 6</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>4,000–5,000 light years</td><td>100 million years</td><td>16′</td><td>6.9</td></tr>
<tr><td colspan="4">This is a relatively rich cluster. At magnitudes brighter than 15.0, there is nearly one star for every square arcsecond of sky in its densest parts (although about one in ten of these is a field star and not a cluster member – see M39). To magnitude 14.5, a total of about 130 stars belong to the cluster (with only about 30 field stars “contaminating” the cluster), with these cluster members having masses about two to five times that of our Sun. To magnitude 19.5, over 6,000 stars belong to the cluster (with about the same number of field stars present), with most of these dimmer cluster members having masses near that of our Sun. The stars in this cluster appear to have a much larger spread of ages (tens of millions of years) than most open clusters (where the stars are typically only a few million years apart in age). Gas and dust between us and the cluster dim the stars in this cluster considerably (by a few magnitudes).</td></tr>
</table>

NGC 7662

<table>
<tr><th>Constellation</th><th>Object type</th><th>RA, Dec</th><th>Approx. transit date at local midnight</th></tr>
<tr><td>Andromeda</td><td>Planetary nebula</td><td>23 h 25.9 m, +42° 32′</td><td>October 6</td></tr>
<tr><th>Distance</th><th>Age</th><th>Apparent size</th><th>Magnitude</th></tr>
<tr><td>4,000–6,000 light years</td><td></td><td>37″</td><td>8.3</td></tr>
<tr><td colspan="4">This is nicknamed the “Blue Snowball.” It has a triple-shell ellipsoidal structure (the innermost shell brightened by a spherical shock wave, the middle due to ionization from the central star, while the outer shell is a faint 2′ diameter halo). In professional telescopes, NGC 7662 appears to be one of about 50 % of planetary nebulae that have a pair of fast-moving, low-ionization emission regions (“FLIERS”) placed symmetrically on either side of the nebula (like small ears on a head). The nebula is thought to be a little over 1,000 years old.</td></tr>
</table>

NGC 7686

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Andromeda	Open cluster	23 h 30.1 m, +49° 08′	October 8
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years	2 billion years	15′	5.6
This has a diameter of about 20 light years and was discovered in 1787 by William Herschel.			

NGC 7723

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aquarius	Barred spiral galaxy	23 h 39.0 m, −12° 58′	October 10
Distance	**Age**	**Apparent size**	**Magnitude**
90 million light years		3.5′×2.2′	11.2
This has an optical diameter of about 90,000 light years. Professional telescopes show the bar in this barred spiral has a radius of 23″ along the major axis of the galaxy. Stars at the ends of the bar are observed to be rotating at the same speed as a spiral wave there, so that the usual formation of new stars by density waves does not occur in these regions, causing star populations there to be older than at other locations. It is part of the NGC 7727 galaxy group (see NGC 7727).			

NGC 7727

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Aquarius	Peculiar barred spiral galaxy	23 h 39.9 m, −12° 18′	October 11
Distance	**Age**	**Apparent size**	**Magnitude**
80 million light years		4.7′×3.5′	10.6
This is believed to be the result of two disk galaxies having merged approximately 1 billion years ago. The merger appears to have caused the formation of more than 20 young globular clusters within this galaxy. It forms a group of five gravitationally bound galaxies that includes nearby NGC 7723 (43′ SSW – see NGC 7723), along with two other dim non-NGC galaxies and the faint NGC 7724 (12′ WNW, mag. 13.5).			

NGC 7789

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	23 h 57.4 m, +56° 43′	October 15
Distance	**Age**	**Apparent size**	**Magnitude**
7,000 light years	1–2 billion years	25′	6.7
This has a mass of about 7,000 suns. It has a diameter of about 50 light years and was discovered in 1783 by Caroline Herschel (William Herschel's sister).			

NGC 7790

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Open cluster	23 h 58.4 m, +61° 13′	October 15
Distance	**Age**	**Apparent size**	**Magnitude**
10,000 light years	60–80 million years	10′	8.5
This has a diameter of about 30 light years and a mass of a few hundred suns. It is an unusual cluster because it contains an Algol type eclipsing binary (QX Cas, mag. 10.2) that has ceased eclipsing presumably due to orbital changes, as well as three Cepheid variable stars: CF Cas (mag. 10.8–11.4, period 4.9 days), and CE Cas A and B (A: mag. 10.5–11.2, period 4.5 days, B: mag. 10.6–11.4, period 5.1 days). CE Cas is a binary system with separation 2.3″ and a position angle of about 80°. CE Cas is one of only two known double-star systems in our galaxy that consists of two Cepheids (the other is EV Set in NGC 6664, but it is a spectroscopic binary). These Cepheids can be seen in amateur telescopes just west of the center of the cluster (see Fig. 3.13, overleaf), with the two stars making up CE Cas being discernable under good seeing conditions in amateur telescopes. Cepheids are variable stars whose luminosity varies in a regular manner due to periodic pulsations in the opacity of the star's atmosphere. These pulsations are the result of a cycle where radiative heating of the atmosphere causes expansion of the atmosphere, resulting in a more transparent atmosphere that leads to energy release, compression, and a more opaque atmosphere that starts the cycle again. The period is directly related to luminosity and so Cepheids are a standard means of determining astronomical distances.			

