A New Foundation for Modern Science

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ABSTRACT
This research is a continuation of recent efforts to expand classical electrodynamics to embrace elastic finite-size elementary particles with internal structure in an effort to satisfy the logical criteria that undergird the scientific method and point scientific theories in the direction of truth. Earlier work reported the logical inconsistencies, false assumptions, and defects of the relativistic quantum electrodynamic theory of the atom, including relativity theory and quantum mechanics.[14] This was followed by derivations of Maxwell's equations of electrodynamics showing where the point particle approximation is used and the field transformation information between moving frames is removed causing them to fail for relativistic phenomena.[15] Then the principal results of special relativity theory were derived from classical electrodynamics for finite size elementary particles using the Galilean transformation.[16] More recent research has shown from combinatorial geometry for arbitrary-shaped finite size electrons and protons obeying classical electrodynamics under the assumption of spherical packing symmetry that the details of the periodic table of the elements as well as the structure of the nucleus could be predicted more completely and accurately than previously possible with the relativistic quantum theories.[16,17,18] This work derives expressions for the blackbody radiation, the photoelectric effect, and the emission spectra of atoms from classical electrodynamics for finite size electrons in the shape of a toroidal ring. The results are logically superior to the relativistic quantum electrodynamic theory as developed by Planck, Einstein, and Dirac and describe experimental data previously unexplained by quantum electrodynamics.

INTRODUCTION
The issue of truth has been largely neglected in modern science. Most high school and college science textbooks no longer even mention the logical principles and criteria that undergird science and guide it in the direction of truth. Modern science has evolved to the point that peer approval is more important than being based upon the physical laws of cause and effect and being logically correct and consistent. As a result the modern theory of the atom is based on quantum electrodynamics which gives a nonphysical mathematical view of the universe governed 100% by random statistical processes. The purpose of this work is to explore the possibility of returning to a physical view of the universe based on the laws of cause and effect and the logical criteria supposedly guiding science toward truth.

Logical Principles and Criteria Undergirding Science
Since the days of the ancient Ionian, Greek, and Roman natural philosophers, the role of logic in science has been clearly understood. The most celebrated example of this was Euclid's Elements. Natural philosophers considered the development of a scientific theory as analogous to the proof of propositions and theorems in geometry. Some of the logical rules or criteria that have been continuously held for thousands of years are as follows:

1. No scientific theories are allowed based upon postulates or assumptions known to be false.
2. No scientific theories are allowed that can not explain all the valid relevant experimental data.
3. All scientific theories must be self-consistent with one another.
4. All different types of valid measurements of the same quantity in science must be self-consistent with one another.

Since the discovery of the infinite range of the gravitational force between massive particles and the discovery of the infinite range of the electromagnetic force between charged particles, an additional rule has been added, i.e.

According to this statistical version of quantum theory all phenomena in the universe are governed 100% by random statistical processes. Many scientists have noticed that this does not agree with common every day experience. Einstein objected to this version of quantum theory with his famous quote "God doesn't play dice with the universe" and "God is subtle but he is not malicious," indicating his belief in an exactly engineered universe [19, vol. 6 p. 512].

For the reasons above and many other lesser reasons, some philosophers and scientists have been unhappy with current modern science based upon the quantum mechanical relativistic theory of the atom. Bergman [2] is one of the many scientists that have tried from time to time to correct these problems. He has replaced the simplistic "point particle model" with a realistic finite size toroidal "ring" model. His work has successfully shown that if the charges in the ring move at approximately the speed of light, then the electrical repulsion of the continuous charge in the ring is exactly balanced by the magnetic forces produced by the current in the ring. Bergman's ring model for elementary particles is the first published model for finite size elementary particles that appears to be stable kinematically.
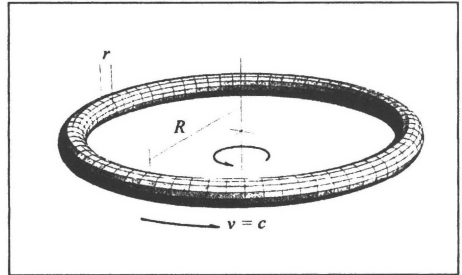

FIGURE 3
BERGMAN'S SPINNING RING MODEL
OF ELEMENTARY PARTICLE [2]

Standard texts on electrodynamics [21] show that continuous charge densities that move around rings do not radiate according to Ampere's and Faraday's Laws, because there is no variation in the radiation field due to the ring symmetry. Thus Bergman's ring model of elementary particles appears to allow the possibility of constructing a new atomic model with none of the problems identified above. The purpose of this work is to construct new physical models of the atom and nucleus based on Bergman's model for elementary particles.

