

Reflections on a Variational Principle in Space, Gravity and Light

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Abstract

This paper argues for revisions in notions of space and gravity toward unifying physics with solutions for the wave/particle duality, dark matter, and the cosmological constant. The argument proceeds conceptually by taking up symmetry, space, gravity, waveform and spectral light. A variational principle emerges that is capable of generating salient physical phenomena on all scales of the universe. Both specific predictions and a suggestion for deriving characteristics of light from other conditions result. Besides the philosophical importance of these issues, there are additional motivations for airing these considerations. First, it promotes greater flexibility in physical theorizing at a time when alternative theories and their formalisms as well as new data from highly rigorous sources such as the Hubble orbiting telescope are both rapidly increasing. Second, it promotes a decoupling of physical and especially cosmological theory from theological dogma at a time when international pressures induce hardening of particular theological positions across all major monotheistic religions. It seems appropriate for philosophy to assist in distinguishing the pressure for discovery and innovation in science from the pressure for certainty and hegemony in religion.

I. Symmetry.

The analysis begins by examining the concept of symmetry in cosmology and quantum physics. The cosmological use of symmetry is illustrated by Smoot and Davidson when they write that “the primordial universe was extremely hot and dense. The forces were united in a single, symmetric force—a primal force” (167). If the primal force were symmetric, then how would it change into an explosive expansion? Where in the symmetry would there be any cause to change state? If the initial condition was a physical “equilibrium” in which “reactions flow readily in both directions” (112), where did the directionality of the expanding universe come from?

Explaining inflation theory, Smoot and Davidson perform the same illogic:

...all the potential mass and radiation of our part of the universe was subsumed in a primal soup of energy...everything was connected to and equivalent to everything else—a primal homogeneity. Then our part of the universe experienced an incomprehensibly rapid eruption of space.... (180)

However, there is no matter-anti-matter reaction; there are no opposing charges for repulsion; there is no fission or fusion because there are no atoms or molecules; there are no quantum effects because there are no waves or particles. How would anything get the force to move away from anything else? Additionally, the word "Then" implies that there was time; but if there was no space how could there have been time?

In discussing the connection of "the spontaneous violation of time symmetry" with that of "the symmetry between matter and antimatter" (195-196), Murray Gell-Mann shows that the Standard Model, as well as cosmological theory, depends on a symmetrical initial condition: "The very early universe was symmetrical between matter and antimatter, but soon produced the present asymmetrical situation through the same effect that produces spontaneous violation of time symmetry" (196). The absence of any known process or "mechanism" by which the symmetry could transform into an expanding asymmetry makes both the Standard Model and current cosmology incapable of "explaining the arrow (or arrows) of time—the...differences that we...observe between events moving forward in time and the...reversed version of those events" (Gell-Mann 195). There is no change from symmetry to asymmetry without a difference or an asymmetry being in the symmetry. But since the initial symmetry is all there is, (cosmo)logically speaking, the universe is frozen there.

## II. Another Story.

In our Judeo-Christian traditions it is fairly easy to accept the universe of big bang cosmology. Space and time came into being with the universe so it makes no sense to ask where or when the original event occurred, or what there was and where it was before it occurred. It is not a surprise that the one birth-one life-one death-one eternity dogma of Western religion would be echoed in the one universe-one beginning-one end view of its most powerful science. Or, that the religion that banned reincarnation to heterodoxy early in its formative period would lie in the same cultural bed as a science whose view of the physical universe supports the one birth-one life-one death-one eternity story. Finally, it is certainly of interest that the man who first brought the big bang into the technical terms of astrophysics, George Lemaitre, was a French astrophysicist who was also a Catholic priest:

In January 1933, both Lemaitre and Einstein traveled to California for a series of seminars. After the Belgian detailed his theory, Einstein stood up applauded, and said, "This is the most beautiful and satisfactory explanation of creation to which I have ever listened." The very word 'religion' is a study in locating the first cause, namely The Creator. At this ubiquitous moment of time, the dogma of science and religion intersect. (<http://www.searchet.com/lemaitre.html>)

Another story could be more useful. Related by Heinrich Zimmer (3-11), it tells the events just after Indra slew the titan dragon that was hoarding the waters of life and then sent the titans into retreat so that life could begin again. Indra decides to have the most splendid residence ever built made in his honor by the divine craftsman, Vishvakarman. Indra's desires for grandeur become insatiable and Vishvakarman, exhausted and in despair, appeals to the highest powers for help. His plea is answered by