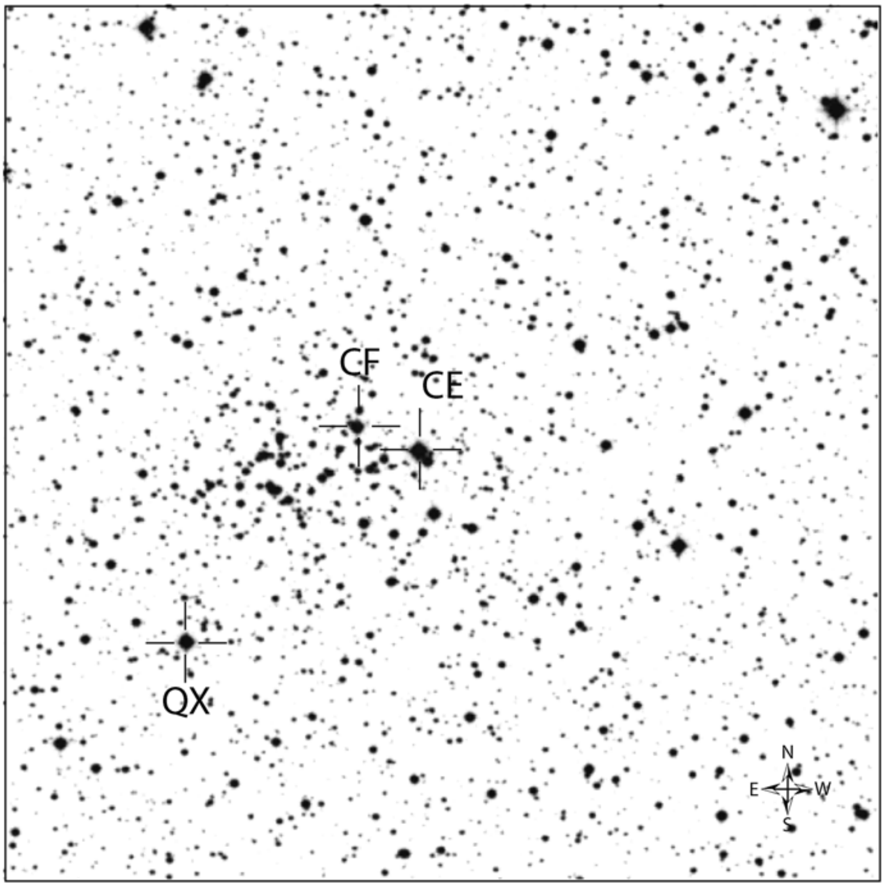

Fig. 3.13 The open cluster NGC 7790 contains the Cepheid variable stars CF and CE Cas, as well as the previously eclipsing binary star QX Cas, as marked. The area shown is 15′ × 15′. (From the Digitized Sky Survey, Space Telescope Science Institute, based on photographic data of the National Geographic Society, Palomar Observatory Sky Survey, POSS I.)

NGC 7814

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Pegasus	Spiral galaxy	00 h 03.2 m, +16° 09′	October 17
Distance	**Age**	**Apparent size**	**Magnitude**
50 million light years			

This galaxy is almost exactly edge-on. It has an exceptionally prominent bulge. It has nearly 200 globular clusters. Its size of 5.5′ gives it an actual diameter of about 80,000 light years. Professional telescopes find its disk is warped (e.g., starting at 2.3′ from the center in the SE the dust lane bends to the SW in professional telescopic studies, twisting with the bend). Such warps are common, being observed in the neutral hydrogen (HI) distribution of about half of all galactic disks.

Chapter 4

IC (Index Catalogue) Objects and the Large Magellanic Cloud

IC 289

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Cassiopeia	Planetary nebula	03 h 10.3 m, + 61° 19′	November 17
Distance	**Age**	**Apparent size**	**Magnitude**
5,000 light years		48″	13.2
In professional telescopic studies this nebula has a ring-like structure inside two fainter spheroidal shells. The progenitor star is thought to have had a mass about twice that of our Sun and created the nebula within the past 10,000 years. The nebula has a diameter of about a light year.			