Classical Explanation of Quantum Phenomena
Historically the theory of quantum physics was invented to explain three phenomena, i.e. black body radiation, the photoelectric effect, and the structure and energy levels of the atom. In the first part of this research based on Bergman's physical model of elementary particles, the structure of both the atom and the nucleus has been predicted using combinatorial geometry and electrodynamics. In this part the research is extended to explain the phenomena that are foundational to quantum theory.

Black Body Radiation
In 1901 Max Planck [22] was able to find a mathematical expression that fit the black body radiation data. His attempts to work backwards to find the correct physical theory resulted in the birth of quantum physics. However, this theory was never fully satisfactory. It was based on the notion that point charges undergoing simple harmonic motion in the black body were absorbing and emitting radiation. This picture led to oscillations of point electron charges that were too big to remain in the lattice of the solid. Also the empirical laws of electrodynamics were violated by this quantum theory. Both Ampere's Law and Faraday's Law require continuous emission and absorption of radiation for simple harmonic motion of point electric charges. Finally the quantum theory of black body radiation was not compatible with optical reflection, refraction, and diffraction phenomena due to its emission of radiation that is *discontinuous* in time.

The problem with Planck's work, which was to develop a proper scientific theory to predict his mathematical expressions that described black body radiation, was that he had an inadequate model for charged elementary particles in nature. He had the notion that elementary particles are point particles. This notion is still found today in quantum theories and in relativity theory.

Bergman's toroidal "ring" model of elementary particles behaves quite differently with absorption and emission of radiation than is the case for point particles. Radiation may be continuously absorbed by the ring structure. Since it is a ring structure, the laws of electrodynamics do not require it to re-radiate the energy absorbed[21, p. 370].

When electromagnetic energy or light is absorbed by the ring, there is a disturbance of the flow of charge around the ring, resulting in oscillations of the electric charge distribution which is flowing around the ring at the speed of light. These oscillations reflect the wavelength of the light being absorbed. The flow of charge around the ring may be thought of as the superposition of the original continuous flow plus the oscillations of charge resulting from the absorption of various lightwaves.(See Figure 4)

The original state of the ring, i.e. the continuous flow of charge around the ring, is known as a stationary state. No change can be detected over time. Additional stationary states of the ring structure will occur when the oscillations of the charge produced by the the absorption of radiation produce standing waves, i.e. the wavelength is exactly an integral number of circumferences of the ring, i.e. $n(2\pi r) = \lambda$ $n = 1,2,3,...$ or the circumference of the ring is exactly an integral number of wavelengths, i.e. $(2\pi r) = n\lambda$ $n = 1,2,3,...$

If the oscillations of the charge density in the ring do not form standing waves, the ring will quickly radiate the excess energy away. However, the ring may retain the radiation energy that forms standing waves until the ring is perturbed by some outside force. The laws of electrodynamics do not require it to emit any radiation. However, if the ring has a collision or significant interaction with another moving ring, an additional oscillation of the charge density may result making the ring unstable. The laws of electrodynamics now require the ring to radiate. At this point one makes the reasonable assumption that radiation from ring structures occurs primarily from one slightly perturbed stationary state to another stationary state.

From Bergman's paper [2, eq 7 and eq 35]

$$E_n = n\frac{e^2}{2\pi\epsilon_o cR}\log_e 8\frac{R}{r} = n\frac{hc}{\lambda} = nh\nu \quad (5)$$

and $n(2\pi R) = n\lambda$ the energy of the stationary states is

$$E = \frac{hc}{2\pi R} = \frac{hc}{2\pi\frac{\lambda}{2\pi n}} = nh\nu \quad where \quad \lambda\nu = c \quad (6)$$
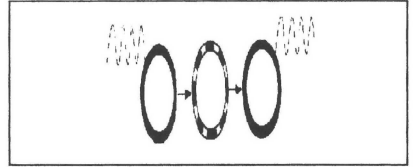

