The Impact of the Predictions of the Heaston Equations on the 21st Century Physics Paradigm

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During the latter half of the 20th century scientists agreed that all phenomena could be explained by four fundamental forces: the gravitational, electromagnetic, weak and strong forces. Extensive efforts to unify these forces also agreed that the four forces converged on a superforce at the Planck scale. These attempts at unification, particularly quantum field theory, the standard model, and string theory, failed because they were flawed for three reasons. (1) The four fundamental forces were not all characterized as force laws. (2) There is no Planck scale theory since the Planck functions of length, mass, time and energy that make up the Planck scale are artificial units that Planck defined using dimensional analysis. (3) Moreover, the Planck constant is introduced via the back door in the quantum theory definition of the weak force. Whenever so many great scientists work so hard for so long and still do not succeed, it is time to redefine the problem. Consequently, the four fundamental forces have all been redefined as force laws: Newton gravitational force, Coulomb electromagnetic force, Planck quantum force and Einstein strong force. These four forces, referred to as *the Heaston equations*, may be derived in five different ways and result in several predictions and suggested experiments. The interactions of the redefined forces yield over 100 old and new functions of physics that provide a foundation for a 21st century physics paradigm.

Introduction

The thesis of this paper is "Something is still incomplete, misleading, or even wrong with the physics paradigm that we inherited from the 20th century." A brief look at the four primary assumptions of the 20th century physics paradigm offers a clue to what changes might be made.

1. The universe has a pre-existing objective structure, pattern, or design waiting to be discovered.
2. The goal of physics is to discover the structure of the universe in terms of rules, constants, principles, theories and laws that may be expressed in reproducible measurements, observations and mathematical expressions.
3. Energy is conserved.
4. All physical phenomena have been explained since the 1950s by one or more of the four fundamental forces: gravitational force, electromagnetic force, weak force and strong force.

Of course, there may have been other components of the 20th century physics paradigm, such as the Système International (SI) set of standard units, quantum theory, relativity theory, particle, atomic and molecular structures and specific measurement techniques. The primary four components listed above will suffice since my objective is to question the status of the four fundamental forces.

Open almost any introductory physics textbook published after 1950 and there will be a statement in its contents that all phenomena may be explained in terms of one or more of the four fundamental forces (interactions). For example, consider the textbook on **Contemporary College Physics** by Tilley [1], "The interactions of different chunks of matter arise from the interactions of the particles comprising that matter. Investigations of the interactions between particles such as electrons, protons, neutrons, and other 'elementary particles' . . . suggest that there are just four fundamental types of forces or interactions." These four forces with a few properties are listed in Fig. 1.

Much effort has been expended during the latter half of the 20th century to characterize and to unify two or more of the four forces. Moreover, extensive investigations were performed to explain these forces in terms of quantum mechanisms: quantum electrodynamics (QED), quantum chromodynamics (QCD, related to strong force), and quantum field theories (QFD). A valid theory for quantum-gravity or quantum-relativity is still on the to-do list. The unification of the electromagnetic and the weak forces into the electroweak force and the adaptation of the electroweak unification approach to include the strong force have become known as the *standard model*. The standard model was a major success story of the 20th century. Nevertheless, this model was never able to incorporate the gravitational force.

FOUR FUNDAMENTAL FORCES			
FORCE	**INTERACTION**	**MEDIATOR**	**YEAR**
F_G – Newton	**Gravitational**	**Graviton**	**1687**
F_e – Coulomb	**Electromagnetic**	**Photon**	**1785**
F_w – Fermi	**Weak**	**W^+, W^-, Z^0**	**1933**
F_c – Yukawa	**Strong**	**Mesons, Gluons**	**1935**

Fig. 1. The standard four fundamental forces of the 20th century physics paradigm.