Brahma and Vishnu in the form of a young boy who comes to Indra's palace. The holy mien of the child wins him an invitation to sit with Indra. The boy tells Indra:

...I have known the dreadful dissolution of the universe, I have seen all perish, again and again, at the end of every cycle...[when]...every single atom dissolves into the primal, pure waters of eternity, whence originally all arose. Everything then goes back into the fathomless, wild infinity of the ocean, which is covered with utter darkness and is empty of every sign of animate being. [W]ho will count the universes that have passed away, or the creations that have risen afresh, again and again, from the formless abyss of the vast waters? Who will number the passing ages of the world, as they follow each other endlessly? And who will search through the wide infinities of space to count the universes side by side, each containing its Brahma, its Vishnu, and its Shiva?

Conceptual elements can be abstracted from this myth: 1. There are multiple universes linearly through time and laterally through space; 2. There is no absolute end to either dimension so there can be only relative beginnings and endings; 3. The lateral universes exist simultaneously; 4. The uniqueness of universes is not a requirement; 5. Symmetry or asymmetry is not needed as an initial condition in the creation of any universe.

The big bang cosmology can be taken as a phase of the above cosmology—one universe being born. Beyond that is the death of our universe as well as the coming and going of innumerable other universes, none of which need be exactly like ours. The rhythm of creation and destruction does not require symmetry as an initial condition of the beginning of our universe. Indeed, any religion with a theology that posits a unitary, symmetrical, undifferentiated first cause must be limited by the articulation of a principle of variation that does not favor metaphysical priority structures with physical interpretations as singular, homogenous first causes, or, monoontic projects (Cornberg). This point can be made from the “many worlds” interpretation of quantum mechanics as well (Gell-Mann 138, 150; Albert 113-15). Since no one has shown that there are not such universes, it remains “conceivable that there is a large set of inequivalent maximal quasiclassical domains, of which the familiar one is just a single example” (Gell-Mann 163).

### III. Space.

In astrophysics, special and general relativity regard space as spacetime and as a property of the gravitational field. However, theorizing in astrophysics often treats space as an independent container, or vacuum, in which events happen. In terrestrial physics, space is less of a container than a medium that, along with the atmosphere, allows certain kinds of propagation to occur. In quantum mechanics (QED), space is a vacuum with characteristics governed by basic principles such as Heisenberg's indeterminacy (Setterfield 5, 11; www.dao; Peebles 68-70).

Cosmologists deepen the aporia with the adjectives “curved” and “flat”, from an analogy with a one-dimensional plane. But there is no observation that shows a flat, transparent plane upon which bodies move. There is also no observation that shows a flat

surface curved around large masses in the "rubber sheet" image of "curved space," (Smoot and Davidson 35).

The idea of space in cosmology is further blurred by the insistence that "the big bang did not move *into* existing space; it created space as it expanded (and continues to do so)" (Smoot and Davidson 8, italics in original). If so, space was created either by matter or by something else. If by matter, then either all of space was created at the beginning or space is still being created. In either event, there should be observations showing that space was created or is being created by matter. If it was created by matter then matter existed prior to space. But matter without space is inconceivable and unobservable. Finally, if it was created by matter then some change had to take place in matter for it to create space. But if matter were spaceless then there would have been no source in matter to create space. If space was created by something other than matter then another creative principle is needed. If space is being created by matter, then there should be observations that show it. In the absence of such observations, this argument leads, first, to Einsteinian spacetime and, second, to a new idea of space.

We can come to the new idea by considering an image used to illustrate an expanding universe as a balloon with dots on it. The surface of the balloon is space expanding and the dots are universes that move away from each other and farther from the center of the balloon as the balloon fills (Smoot and Davidson 52). The center of the balloon is the beginning of the universe. But if expanding space implies "stretching" of space (Smoot and Davidson 57-8) and if space has been stretching with matter from the beginning, then how has matter compressed into solid bodies? Positing expansion first makes compression logically inconceivable as positing compression first would make expansion inconceivable.

The remarkable thing about space is that enormous things float in it. We could analogize its property with that of water as buoyancy. But when something else comes along, the floating can become directional so that orbits are established. To change its property of buoyancy, space must be connected in some way to matter. In a compression view of the formation of bodies, such as stars and planets, and a compression view of structures such as galaxies, space must change from buoyant to *slippery*. In the buoyant condition, position is difficult to predict; in the dense and slippery condition, position is easy to predict. However, buoyancy and slippery are both conditions of space in relation to mass or matter.