FIGURE 4
ABSORPTION AND EMISSION OF RADIATION BY RING ELECTRON

Although this result is mathematically identical to Planck's result, it is fundamentally different in the following ways:

1.   **It does not violate any known laws of electrodynamics.**

2.   **It does not use an unrealistic point-particle model for the electron, which undergoes simple harmonic motion.**

3.   **It does not require an amplitude of electron oscillation that is too large for the electron to remain in the atom.**

4.   **Simple harmonic motion of point charges is not the physical mechanism involved in blackbody radiation.**

Let us calculate $\rho_T(\lambda)$. i.e. the energy density ρ as a function of λ for a specific temperature T, under the assumption above that the radiation from the ring electrons only occurs from one stationary state to another stationary state. The first step is the evaluation of the average energy contained in each standing wave of wavelength λ or frequency $\nu = c/\lambda$. According to classical physics the particular energy of some wave can have any value from zero to infinity. The actual value is proportional to the square of its average amplitude, i.e.

$$\rho \propto \frac{E^2}{4\pi} \quad (7)$$

However, if we have a system containing a large number of identical ring electrons which are in thermal equilibrium with each other at a temperature **T**, the classical theory of statistical mechanics requires that the energies of the standing waves be distributed according to a definite probability distribution whose form is specified by **T**.

From the law of equipartition of energy the average kinetic energy ε of the standing wave in the rings is

$$\overline{\epsilon_{kE}} = \frac{kT}{2} \quad (8)$$

Where $k = 1.38 \times 10^{-16}$ erg/deg is Boltzmann's constant. For an electromagnetic wave where only the amplitude of the wave executes simple harmonic oscillations, the total average energy is just twice the average kinetic energy, i.e.

$$\overline{\epsilon} = kT = \sum_{n=0}^{\infty} nh\nu\, e^{\,nh\nu/kT} / \sum_{n=0}^{\infty} e^{\,nh\nu/kT} = \frac{h\nu}{e^{h\nu/kT} - 1} \quad (9)$$

Figure 4). For the same reason a ring electron can only emit radiation of such wavelengths as it has synchronous Fourier components in its current distribution[21,10]. In order for this to occur in the very short observed time frames, the electric and magnetic fields of individual ring electrons must interact with individual electromagnetic wave quanta.

Energy Levels of the Atom

When experimenters of the past examined the emitted spectra from hot solids and gases, they discovered that solids emit a continuous spectrum of electromagnetic radiation while gases emit radiation concentrated at a number of discrete wavelengths. Each of these wavelength components is called a line, because the spectroscopes used to record the spectra on film employed slits with a prism to separate the wavelengths of light or different colored images of the slit. (See Figure 8) These spectroscopes were only able to measure those wavelengths near the range of visible light.

Experimenters observed patterns in the spectroscopic lines of gases like hydrogen (See Figure 9). In these patterns or series of lines the spacing between adjacent lines of the spectrum continuously decreased with decreasing wavelength of the lines until it converged at some limit. A number of these
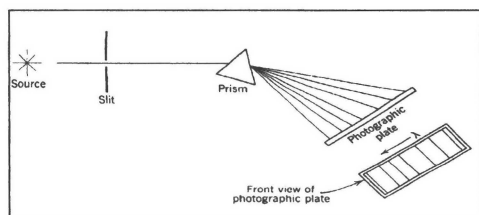

FIGURE 8
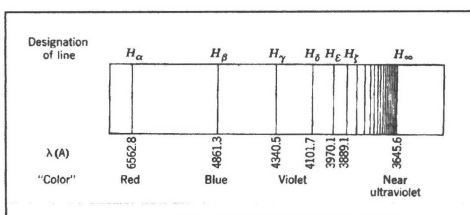APPARATUS FOR ATOMIC SPECTROSCOPY
[9, p. 111]

FIGURE 9
BALMER LINE SERIES FOR HYDROGEN
[9, p. 111]

series were found for hydrogen gas. About 1890 Rydberg[9, pp 112-113] found an empirical formula, called the Rydberg formula, that described these series of wavelengths as shown in Table 1.