If unification efforts starting with the electromagnetic, weak and strong forces could not embrace the gravitational force, then attention was focused on starting with the gravitational force and subsequent unification with other forces. A model called *string theory* (often *superstring theory*) [2] has been imminently successful

mathematically. String theory evolved as follows. Beginning with the Einstein four-dimensional field equations of general relativity that describe the gravitational force so well, a fifth dimension was added by Kaluza and improved by Klein to unify the gravitational and the electromagnetic forces. More dimensions were added to incorporate the weak and the strong forces. The result became known as string theory and then superstring theory. As the 20th century ended string theory appeared to exhibit a major potential to be a *theory of everything*. But, this potential is yet to be realized.

An assessment of the 20th century understanding of the four fundamental forces and attempts at their unification indicate a variety of anomalies. Only two of the four fundamental forces are defined as forces, force laws or in Newton units. Two of the forces (gravitational and electromagnetic) have infinite ranges whereas the other two (strong and weak) have ranges much less than a nanometer. All four forces are predicted to converge on a superforce at the Planck scale. Yet, the superforce has never been identified and the Planck scale is an artificial creation using dimensional analysis. The standard model predicts that the four forces converge at the Planck energy, but the Einstein general relativity theory has the gravitational force collapsing to a singularity. Unification has been defined based upon showing that the mediating bosons are members of the same family. In my opinion, unification of forces based upon quantum field theory principles of showing that the mediators of forces are members of the same family is like taking a bypass around a city and claiming to have been downtown. The standard model, which unifies the electromagnetic, weak and strong forces, requires 19 arbitrary constants. String theory, which supposedly unifies all four forces, has not predicted any measurable phenomena.

Historical Development of the Heaston Equations

In October 1975 I deliberately began a long range study of the characteristics of the four fundamental forces and efforts to unify two or more of the forces. I concluded after a few months work in early 1976 that the gravitational, electromagnetic, weak and strong forces were not at all similarly defined. The gravitational and the electromagnetic forces are definitely defined as forces, are measured in Newtons, and can be represented as force laws. The weak and the strong forces are neither forces, per se, nor have they been expressed as force laws, but represent phenomenological interactions characterized by experimental observations. Moreover, it appeared to me during the summer of 1976 that much of physics has been working on the wrong problem—the four fundamental forces should be redefined.

My primary assumption in approaching redefinition of the standard four fundamental forces was that much of physics must be retained unchanged, as well as being derivable from the new set of force laws. By 20 September 1976, I had redefined the four fundamental forces. I referred then to my redefinition as the *four-force model*. Nine days later, I mathematically described how my four-force model converged on a specific superforce, $F_S = c^4/G = 1.21x10^{44}$ N, embedded within the Einstein field equations of general relativity in the mass-energy tensor component. I launched my new approach to the fundamental forces on 8 October 1976 by submitting an abstract to give a slide presentation [3] on "Speculations on a Unified Model of the Four Fundamental Forces" at the 143rd National Meeting of the American Association for the Advancement of Science and the 53rd Annual Meeting of the AAAS Southwestern and Rocky Mountain Division in Denver, CO on 22 February 1977. Later in 1977, I gave a talk [4] on "The Evolution of the Concept of Force" at a seminar in the Physics Department of the University of Mississippi on 8 December 1977. An unknown graduate student first gave *the Heaston equations* and *the Heaston superforce* their names at this seminar. After this presentation I prepared a paper entitled "Unified Interaction Model of the Four Fundamental Forces" that was published in the first issue [5] of **Speculations in Science and Technology.**

The Heaston equations are displayed in Fig. 2. A static format is used for simplicity in explaining. The weak force has been dropped and replaced by the Planck quantum force. The Planck constant is an open addition in the form of a straight-forward force law instead of through the back door buried in the weak force. A new force law, the Einstein strong force, not only goes through the measured experimental data for the strong/color force, but also offers a means to engage the strong force in other interactions. As will be seen, the Heaston equations exhibit an intrinsic parallelism of definition, form, and simplicity.