We can conceptualize buoyant and slippery space as an n-dimensional surface. It aligns in all directions simultaneously—it is isotropic. When an object passes through it, space aligns toward the heaviest part of the object. The larger and denser the object, the more likely it is that nearby objects will move toward it along the alignment of space. Nearer objects may prevent further objects from reaching the center of heaviest alignment as planets create alignments that counteract the sun's alignments and contribute to orbital stability.

Matter works on space as general relativity tells us: space is made dense and slippery by compression with the result that regular orbits are established and maintained. Compression creates a directional lens, a "gravitational lens" (Smoot and Davidson 35-36), which carries everything, even light near large bodies, toward the center of compression. However, Einstein's prediction of the deflection of starlight was accurate (www.upscale) but the explanation was not. Space does not curve (or warp). It aligns,

compresses and changes from buoyant to slippery. The compression around massive objects creates gravitational lenses. Also, the fact that a cesium atomic clock has a lower frequency in the upper earth atmosphere than at the surface of the earth ([www.einstein...gpa & gpa1](http://www.einstein.gpa&gpa1)), can also be explained by the stronger alignment of space closer to the center of gravitational mass. Since space is more strongly and uniformly aligned near the surface, the cesium emissions would be slowed by the energy required to realign enough of space to allow their propagation. This explanation, which although physical still conforms with the mathematical predictions of special and general relativity, predicts that if the cesium emissions could be accelerated at the surface, their frequency could be increased to match the frequency of emissions in the upper atmosphere.

Compressed, dense space may also be the missing mass—the so-called “dark matter”—in galaxies needed to account for orbital periods that cannot be accounted for by visible matter. The search for MACHOs and WIMPs (Naeye 38-9) can then be seen as an extension of the particle or “image point” (Jammer 263) conception that has motivated the search for gravitons.

#### IV. Gravity

The lack of unity in physics also appears in differing treatments of gravity. Quantum mechanics posits a field and a particle for every fundamental force in nature, hence the hypothesis of the Higgs boson (Gell-Mann 193-6) and the search for the graviton. General relativity posits the equivalence of spacetime and the gravitational potential field. According to Einstein, “Spacetime does not claim existence on its own but only as a structural quality of the [gravitational] field” (155). General relativity also posits the equivalence of inertial and gravitational force so gravity becomes a wave propagated through space like electromagnetism. Since a wave conventionally involves a particle, the graviton receives theoretical support from general relativity.

Eddington's 1919 experiment ([www.astro](http://www.astro)) is difficult to interpret in a reasonable way as the result of either a particle or a propagated wave. If there were a graviton one would expect a photon of starlight to be perturbed in some way by gravitons rather than having its trajectory bent uniformly toward the center of the gravitons' source. If there were a gravity wave then it would need a feature that pulled, pushed or drew the photon inward, such as a reverse curl or backwash of some kind. It seems safe to assert that gravitational force does not bend light rays.

The explanation of displacement of light-source location, whether star or quasar, as a gravitational lens in a gravitational potential field certainly improves on the rubber sheet analogy. Spacetime localized, that is, compressed by a massive body, such as the sun, can be visualized as becoming denser around the body. In gravitational redshift, to pass through the increased denseness, a light ray contracts in height thus lengthening its frequency until it passes out of the lens.

Two questions arise here with respect to spacetime and light. First, How does spacetime condense, compress, or become lenslike?; and, second, How does spacetime interact with the light ray as it leaves the lens so that the light ray not only returns to normal shape but does not exceed its previous speed? The second question can be understood as a focus on boundary conditions. If the lens is a local phenomenon, then

there must be some kind of transition between it and non-lenslike spacetime. If the light ray passes into and out of the lens, then it must pass through two transitions. How the light ray maintains its integrity through the transitions and, especially, how it regains normal frequency with no increase or decrease in speed after the second transition are certainly interesting questions. This issue of transition between different forms of energy can also be illustrated in terms of the general relativity tensor formalism:

Einsteinian gravitational forces are defined as the curvature of space-time. But, this curvature in 4-dimensional space-time is specified by 20 distinct terms. Only 10 of these are defined by the local distribution of matter, which is mathematically found by solving Einstein's equation of gravity. The other 10 terms in the full 'Riemann Curvature' tensor define how the space-time outside the massive body responds to the presence of the mass, and define a 'source-free' solution for gravity. (www.einstein, Gravity Probe B)

The term of key philosophical interest in this statement is “outside.” In a physical interpretation, source-free, spacetime gravitation exists, in some sense, separate from the massive body. A light ray approaching the massive body, from the sun, for example, must therefore experience two kinds of gravitation—the gravitational potential field, or spacetime curvature, and the gravitational force of the massive body. Light must somehow negotiate these transitions and multiple boundaries without a decrease in velocity.