W.H. Finlay, *Concise Catalog of Deep-Sky Objects: Astrophysical Information for 550 Galaxies, Clusters and Nebulae*, The Patrick Moore Practical Astronomy Series,
DOI 10.1007/978-3-319-03170-5_4,

IC 2391

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Vela	Open cluster	08 h 40.3 m, −52° 55′	February 8
Distance	**Age**	**Apparent size**	**Magnitude**
500 light years	30–50 million years	60′	2.6

It has a mass of about 500–700 Suns. It is a young cluster, with its Solar mass stars just reaching the main sequence and some still having their pre-main sequence debris disks. It is quite close to us and is thought to be in the process of dissolving. Indeed, the Argus association of stars that is spread out over more than 50° across the sky, and includes Denebola (β Leo) and perhaps AP Columba (the closest known pre-main sequence star), is thought to have once been part of this cluster.

IC 2602

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Carina	Open cluster	10 h 42.9 m, −63° 24′	March 11
Distance	**Age**	**Apparent size**	**Magnitude**
500 light years	30–50 million years	1.7°	1.6

Nicknamed the Southern Pleiades, this is a young cluster with its lower mass stars not quite having reached the main sequence. It had a close approach with IC 2391 about 3 million years ago, when they came within 80 light years of each other while passing through the Galactic plane. It contains the bright star θ Carina (mag. 2.8), which is a blue straggler (see NGC 6633) with a mass of about 15 Suns. This star is part of a binary system with an exceptionally short orbital period (2.2 days) for its high mass. Its secondary star is of approximately Solar mass, and has fed mass to the primary star, giving the latter its blue straggler status.

IC 4715 (M24)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Star cloud	18 h 16.5 m, −18° 50′	July 15
Distance	**Age**	**Apparent size**	**Magnitude**
9,000–12,000 light years		1.6°×0.6°	4.6
This is a patch of the Milky Way seen through a hole in the foreground interstellar dust that obscures the surrounding sky, making the patch appear as a cluster to Messier even though it is not a true cluster. It is nicknamed the "Small Sagittarius Star Cloud." The open cluster NGC 6603 (mag. 11.1, 9,000–12,000 light years away, 100–200 million years old) lies within M24 (probably on the near side of the star cloud that makes up M24) and is sometimes incorrectly labeled as M24 instead.			

IC 4725 (M25)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Sagittarius	Open cluster	18 h 31.8 m, −19° 07′	July 24
Distance	**Age**	**Apparent size**	**Magnitude**
2,000 light years	70–100 hundred million years	26′	4.6
It has a diameter of about 15 light years and has a mass of over a thousand Suns. It contains one Cepheid variable star (U Sgr, mag. 6.4 – see NGC 7790 for explanation of Cepheid variables). It also contains six known Be stars (see M47 for explanation of Be stars).			

Large Magellanic Cloud (LMC)

Constellation	Object type	RA, Dec	Approx. transit date at local midnight
Dorado	Barred spiral galaxy	05 h 23.6 m, −69° 45′	December 20
Distance	**Age**	**Apparent size**	**Magnitude**
160,000 light years		10°	0.9

The LMC is a satellite galaxy of the Milky Way. Sometimes referred to as Nubecula Major, it is part of the Magellanic System that also includes the Small Magellanic Cloud (see NGC 292) as well as the Magellanic Bridge of gas and stars plus the Magellanic Stream of neutral hydrogen gas that trails the Magellanic Clouds. The Bridge that connects the two Magellanic Clouds may have been created when the two had a close encounter a couple hundred million years ago. Two large concentrated arcs of stars and clusters are present in the NE part of the LMC, that include the open clusters NGC 1974 (mag. 9.0), NGC 1955 (mag. 9.0) and NGC 968 (mag. 9.0) in the Sextant arc (20′ in size) and the OB1 association LH77 in the Quadrant arc (30′ in size) that is 45′ NE of the Sextant arc. These two arcs may have formed when giant transient jets were shot from the Milky Way's nucleus some dozen million years ago that created circular bow shock waves in the LMC, triggering star formation in these arc-shaped regions. The disk of the LMC is nearly face-on to us. The stellar mass of the LMC is several billion Suns. While not very massive as galaxies go, it still ranks fourth in mass in our Local Group (behind M31, the Milky Way and M33). It hosts the Tarantula Nebula (see NGC 2070) where the most luminous stars in our Local Group of Galaxies are found. Star formation continues throughout the disk of the LMC, and it is the nearest star-forming galaxy to us. Only three other dwarf satellite galaxies are closer to the Milky Way.

Index[1]

[1] **Note**: Messier objects, IC objects and NGC objects with separate entries in Chapters 2–4 are not listed in the index since they are given in numerical order in the book and are therefore readily found.

W.H. Finlay, *Concise Catalog of Deep-Sky Objects: Astrophysical Information for 550 Galaxies, Clusters and Nebulae*, The Patrick Moore Practical Astronomy Series, DOI 10.1007/978-3-319-03170-5, © Springer International Publishing Switzerland 2014

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