THE HEASTON EQUATIONS			
FORCE	**INTERACTION**	**EQUATION**	**YEAR**
Newton	**Gravitational**	$F_G = m^2G/r^2$	**1687**
Coulomb	**Electromagnetic**	$F_e = e^2/4\pi\varepsilon_0 r^2$	**1785**
Planck	**Quantum**	$F_h = hc/2\pi r^2$	**1978**
Einstein	**Strong**	$F_c = mc^2/r$	**1978**

Fig 2. Redefinition of the four fundamental forces and replacement by the Heaston Equations

The Heaston equations may be derived five different ways. Brief comments will be made on each derivation approach and references will be made to prior presentation at *Natural Philosophy Alliance (NPA)* conferences

Dimensional: The dimensional analysis approach to interpreting experimental data was a standard approach that was taught in my chemical engineering curricula. I first "derived" the Heaston equations in 1976 by starting with the assumption that the familiar Einstein $E = mc^2$ and the Planck $E = h\omega/2\pi$ energy relationships actually represent the potential energies of fundamental forces. I combined the two resulting forces with the gravitational and the electromagnetic forces to create the *Heaston equations*.

Mathematical: I presented a talk [6] on the "Redefinition of the Four Fundamental Forces" at the annual **Army Science Conference** held at the US Military Academy at West Point, NY in June 1980. Someone in the audience stated, "I will not believe in your forces until you show me that they can be derived from potentials." During the next two weeks I read many articles on force potentials and potential energies. On 27 June 1980 I

discovered a new mathematical definition of the concept of force. It then took two years of work to derive several different forces (Newton, Huygens, Hooke, Fourier, Fick, Gilbert, Coulomb, Planck and Einstein forces) using the same model which I called the *generic field theory*. I first published my approach in **Speculations in Science and Technology** [7] in 1983 and in the **12th NPA Conference Proceedings** [8] in 2005.

Geometrical:: On 20 May 1981 I was having dinner in Havre de Grace, MD the evening before visiting the Ballistics Research Laboratory in Aberdeen, MD. I was working on some derivations of forces. I had no paper, so I turned over my paper place mat and started scribbling. Then, I needed a straight edge to plot something, but I did not have one. An idea occurred to me that it possible to fold a piece of paper ala the Japanese art of origami so that the boundaries, the creases from the folds and the intersection of the creases correspond to mathematical relationships that define the Heaston equations and over 100 functions of physics. I gave a talk [9] on "Origami and the Design of the Universe" at a meeting of Sigma Xi at Argonne National Laboratory on 3 April 1996 and later at the 13th NPA Conference [10] in 2006.

Spectral: From 1993 to 2001, I was a member of the Board of Army Science and Technology of the National Academies. While attending a meeting of this board on 11 March 1998, a briefing about the frequencies used in Army plans for the future immediately suggested to me a discrete structure for the electromagnetic spectrum (EMS). One of the major predictions of the Heaston equations is that the interactions of the Coulomb electromagnetic force and the Planck quantum force describes a discrete structure for the EMS that can be extended at both ends to form a universal spectrum that spans the universe from the Planck scale to the edge of space. The Planck and Einstein forces, as well as the electromagnetic spectrum, can be derived starting with the Coulomb electromagnetic force, the classical radius, Compton length and the Bohr length. I wrote a paper "Electromagnetic Spectrum" [11] that was published in the **GACIAC Newsletter** published by the Guidance Control Information Analysis Center, operated by IIT Research Institute under contract to the US ARMY. I also talked about a "Description of the Overall Electromagnetic Spectrum in Terms of Discrete Theoretical Bands" at the 12th Annual NPA [12] in 2005.

Gravitational: The gravitational approach to deriving the Heaston equations grew out of a discussion that continued over three years with Dr. Cynthia Kolb Whitney, editor of **Galilean Electrodynamics**, about publishing an article on "Why is Gravity Hard to Unify with Other Forces" [13]. Her constructive comments triggered the idea in the fall of 2002 for the gravitational superforce hypothesis: "The gravitational force is always equal to a finite superforce at the mass-energy equivalence of the gravitational potential energy." This hypothesis can be used with the Planck length and the electromagnetic force to derive the Heaston equations. A paper on this hypothesis was presented [14] at the 10th Annual NPA Conference in 2003. My hypothesis later turned out to break the code on understanding how Einstein derived his field equations of general relativity [15].