We may summarize the analysis to this point. Gravitational force and inertial force result from matter compressed within dense and slippery space. Things moving on the periphery of a large body or system enter the gravitational force field and gain motion aligned toward the center of compression. Things already in the field or on an established body, such as rocks on the earth, move without additional force only toward the center of compression. The alignment field intensifies the closer to the center of compression a body approaches: gravitational force is a stepwise compression with force proportional to density. The structural process of compression is a layered spiral wave. Layered radiantly and tangentially, it spirals by continually pulling around a rotating mass that creates capture pathways in the structure of space. It is a wave as an oscillation in magnitude across small ranges of value whose stepwiseness may be seen as oscillating layers of force.

This model yields the following predictions:

1. Gravity Probe B should show twisting, or, frame-dragging of spacetime. (<http://einstein.stanford.edu/>; Taubes 63-5)
2. There is no graviton.
3. Freely falling bodies tend to have spiral paths (Feyerabend 7-75).
4. Edges of gravity steps oscillate, i.e. vary rhythmically.
5. Unforced growth of matter/energy shows characteristics of the gravitational field, i.e. layering, spiraling, and oscillating.
6. Infinities in the theory may be understood and treated as recursive oscillations. (That is, a. The physical universe is infinite in the sense that there is no end to the physical

process of variation, and, b. Variation is something that the universe does to itself, which involves recursion, feedback and emergence as the conditions necessary for self-similar order, complexity and chaos across all scales of the universe.)

7. The speed of light varies in frequency and velocity. (See Section VI, below.)

A complete account of gravity must also be able to explain how gravity operates in the microworld.

## V. Waveform.

The standard view of the incompatibility of general relativity and quantum mechanics can be simply stated:

In 'Classical' general relativity...gravitational fields are continuous entities in nature. In quantum mechanics, fields are discontinuous and are defined by 'quanta'. There is no analog in conventional quantum mechanics for the gravitational field, even though the other three fundamental forces have now been described as 'quantum fields' after considerable work in the 1960-1980s. Quantum mechanics is incompatible with general relativity because in quantum field theory, forces act locally through the exchange of well-defined quanta. (www.einstein)

Since energy is the same stuff on all scales of the universe, nature must be able to vary its basic substance through a wide range of experimentally detectable conditions. The fact that physical theory has not united the results of those experiments suggests that a variational principle of compression and expansion needs to come into physical theory in some way. Compression is characterized by decrease in distance among components, elimination of forms, structures, and trajectories, and changes in quantities and qualities of information. Decompression or expansion is characterized by increase in distance among components, addition of forms, structures, and trajectories, and changes in quantities and qualities of information. Compression and expansion are properties of energy not conditions imposed upon it. Waveform is the signature of the alteration of compression and expansion. The physical universe expands after compression of its energy. This process is required for the conservation of force and guarantees that energy is always in some phase of compression/decompression(expansion).

Matter retains the ability to compress and expand on all scales. The scale invariance of this variational property provides both the self-differentiating principle necessary to escape from extreme compression and the structural integration of the wave/particle features of microphysical phenomena. In this view, the universe is not symmetrical and then asymmetrical; it is symmetrical and asymmetrical, continuous and discontinuous, and discrete and nondiscrete from the beginning. Because the variational property can vary between symmetry and asymmetry, it provides an explanation of the diversity, irregularity and non-uniformity of the physical universe. The variational property also transparentizes the time arrows of growth as rhythms of asymmetry in energy change. Nothing, no matter how complicated or large, exists which does not undergo transformation.

