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SYMBOLS

μ_o	permeability of free-space
ε_o	permittivity or capacitivity of free-space
$\eta = \sqrt{\frac{\mu_o}{\varepsilon_o}}$	intrinsic impedance of free-space
$c = \sqrt{\frac{1}{\mu_o \varepsilon_o}}$	speed of light
$\alpha = \frac{\mu_o e^2 c}{2h}$	fine structure constant
$\hbar$	Planck constant bar
e^2	electron charge squared
$a_o = \frac{4\pi\varepsilon_0 \hbar^2}{e^2 \mu_e}$	Bohr radius
$\Phi_0 = \frac{h}{2e}$	magnetic flux quantum
$\mu_N = \frac{e\hbar}{2m_P}$	nuclear magneton
$\mu_B = \frac{e\hbar}{2m_e}$	Bohr magneton
$\bar{\lambda}_c$	Compton wavelength bar
$\bar{\lambda}_c = \alpha a_o = \frac{\hbar}{m_e c}$	electron Compton wavelength bar
G	gravitational constant
m_e	mass of the electron
m_μ	rest mass of the muon
m_τ	rest mass of the tau
μ_e	reduced electron mass
m_N	rest mass of the neutron
m_P	rest mass of the proton

And God said, "Let there be light"; and there was light. And God saw that the light was good; and God separated the light from the darkness.

Genesis 1:3

Apparently there is color, apparently sweetness, apparently bitterness; actually there are only atoms and the void.

Democritus 420 BC

I cannot believe that God would choose to play dice with the universe.

Albert Einstein

All truth goes through three steps. First, it is ridiculed. Second, it is violently opposed, and finally it is accepted as self-evident.

Arthur Schopenhauer
German Philosopher

FOREWORD

BLACKLIGHT POWER, inc. (BLP) of Malvern, Pennsylvania, is developing a revolutionary energy technology--catalytic hydrogen collapse. More explicitly, thermal energy is catalytically released as the electrons of atomic hydrogen atoms are induced to undergo transitions to lower energy levels corresponding to fractional quantum numbers. The Company uses a hot refractory metal (e.g.. a hot tungsten filament) to break hydrogen molecules into individual, normal hydrogen atoms. A vaporized inorganic catalyst causes the normal hydrogen atoms to collapse to smaller-than-normal hydrogen atoms. The hydrogen collapse is accompanied by a release of energy that is intermediate between chemical and nuclear energies. BLP's new technology can operate under the conditions of many existing electric power plants. It should be possible to retrofit these power plants to accommodate the new technology. The advantages are that the hydrogen fuel can be obtained by diverting a fraction of the output energy of the process to split water into its elemental constituents, and pollution which is inherent with fossil and nuclear fuels is eliminated.

BLP is not developing so-called "Cold Fusion", which refers to the failed attempt of producing substantial nuclear energy at room temperature. In contrast, BLP has obtained compelling theoretical and experimental support for fractional quantum energy states of hydrogen, which is the basis of a new hydrogen energy source. Some revisions to standard quantum theory are implied. Quantum mechanics becomes a real physical description as opposed to a purely mathematical model where the old and the revised versions are interchangeable by a Fourier Transform operation [1]. These revisions transform Schrödinger's and Heisenberg's quantum theory into what may be termed a ***classical quantum theory***. Physical descriptions flow readily from the theory. For example, in the old quantum theory the spin angular momentum of the electron is called the "intrinsic angular momentum". This term arises because it is difficult to provide a physical interpretation for the electron's spin angular momentum. Quantum Electrodynamics provides somewhat of a physical interpretation by proposing that the "vacuum" contains fluctuating electric and magnetic fields. In contrast, in Mills' theory proposed herein, spin angular momentum results from the motion of negatively charged mass moving systematically, and the equation for angular momentum, $\mathbf{r} \times \mathbf{p}$, can be applied directly to the wave function (a current density function) that describes the electron.