The five different approaches described above related to deriving the Heaston equations depend upon how the four fundamental constants (universal gravitational constant G; speed of light c; charge on the electron e; and the Planck constant h/π) are introduced into the process.

Discussion of the Heaston Equations

Experience in working with the Heaston equations reveals nine distinct zones of interactions that hopefully provide a hint at the complexity of the universe that is concentrated in just four equations. These zones are illustrated by Fig. 3 where the nine zones are enclosed by overlapping domains. A name is given to each zone based upon its primary characteristic. There is some overlap between discussions of the zones and the five approaches to deriving the Heaston equations just described that necessitate using some of the same references.

Fig. 3 is a log force versus log distance plot that is actually to scale for some arbitrary mass determined solely by the separation of points K and P at the top of the figure. The redefined four fundamental forces that are called the Heaston equations are indicated by the four thick lines sloping downward from left to right: Newton gravitational force, Einstein strong force, Coulomb electromagnetic force and Planck quantum force. Three of the forces are inverse square and the Einstein strong force is inverse linear. The large black dots are each named and represent significant intersections of the four forces. Vertical dotted lines correspond to important lengths. Horizontal lines are specific derived forces that are meaningful. The zones are briefly discussed below with references to sources for more details. The discussion of each zone ends with a question or two that suggest issues that need to be answered or possible experiments to test specific predictions of the Heaston equations.

Heaston Equations Zone. Zone 1 is the small horizontal ellipse between the two larger ones in Fig. 3. This zone is limited to discussing the Newton gravitational force, Coulomb electromagnetic force, Planck quantum force and the Einstein strong force together as a set or group. The dimensional, mathematical and geometrical derivations mentioned above mostly emphasize Zone 1. This zone could be located any place up and down the four forces, but is situated in Fig. 3 for artistic convenience. Discussed Zone 1 at 12th NPA in 2005 [8, 16] and 13th NPA in 2006 [9].

Does the Einstein strong force correspond with the strong-color force? Is the Planck quantum force the mechanism behind the Casimir effect? What is the significance of defining the Planck force as a rotational force versus a translational force? How could the Heaston equations be used to predict the weak force? Can the mathematical model called "the generic field theory" be used to theoretically define other forces?

Superforce Zone. Zone 2 is at the top of Fig. 3. This zone fulfills predictions of string theory, the Standard model and the Einstein field equations of general relativity. The standard four fundamental forces have been predicted [17] for a long time to converge on an unspecified superforce at the Planck scale. Zone 2 in Fig. 3 is where the Heaston equations converge upon a specific Heaston superforce with a magnitude of $1.21x10^{44}$N, the maximum possible force noted by the dashed line at the top of Fig. 3. The Planck energy occurs at the Planck point P in Fig. 3. An observation from Fig. 3 of great significance is that different forces converge on a common superforce but the convergences may occur at different energy levels. The standard model predicts convergence of the electroweak, strong and gravitational forces on the Planck scale at a superforce, but plots and thinking are

based upon the Planck energy as a single level of convergence. The gravitational force will converge on the Planck force and the Planck scale at point P and the Planck mass (energy). This statement may be validated by simply substituting the Planck mass and the Planck length into the Newton gravitational force.

The electromagnetic force is not a function of mass and cannot converge on the Planck force and Planck scale point P unless a prohibitively large charge is assumed. Consequently, the electromagnetic force terminates at the superforce at the Coulomb point K at a specific Coulomb length and a hypothetical Coulomb mass when the gravitational force is equal to the electromagnetic force. Point K has its own Coulomb scale (Coulomb length, Coulomb time and Coulomb mass) in parallel with the Planck scale.