The most abundant elements are the easiest for vibratory energy, between expansion and compression, to form. The hydrogen atom is the simplest form of this alterity. But why hydrogen in the first place—why are there three charges? Hydrogen is the simplest form of matter understood as scale invariant self-differentiating energy. There are three charges because the proton continues compression, the electron continues expansion, and the neutron preserves variation by preventing collapse into either one. But because the variational principle is scale invariant, each vibratory moment has structure. Hence the structure of the proton (Gell-Mann 180-85), the variable manifestations of the electron (Schrodinger 16-17; Jammer 244-50; Albert 7-16), and the decay products of free neutrons (Smoot and Davidson 62). Because compression tends toward homogeneity and expansion toward heterogeneity, the mobility of the electron enables variation on an atomic scale that transforms into variation on molecular, chemical, and perceptual scales.

In a discussion of ways to understand the behavior of "a limited volume of gas" (20), Schrodinger points out that when you view the "gas as consisting of particles, no individuality must be ascribed to them" (21). If particles were the condition of primal matter, and they were all equivalent and the same, no change would have taken place as has been argued above.

If energy is considered to be "wave trains," then "every one of the wave trains has a well-defined structure that is different than that of any other" (21). On the scale of wave trains, the variational principle operates to prevent energy from collapsing into static homogeneity. Energy is self-regulating, which provides a clue as to how macroscopic complexity and diversity emerge from microscopic simplicity and homogeneity.

How then does gravity operate and how might a quantum theory of gravity look? Since there is no graviton there is no mechanism by which particles are propagated in relation to density. Since the contentions of general relativity that gravity and inertia are equivalent and that gravity is a property of spacetime formation are accepted here, there is likewise no mechanism by which vibratory resonance attract objects of lesser density to those of greater density. Gravity operates because space is continuous throughout matter. There are places with no air but, apart from theoretical singularities, there are no places with no space. Space is compressed with matter. The compression creates gravitational lenses with slippery spatiotemporal alignments toward the center of compression—the center of density and the center of inertia. The space within objects of lesser density is aligned with the lens of denser objects. This accounts for the fact that differences in mass have no effect on the rate of acceleration toward the center of highest density: space works on space, not on material structure.

This view has two implications for the quantum world. First, because densities are so small and space so ample there, the microworld goes along for the ride. Second, because matter waves are vibrations in space, they can be drawn into denser and denser configurations. Hence dust can form from molecules, nebulae can form from dust and so on. Also, a sufficiently dense body can cause a bend in the vibratory trajectory of light energy.

## VI. Spectral Light.

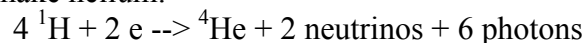
We now consider spectral light, the visible part of electromagnetism, from the standpoint of a variational principle. Electromagnetism is one of the four fundamental

forces of the universe. From highest energy, highest frequency and shortest wavelength to lowest energy, lowest frequency and longest wavelength, the whole electromagnetic spectrum consists of gamma rays, x-rays, ultraviolet, visible, infrared, microwave and radio waves. The wavelengths range from a picometer (0.000000000001 m) for gamma rays, to 10,000 m for radio. Both ends of the scale are unbounded. As part of one of four, spectral light is not the primary form of energy. Since it is not the primary form of energy, it must come from other forms of energy. Since it comes from other forms of energy, the characteristics of light, including its speed, must be derivable from the characteristics of those other forms.

Current knowledge about spectral light comes from study of natural sources such as the sun and artificial sources such as lasers. Physics traditionally answers the question of the nature of light in terms of particles or waves. Light is composed of particles called photons. Each photon is a discrete packet of electromagnetic energy that travels at a constant rate. The only thing that affects the speed of light is the refractive index of the medium through which it moves, and for empty space, this number is 1.000000 and gives the maximum possible speed of light. In glass, it is 1.3333 times smaller since  $c/n = c/1.333 = 300,000 \text{ km/sec}/1.333 = 225,000 \text{ km/sec}$ . (<http://image>) (Or, more precisely, its speed was set by agreement in 1967 as 299,792.458 kilometers per second. [Setterfield [www.1dolphin.org](http://www.1dolphin.org)]) The packets carry no mass, but have an effective mass that is determined by the energy they carry according to  $E = mc^2$ . The amount of energy that each photon carries is determined by its size, which in the wave description is just the wavelength of the light wave. Each quantum can be thought of as one complete oscillation of the electromagnetic wave. Specifically  $E = hc/\text{wavelength}$  where  $h$  is Planck's constant and  $c$  is the velocity of light.