TABLE 1
HYDROGEN SPECTRA LINE SERIES

NAME	WAVELENGTH RANGE (λ)	RYDBERG FORMULA
Lyman	Ultraviolet	$k = 1/\lambda = RH(1/(1)2 - 1/(n)2)$ n=2,3,4,...
Balmer	Visible	$k = 1/\lambda = RH(1/(2)2 - 1/(n)2)$ n=3,4,5,...
Paschen	Infrared	$k = 1/\lambda = RH(1/(3)2 - 1/(n)2)$ n=4,5,6,...
Brackett	Infrared	$k = 1/\lambda = RH(1/(4)2 - 1/(n)2)$ n=5,6,7,...
Pfund	Infrared	$k = 1/\lambda = RH(1/(5)2 - 1/(n)2)$ n=6,7,8,...

where $R_H = 109677.576 \pm 0.012$ cm^{-1} is the Rydberg constant.

FIGURE 10
STANDING WAVE PATTERNS OF
BOHR ORBITS [9, p. 152]

In 1913 Bohr developed his quantum model, called the Bohr model, to describe the atom and predict the atomic line series described so well by Rydberg's empirical formula. Bohr's model was based on the following postulates:[9, p. 114]

1. An electron in an atom moves in a circular orbit about the nucleus under the influence of the Coulomb attraction between the electron and the nucleus, and obeying the laws of classical mechanics.

2. But, instead of the infinity of orbits which would be possible in classical mechanics, it is only possible for an electron to move in an orbit for which its angular momentum L is an integral multiple of Planck's constant h divided by 2π, i.e. L = nh/2π

3. Despite the fact that it is constantly accelerating, an electron moving in such an allowed orbit does not radiate electromagnetic energy. Thus its total energy E remains constant.

4. Electromagnetic energy is emitted if an electron, initially moving in an orbit of total energy E_i, discontinuously changes its motion so that it moves in an orbit of total energy E_f. The frequency of the emitted radiation ν is equal to the quantity (E_i - E_f) divided by Planck's constant h, i.e. ν = (E_i - E_f)/h
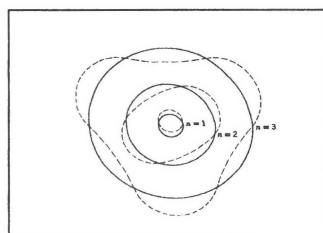
Bohr's postulates were very radical. They assumed that the electromagnetic Coulomb force law held on the microscopic scale, but not Ampere's law or Faraday's law. Thus the laws of physics were assumed to be different on the microscopic scale than on the macroscopic scale. Also Bohr neglected the finite size of the electron.

The justification for Bohr's postulates was that they led to a model that produced a mathematical equation that predicted the atomic emission line spectra of one-electron atoms. Logically, however, this type of justification is incomplete. One must also justify each of the assumptions or postulates individually. This was never done.

The success of the Bohr theory was very striking, but the Bohr postulates were somewhat mysterious. Also there was the question of the relation between Bohr's quantization of the angular momentum of an electron moving in a circular orbit and Planck's quantization of the total energy of an entity, such as an electron, executing simple harmonic motion since both incorporated Planck's constant **h**.

In 1916 Wilson and Sommerfeld[9, pp. 128-131] postulated a set of rules for the quantization of any physical system for which the coordinates are periodic functions of time as follows:

"For any physical system in which the coordinates are periodic functions of time, there exists a quantum condition of each coordinate. These quantum conditions are where q is one of the coordinates, p_q is the momentum associated with that coordinate, n_q is the quantum number which takes on integral values, and f means that the integration is taken over one period of the coordinate q.

$$n_q h = \oint p_q dq \qquad (19)$$

is one of the coordinates, p_q is the momentum associated with that coordinate, n_q is the quantum number which takes on integral values, and $\oint$ means that the integration is taken over one period of the coordinate q.