The Heaston point S at the top left in Fig. 3 is the terminus of the Newton gravitational force and the Einstein strong force at the Heaston collapse length r_S. The mass m_S at point *S* is equal to E/c^2, just as Einstein requires for deriving the equations for the bending of light [18]. To the left of point *S* and r_S, the Heaston equations predict that all matter has collapsed to energy with a constant gravitation potential $\Phi = c^2$, the Heaston-Marquardt constant potential [19] of light and energy. Many of the predictions of the Heaston equations in Zone 2 are consistent with predictions of the Einstein field equations when geometrized units are not used [15]. Discussed Zone 2 at 10th NPA in 2003 [14], 13th NPA in 2006 [19], 14th NPA in 2007 [15], and 15th NPA in 2008 [20].

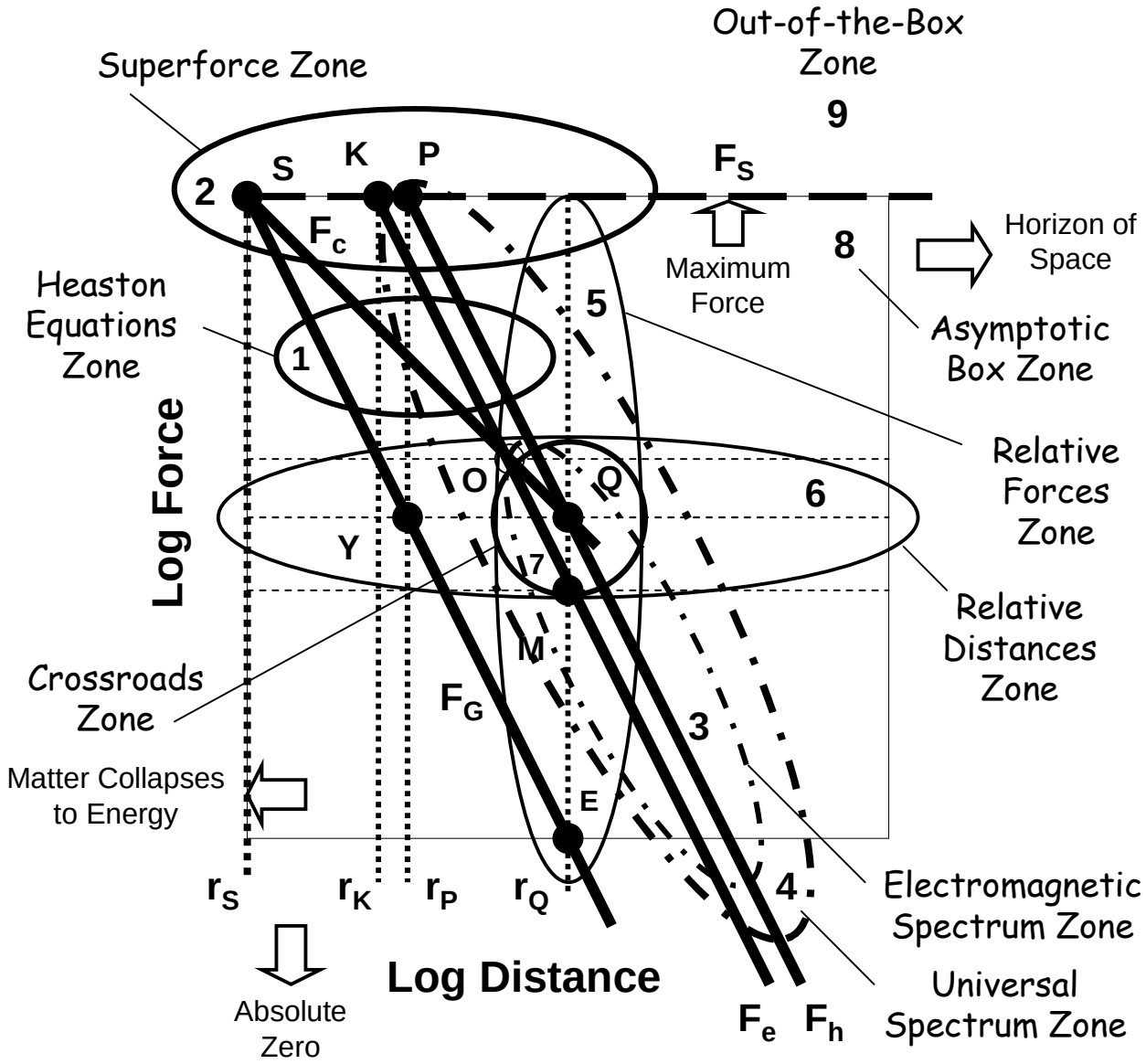

Fig. 3. Zones of interaction of the Heaston Equations.