The quantum number $n=1$ is routinely used to describe the "ground" electronic state of the hydrogen atom. I will show that the $n=1$

state is the "ground" state for "pure" photon transitions (the $n=1$ state can absorb a photon and go to an excited electronic state, but it cannot release a photon and go to a lower-energy electronic state). However, an electron transition from the ground state to a lower-energy state is possible by a "resonant collision" mechanism. These lower-energy states have fractional quantum numbers, $n=\frac{1}{\text{integer}}$. Processes that occur without photons and that require collisions are common. For example, the exothermic chemical reaction of $H+H$ to form H_2 does not occur with the emission of a photon. Rather, the reaction requires a collision with a third body, M, to remove the bond energy- $H+H+M \to H_2+M^*$. The third body distributes the energy from the exothermic reaction, and the end result is the H_2 molecule and an increase in the temperature of the system. Similarly, the $n=1$ state of hydrogen and the $n=\frac{1}{\text{integer}}$ states of hydrogen are nonradiative, but a transition between two nonradiative states is possible via a resonant collision, say $n=1$ to $n=1/2$. In these cases, during the collision the electron couples to another electron transition or electron transfer reaction which can absorb the exact amount of energy that must be removed from the hydrogen atom, a resonant energy sink. The end result is a lower-energy state for the hydrogen and an increase in the temperature of the system.

NEW QUANTUM THEORY

J. J. Balmer showed in 1885 that the frequencies for some of the lines observed in the emission spectrum of atomic hydrogen could be expressed with a completely empirical relationship. This approach was later extended by J. R. Rydberg, who showed that all of the spectral lines of atomic hydrogen were given by the equation:

$$\bar{\nu} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) \tag{1}$$

where $R = 109,677\ cm^{-1}$, $n_f = 1,2,3,\ldots$, $n_i = 2,3,4,\ldots$, $and\ n_i > n_f$.

Niels Bohr, in 1913, developed a theory for atomic hydrogen that gave energy levels in agreement with Rydberg's equation. An identical equation, based on a totally different theory for the hydrogen atom, was developed by E. Schrödinger, and independently by W. Heisenberg, in 1926.

$$E_n = -\frac{e^2}{n^2 8\pi\varepsilon_o a_H} = -\frac{13.598\ eV}{n^2} \tag{2a}$$

$$n = 1,2,3,\ldots \tag{2b}$$

where a_H is the Bohr radius for the hydrogen atom ($52.947\ pm$), e is the magnitude of the charge of the electron, and ε_o is the vacuum permittivity.

Recently, I have built on this work by deriving a new atomic theory based on first principles. The novel theory hereafter referred to as Mills' theory unifies Maxwell's Equations, Newton's Laws, and General and Special Relativity. The central feature of this theory is that all particles (atomic-size and macroscopic particles) obey the same physical laws. Whereas Schrödinger postulated a boundary condition: $\Psi \rightarrow 0$ as $r \rightarrow \infty$, the boundary condition in Mills' theory was derived from Maxwell's equations [2]:

> *For non-radiative states, the current-density function must not possess space-time Fourier components that are synchronous with waves traveling at the speed of light.*

Application of this boundary condition leads to a physical model of particles, atoms, molecules, and, in the final analysis, cosmology. The closed-form mathematical solutions contain fundamental constants <u>only</u>, and the calculated values for physical quantities agree with experimental observations. In addition, the theory predicts that Eq. (2b), should be replaced by Eq. (2c).

$$n = 1,2,3,\ldots,\ and,\ n = \frac{1}{2},\frac{1}{3},\frac{1}{4},\ldots \tag{2c}$$

FRACTIONAL QUANTUM ENERGY LEVELS OF HYDROGEN

A number of experimental observations lead to the conclusion that atomic hydrogen can exist in fractional quantum states that are at lower energies than the traditional "ground" ($n = 1$) state. For example, the existence of fractional quantum states of hydrogen atoms explains the spectral observations of the extreme ultraviolet background emission from interstellar space [3], which may characterize dark matter as demonstrated in Table 1. (In these cases, a hydrogen atom in a fractional quantum state, $H(n_i)$, collides, for example, with a $n = \frac{1}{2}$ hydrogen atom, $H\left(\frac{1}{2}\right)$, and the result is an even lower-energy hydrogen atom, $H(n_f)$, and $H\left(\frac{1}{2}\right)$ is ionized.

$$H(n_i) + H\left(\frac{1}{2}\right) \rightarrow H(n_f) + H^+ + e^- + photon \tag{3}$$

The energy released, as a photon, is the difference between the energies of the initial and final states given by Eqs. (2a-2c) minus the ionization energy of $H\left(\frac{1}{2}\right)$, $54.4\ eV$.)