The application of the Wilson-Sommerfeld quantization rule to the coordinate θ where **q** = θ and **p_q** = **L** = **mr^{2}dθ/dt** yields

$$n_q h = \oint p_q dq = \oint L d\theta = L \oint d\theta = L \int_0^{2\pi} d\theta = 2\pi L \qquad (20)$$

or

$$L = \frac{nh}{2\pi} = n\hbar \qquad (21)$$

The application of the Wilson-Sommerfeld quantization rule to a particle of mass **m** executing simple harmonic motion with frequency ν yields

$$nh = \oint p dx = mx_o^2 \omega \pi = \frac{E}{\nu} \qquad i.e. \quad E = nh\nu \qquad (22)$$

Sommerfeld used the Wilson-Sommerfeld quantization rules to evaluate the size and shape of the allowed elliptical orbits as well as the total energy of the electron moving in such an orbit. Describing the motion in terms of the polar coordinates **r** and θ, he obtained the quantum conditions

$$\oint L d\theta = n_\theta h \quad \rightarrow \quad L = n_\theta h/2\pi \quad n_\theta = 1, 2, 3, \ldots \qquad (23)$$

$$\oint p_r dr = n_r h \quad \rightarrow \quad L(a/b - 1) = n_r h/2\pi \quad n_r = 0, 1, 2, 3, \ldots$$

By requiring a condition for mechanical stability, i.e. the centripetal force is equal to the electrical Coulomb force, a third equation is obtained. Solving them simultaneously he obtained

$$a = \frac{n^2 (h/2\pi)^2}{\mu Z e^2} \qquad n = n_\theta + n_r = 1, 2, 3, \ldots \qquad (24)$$
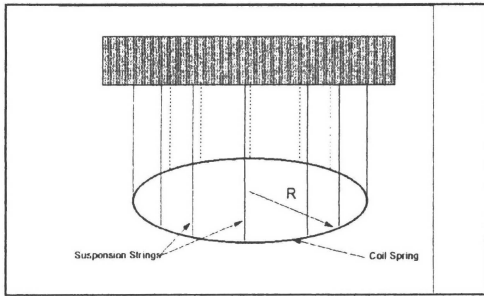
FIGURE 11
MECHANICAL MODEL OF A
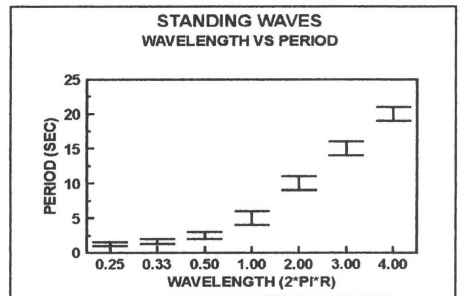TOROIDAL ELEMENTARY PARTICLE

FIGURE 12
EXPERIMENTAL STANDING WAVES
IN TOROIDAL RING

New Experiments on Standing Waves in a Ring

In order to learn more about standing waves in mechanical rings, a large metal spring 1.5" in diameter and 12" long (Slinky from James Industries, Inc. Beaver Street Extension Hollidaysburg, PA 16648) was obtained with the two ends fastened together to form a ring. The ring was suspended by 100 thin strings 19" long to form a "ring" with a diameter of 48" (See Figure 11). When the ring was perturbed to form standing waves, the very low energy standing waves had $\lambda = n(2\pi R)$ and the high energy standing waves had $\lambda = (2\pi R)/n$ where $R = 48"$ and $n = 1,2,3, ...$ and λ is the wavelength of the standing wave. (See Figure 12) When the blackbody radiation derivation was modified to take into account these additional standing waves or stationary states, no net contribution to blackbody radiation was found due to them.

New Classical Derivation of One Electron Atomic Energy Levels

The requirements that the new classical approach to the energy levels of the atom must satisfy are as follows:

1. Must be based on the proven laws of physics instead of arbitrary postulates.

2. Must maintain the fundamental laws of physics to be the same on all size scales.

3. Must conserve energy and momentum.

4. Must be consistent with de Broglie's postulate.

5. Must have stable equilibrium states in agreement with observation.

6. Must be consistent with the Wilson-Sommerfeld quantization rules for standing waves or stationary states.

7. Must give rise to a real wave equation describing the current density in the electron ring.

8. Must support the existence of observer-independent natural laws.

For a one-electron atom the equilibrium configuration is shown in Figure 13.

Assuming that the mass m of the electron ring is associated with the charge of the ring, the condition for the mechanical stability of the electron ring is from Newton's laws and electrodynamics

$$\frac{Ze^2}{R^2} = \frac{mv^2}{R} \qquad (33)$$

where v is the velocity of the charge in the ring, R is the radius of the ring, and e is the total charge of the ring.