What is the role of the Coulomb scale, if any? Does matter collapse to energy rather than to a singularity? Does light/energy have a constant gravitation potential? Is the superforce released in atomic/nuclear explosions?

Electromagnetic Spectrum Zone. Zone 3 is the smaller ellipse inside of the bigger ellipse overlaying the Coulomb electromagnetic force and the Planck quantum force in Fig. 3. The electromagnetic spectrum (referred to hereafter as EMS) begins at point Q, the quantum point and continues diagonally downward. The Compton length, which is the vertical line through points Q and M (Maxwell point), is the key to defining the EMS. Stair steps downward beginning at the Compton length may be drawn between the Coulomb force and the Planck force. These stair steps represent a series of Planck-Coulomb bands where pairs of bands remarkably define the gamma ray, x-ray, ultraviolet, infrared, millimeter wave, and microwave spectral bands. The relative bandwidths are a series function of the square root of the inverse of the fine structure constant. The low frequency and long wavelength end of the EMS at the bottom of Zone 3 matches with micropulsation bands. The second Planck-Coulomb band down (to the right) of point Q designates the Bohr length, or minimum Bohr orbit. It is suggested that four bands down from the Compton length represents a maximum Bohr orbit, or maximum atomic orbit. The spectral derivation of the Heaston equations can be accomplished in this zone. Discussed Zone 3 at 12th NPA in 2005 [12].

Does the electromagnetic spectrum have a discrete structure instead of being continuous as currently believed? Could the theoretical maximum atomic orbit be detected?

Universal Spectrum. Zone 4 is the large ellipse surrounding the EMS in Zone 3. It is possible to theoretically stretch the EMS at both ends to create a *universal spectrum* that extends from the Planck scale at point P to the edge of the universe. The resulting universal spectrum is composed of three components. The *high energy spectrum* covers 21 Planck-Coulomb bands from point P to point Q in Fig. 3. The mid section of the universal spectrum is the EMS, which consists of 19 Planck-Coulomb bands beginning at point Q and filling most of Zone 3. The lower end of the universal spectrum with 17 Planck-Coulomb bands is called the *micropulsation spectrum*. The universal spectrum contains 57 Planck-Coulomb bands that stretch over 61 orders-of-magnitude. The node at band 57 corresponds to $13.7x10^9$ years. The first five Planck-Coulomb bands at the low end of the high energy spectrum contain cosmic rays and all particle masses when indicated as de Broglie wavelengths. Discussed Zone 4 at 12th NPA in 2005 [12].

How could the universal spectrum help to explain the hierarchy problem? Can the predicted new micropulsation bands be observed?

Relative Forces Zone. Zone 5 is the long vertical ellipse in the middle of Fig. 3 around the Compton length. Different relationships of relative force magnitudes, such as coupling constants, occur in this zone. The gravitational force coupling constant is the force through point E divided by the Yukawa force at point Q (and point Y). The Eddington number may be defined by the relative magnitude of the superforce to the magnitude of the gravitational force (the Eddington force) at the Compton length at point E (the Eddington point). The Eddington number is 10^{80} for a particle mass less than the proton. Fortuitously, perhaps, there were 10^{80} protons and electrons in the universe before dark matter, dark energy and other issues arose. Several so-called cosmic numbers are predicted in this zone. Discussed Zone 5 at 13th NPA in 2006 [21].

How many different ways can the Eddington number be defined using relative forces in Fig. 3?

Relative Distances Zone. Zone 6 is the large horizontal ellipse that wraps around point Q. Very many distances (vertical lines) are predicted by the EMS and the universal spectrum. The equations for the distances plus relationships from Zone 5 may be used to give a physical explanation for the Dirac large number hypothesis, many number coincidences and several anthropic cosmological numbers. Discussed Zone 6 at 13th NPA in 2006 [21].