Table 1. Observed emission data. (Raw extreme ultraviolet background spectral data taken from raw data and Figure 4 of Labov and Bowyer).

Peak #	Observed Wavelength (Å)	Observed Energy (eV)	Peak Assignment	Predicted Energy[a] (eV)	Predicted Wavelength (Å)
1	84.8	146.2	1/7 → 1/8 H transtiton	149.6	82.9
2	101.5	122.2	1/6 → 1/7 H transition	122.4	101.3
3	116.8	106.2	1/2 → 1/4 H transition	108.8	114.0
4	129.6	95.6	1/5 → 1/6 H transition	95.2	130.2
5	139.6	88.8	He scattered peak #3	87.6	141.5
6	163.2	75.9	Second order of peak #1	74.8	165.7
7	181.7	68.3	1/4 → 1/5 H transition	68.0	182.3
8	200.6	61.8	Second order of peak #2	61.2	202.6
9*	233.8	53.0	1 → 1/3 H transition	54.4	227.9
10	261.2	47.5	He scattered peak #7	46.8	265.0
11	302.5	41.0	1/3 → 1/4 H transition	40.8	303.9
12	459.1	27.0	Second order of peak #9	27.2	455.8
13	584	21.2	He resonance scattered emission	21.2	584
14	607.5	20.4	Second order of peak #11	20.4	607.8
15	633.0	19.7	He scattered peak #11	19.6	633.0
16			1/2 → 1/3 H transition	13.6	912.3

For excited state hydrogen transitions, $n_i \rightarrow n_f$ $n = 1,2,3,...,$

$$E = \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) X 13.6\ eV$$

[a]For lower-energy transitions, $n = 1, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, ...,$ and $n_i > n_f$ induced by a disproportionation reaction with $H\left[\frac{a_H}{2}\right]$

$$E = \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) X 13.6\ eV - 54.4\ eV$$

[a]For helium inelastic scattered peaks of hydrogen transitions, $n_i \rightarrow n_f$

$$E = \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) X 13.6\ eV - 54.4\ eV - 21.21\ eV$$

* Bowyer and Labov used three monochrometers for maximal sensitivity in each energy range: 80-230Å, 230-430Å, and 430-650Å. The monochrometer change at 230Å resulted in the 6 Å discrepancy between the calculated and observed lines.

Table 2. Representative analytical tests performed on BlackLight's novel hydride compounds with the corresponding laboratory.

Laboratory	Analytical Test
Lehigh University	X-ray Photoelectron Spectroscopy (XPS)
Virginia Tech	Raman Spectroscopy
Charles Evans & Associates East	TOFSIMS, XPS, EDS, Scanning Electron Spectroscopy
University of Massachusetts	Proton NMR
Charles Evans & Associates West	ToF-SIMS
Xerox	ToF-SIMS, XPS
Physical Electronics, Inc.	ToF-SIMS
Spectral Data Services	Proton & K NMR
Surface Science Associates	FTIR
IC Laboratories	XRD
Ricerca, Inc.	LC/MS
PerSeptive Biosystems	ESIToFMS
INP	EUV Spectroscopy
Galbraith Laboratories	Elemental Analysis
Franklin & Marshall College	XRD
Pennsylvania State University	Calvet calorimetry, XRD
TA Instruments	TGA/DTA
Northeastern University	Mossbauer Spectroscopy
M-Scan Inc.	FABMSMS, ESIMS, Solids Probe Magnetic Sector Mass Spectroscopy
Micromass	ESITOFMS
Southwest Research Institute	Solids Probe, Direct Exposure Probe Magnetic Sector Mass Spectroscopy
BlackLight Power, Inc.	Calvet and Heat Loss Calorimetry, Cryogenic Gas Chromatography, ToF-SIMS, XPS, LC/MS, UV and EUV Spectroscopy, Thermal Decomposition/Gas Chromatography, MS of Gasses Solids Probe Quadrapole Mass Spectroscopy, ESIToFMS