Now the requirement that the waves associated with a particle undergoing any sort of periodic motion be a set of standing waves is equivalent to the requirement that the motion of the particle satisfy the Wilson-Sommerfeld quantization rules. The angular momentum in the plane of the ring for a free electron is given by Bergman[2,3]

$$L = m_e vr = mcR = e^2/8\pi^2\varepsilon_o c \ \log_e (8R/r) = \hbar/2 \qquad (34)$$

where $2\pi R = \lambda_o$ and $m_e = m_m = m/2$.

For the atom there are standing waves with two or more wavelengths around the circumference of the ring. In this case

$$2\pi R = n \lambda_o \quad n = 1, 2, 3, ... \qquad (35)$$

Also it is possible to have standing waves where the standing wave has a wavelength equal to multiple times the circumference of the ring. In this case

$$2\pi R = n\lambda_o \quad n = 1, 1/2, 1/3, ... \qquad (36)$$

Thus the most general case is

$$2\pi R = n\lambda_o \text{ where } n = ... \ 1/3, 1/2, 1, 2, 3 ... \quad L = n/\hbar \quad (37)$$

Equation (33) may be written

$$Ze^2 = mRv^2 = L^2/mR = n^2\hbar^2/mR \qquad (38)$$

So

$$R = n^2\hbar^2/mZe^2 \quad n = ...1/3, 1/2, 1, 2, 3 ... \qquad (39)$$

FIGURE 13
ONE ELECTRON ATOM CONFIGURATION
WITH ELECTRON RING AND NUCLEUS

Now consider the total energy of an atomic electron. If we define the potential energy to be zero when the electron is infinitely distant from the nucleus, then the potential energy V at any finite distance r can be obtained by integrating the energy imparted to the electron by the Coulomb force acting from ∞ to R, i.e.

$$V = \int_{\infty}^{R} Ze^2/r^2 \ dr = -Ze^2/R \qquad (40)$$

The potential energy is negative, because the Coulomb force is attractive.

The kinetic energy T of the electron can be evaluated from equation (33) to be

$$T = 1/2 \ mv^2 = Ze^2/2R \qquad (41)$$

The total energy E of the electron is then

$$E = T + V = -Ze^2/R + Ze^2/2R = -Ze^2/2R = -T \qquad (42)$$

From equation (39)

$$E = -mZ^2e^4/2\hbar^2 \ (1/n^2) \qquad (43)$$

From $\lambda v = c$ and $E = hv = 2\pi\hbar v = 2\pi\hbar c/\lambda$

$$1/\lambda = E/(hc) = mz^2e^4/(4\pi\hbar^3c)*(1/n)^2 = R_H Z^2(1/n)^2 \qquad (44)$$

where $R_H = me^4/(4\pi c\hbar^3) = 109681 \ cm^{-1}$

Note that the condition for standing waves in the ring leads to a quantization of the total energy of the electron bound to a nucleus of charge Ze.

EXPERIMENTAL CONFIRMATION OF NEW MODEL OF ATOM
When Rydberg analyzed the hydrogen emission spectrum to obtain his empirical formula in 1890, the line spectrum data was only available from the near ultraviolet, the visible and the infrared spectrum. This situation continued through the time that Bohr developed his model of the atom and Schroedinger and Dirac developed their wave equations.

Then in 1991 Labov and Bowyer[13] at the University of California at Berkeley devised a way to measure the extreme ultraviolet spectrum from 80-650 Å. They put a grazing incidence spectrometer on a sounding
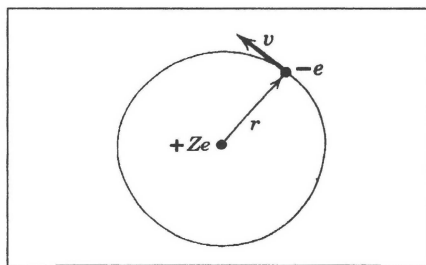
3. No obviously false assumptions
4. Allows the laws of mechanics and electrodynamics to hold on all size scales as always expected
5. Describes the physical mechanism for absorption and emission of electromagnetic energy
6. Eliminates the random chance statistical basis of quantum mechanics in favor of a logical cause and effect basis
7. Allows absolute reference frames for all physical phenomena
8. Allows physical laws to be observer-independent as always expected.

This approach, based on logic, leads to an electrodynamic description of the physical universe based upon the logical laws of cause and effect. It is compatible with the Biblical view of the universe created and sustained by God via electromagnetic means.

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