Crossroads of Physics Zone. Zone 7 is defined as the circle around the quantum point Q, which has a radius out to point O the Weyl point. The Weyl point is the classical radius of the electron. Most micro-phenomena due to particles and atoms interacting occur in this zone. The EMS begins at point Q. The potential well is found here because of the interactions of the Einstein force and the Coulomb force. An interesting symmetry exists at point Q. Note the parallelogram SPQY in Fig. 3 where the gravitational force at the Planck length at the Yukawa point Y is equal to the strong force at the intersection of the Einstein strong force with the Planck quantum force at point Q and the Compton length. The experimental data for the strong-color force [22] goes through point Q. As particle mass increases, the loci of all point Qs define the Planck force all the way to the Planck point. In other words, the Compton length of the Planck mass is the Planck length. During these changes in point Q, the loci of point Ss remain at the superforce and moves right to point P. Perhaps the resolution of quantum-gravity lies at point Q rather than point P. Discussed Zone 7 at 11th NPA in 2004 [23], 12th NPA in 2005 [24] and 15th NPA in 2008 [25].

Does the coupling of relativistic translation with quantized rotation at point Q resolve the quantum-relativity question?

Asymptotic Box Zone. Zone 8 implies that the universe is bounded. At least six limits, thresholds, or asymptotes suggest the metaphor that the universe is an asymptotic box. An asymptote is a limit that can be approached ever so close, but once equaled or crossed, then there is no returning. The six limits suggested by Fig. 3 are the superforce (top), absolute zero (bottom), speed of light (right), collapse to energy (left), birth (front) and death (back). Some other related limits are conservation of energy (adiabatic wall), failure of the laws of physics and the Planck scale. Discussed Zone 8 at 10th NPA in 2003 [26].

Is the universe a closed system?

Out-of-the-Box Zone. Zone 9 is essentially a threshold where the laws of physics fail. Mathematical physicists have done a lot of speculation that is beyond any capability to ever perform an experiment or observation (directly or indirectly) within current understanding to validate any aspect of their speculations. Anything converging on infinity as an asymptote such as a singularity, other universes, membrane theory and its variations, time-travel, worm-holes, or tachyons are all out-of-the-box. Only three approaches can freely move in and out of the box: mathematics, imagination and the supernatural. By definition, the supernatural thrives outside of the natural asymptotic box. Discussed Zone 9 at 10th NPA in 2003 [26].

But, Popper [27] states that no theory can ever be proven, so, are the laws of all physics paradigms meaningless? Is anti-matter in or out of the box? Are negative values of the Heaston equations meaningful?

Conclusions

Redefinition of the four fundamental forces of the 20th century physics paradigm has resolved a number of anomalies, has offered new explanations of phenomena and has introduced an unexpected simplicity into understanding the structure of nature. The Heaston equations have all been defined in a similar manner as force laws. The Planck scale now has a logical, physical and mathematical justification for its existence. The Planck constant then has a readily visible presence in a force law.

The four redefined fundamental forces, referred to as the Heaston equations, may represent the highest degree of scientific information compression of any specific set of equations. The macroscopically large and the microscopically small are both included. The Heaston equations, not only repackage much of what is known in physics, but also provide major revelations of the structure of physics and the universe. Discoveries and contributions include:

- Three new forces;
- A new mathematical definition of the concept of force;
- A discrete structure of the electromagnetic spectrum and its extension at both ends;
- Explanations of many number coincidences;
- Unexpected interactions of matter, energy and motion;
- A different perspective of quantum-relativity;
- Suggestions for conducting a number of experiments, observations and derivations;
- Concepts that impact upon special relativity, general relativity, big bang, inflation, black hole and string theories.
- Consequences that are logically consistent, mathematically reproducible, experimentally testable, and comply with Ockham's razor.

The universe now appears to be a beautiful, complex, interdependent network of physical relationships. The Heaston equations offer a new agenda for the conduct of physics during the 21st century.

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