Other aspects of Mills' theory include the relationship of the mechanism that determines the masses of the fundamental particles to cosmology:

- Fundamental particle production occurs when the energy of the particle given by the Planck equation, Maxwell's Equations, and Special Relativity is equal to mc^2, and the proper time is equal to the coordinate time according to General Relativity. The gravitational equations with the equivalence of the particle production energies permit the equivalence of mass/energy and the spacetime metric from which the gravitational constant and the masses of the leptons, the quarks, and nucleons are derived.

- The gravitational equations with the equivalence of the particle production energies permit the equivalence of mass/energy ($E = mc^2$) and spacetime ($\frac{c^3}{4\pi G} = 3.22\ X\ 10^{34}\ \frac{kg}{\sec}$). Spacetime expands as mass is released as energy which provides the basis of the atomic, thermodynamic, and cosmological arrows of time. Entropy and the expansion of the universe are large scale consequences.

- The universe is closed independently of the total mass of the universe, and different regions of space are isothermal even though they are separated by greater distances than that over which light could travel during the time of the expansion of the universe. The calculated microwave background temperature is 2.7 °K.

- The universe is oscillatory in matter/energy and spacetime with a finite minimum radius, the gravitational radius ($3.12\ X\ 10^{11}$ *light years*); thus, the gravitational force causes celestial structures to evolve on a time scale that is greater than the period of oscillation ($9.83\ X\ 10^{11}$ *light years*).

- The value of the Hubble constant (Mills) is $H_0 = 78.6\ \frac{km}{\sec\ Mpc}$. Presently, stars exist which are older than the elapsed time of the present expansion as stellar evolution occurred during the contraction phase. The maximum energy release of the universe which occurs at the beginning of the expansion phase is $2.89\ X\ 10^{51}\ W$.

References

1. The theories of Bohr, Schrödinger, and presently Mills all give the identical equation for the principal energy levels of the hydrogen atom.

$$E_{ele} = -\frac{Z^2 e^2}{8\pi\varepsilon_o n^2 a_H} = -\frac{Z^2}{n^2} \; X \; 2.1786 \; X \; 10^{-18} \; J = -Z^2 \; X \; \frac{13.598}{n^2} \; eV \qquad (4)$$

The present theory solves the two dimensional wave equation for the charge density function of the electron. And, the Fourier transform of the charge density function is a solution of the three dimensional wave equation in frequency (k,ω) space. Whereas, the Schrödinger equation solutions are three dimensional in spacetime. The energy is given by

$$\int_{-\infty}^{\infty} \psi H \psi \, dv = E \int_{-\infty}^{\infty} \psi^2 dv; \qquad (5)$$

$$\int_{-\infty}^{\infty} \psi^2 dv = 1 \qquad (6)$$

Thus,

$$\int_{-\infty}^{\infty} \psi H \psi \, dv = E \qquad (7)$$

In the case that the potential energy of the Hamiltonian, H, is a constant times the wavenumber, the Schrödinger equation is the well known Bessel equation. Then with one of the solutions for ψ, Eq. (7) is equivalent to an inverse Fourier transform. According to the duality and scale change properties of Fourier transforms, the energy equation of the present theory and that of quantum mechanics are identical, the energy of a radial Dirac delta function of radius equal to an integer multiple of the radius of the hydrogen atom (Eq. (4)). And, Bohr obtained the same energy formula by postulating nonradiative states with angular momentum

$$L_z = m\hbar \qquad (8)$$

and solving the energy equation classically.

The mathematics for all three theories converge to Eq. (4). However, the physics is quite different. Only the Mills theory is derived from first principles and holds over a scale of spacetime of 45 orders of magnitude: it correctly predicts the nature of the universe from the scale of the quarks to that of the cosmos.

2. Haus, H. A., "On the radiation from point charges", American Journal of Physics, 54, (1986), pp. 1126-1129.
3. Labov, S., Bowyer, S., "Spectral observations of the extreme ultraviolet background", The Astrophysical Journal, 371, (1991), pp. 810-819.