The dynamics of light in electromagnetic fields refines this view of light. Light is a disturbance in the electromagnetic fields of charged bodies, whether in the ionized gas at the center of the sun or in the electrically disturbed electrons of filament metal. The electric field of a stationary charge has lines of electrostatic force directed radially away from the charge into space and traveling at  $c$ . Acceleration of the charge changes the geometry of the field; this charge and the information about where the new field is located in space travels outwards as a kink in the electromagnetic field. This happens because a change in the electric field generates a changing magnetic field which then generates a changing electric field and so on. Light is a self-propagating pulse of information announcing that the state of some electromagnetic field has been altered somewhere in space. Maxwell expressed this phenomenon in his wave equations for the electromagnetic field.

Since the sun is the closest source of natural spectral light to the earth, its light has been closely studied. The middle of the sun is a very hot, ionized gas in which all of the electrons have been stripped away from the nuclei. The nuclei available are mostly  $^1\text{H}$  with much  $^4\text{He}$  and some  $^2\text{H}$  and  $^3\text{He}$ . The evidence is strong that the overall reaction is burning hydrogen to make helium:



In this reaction, the final particles have less internal energy than the starting particles. The conserved energy is released as energy of motion of the nuclei and electrons in the solar gas, as production of gamma rays (high energy photons), and as neutrinos. ([www.zebu.uoregon](http://www.zebu.uoregon)) Neutrinos travel directly to the earth from the sun's center in about

8 minutes. Lower energy radiation such as ultraviolet, infrared and light rays leaves the photosphere of the sun and travels to the earth also in about 8 minutes. (Caruso 22-3)

The sun is a body characterized by continuous flux of compression and decompression/expansion. The continuity of the flux accounts for the fact that many kinds of electromagnetism emit from the sun at all times and in all directions. The flux accounts for the fact that the shape of electromagnetism is a waveform, which echoes the rhythm, vibration or oscillation of the originating energy conditions. As already stated, the variational principle implies that all physical quantities vary in some way. Gravitational redshift currently requires an explanation in the variation of the frequency of light in order to preserve velocity and explain visible color change. However, various studies have also called into question both the constancy and the invariability of  $c$ .

Constancy has been questioned recently by collecting measurements of  $c$  from the history of physics. Proponents of this still controversial approach, pioneered by Barry Setterfield and called  $c$  decay (= CDK), argue that the measurements show a decrease in  $c$  across at least the last 300 years. They insist that the measurements of  $c$  have been made with a “very great accuracy” that is more than enough to determine whether or not  $c$  has decreased. “The fact that virtually all the past measurements were above the present value should surely indicate that it could not have been due to ‘errors of measurement with inaccurate instruments’—which is the usual ploy used to dismiss them.” (Bowden, [www.1dolphin](http://www.1dolphin))

Invariability has been challenged in two experimental situations. The earlier was the Casimir effect in which large metal plates in a vacuum are brought close but not touching after which “there is a small but measurable force that pushes them together” (Setterfield 9). Repetitions of this experiment have led to the interpretation that “the impact of the plates on the propagation of light in the vacuum between them” causes “a change (more precisely a raising) in the velocity of light for electromagnetic waves propagating perpendicular to the plates” (Scharnhorst in Setterfield 12, parentheses in original). More recently, invariability has been challenged by experiments in superluminal signal velocity. Laser signals sent through certain types of crystalline material show arrival times that imply velocities in multiples of  $c$ . Physical interpretation of these results is problematic because the properties of evanescent modes are extraordinary: “Their energy is negative, they are not directly measurable, and the evanescent region is not causal since the modes traverse this region instantaneously.” Adequate interpretation is complicated by the fact that no one has successfully inserted a probe into an evanescent region ([www.arxiv](http://www.arxiv)), however all results from the experiments indicate signal velocities in multiples of  $c$ .

Both of the above changes in the traditional understanding of  $c$  are consistent with the variational principle. However, can the variational principle provide a derivation of the properties of spectral light from other conditions? In quantitative terms, Maxwell's electrodynamics, the classical theory of how charged particles and electromagnetic fields operate, is the only theory in which the speed of light is a quantity derivable from two other physical quantities. In it, the speed of light is the square root of the ratio of the dielectric constant ( $\epsilon$ ) and the magnetic permeability ( $\mu$ ) of the vacuum. The current analysis, however, does not try to provide a quantitative derivation. In qualitative terms, we are interested in the conditions under which spectral light first comes into existence and then maintains its characteristics.

This analysis allows us to draw bold and somewhat speculative implications from current knowledge. First, the origin of spectral light in electron energy fluctuations gives light the fundamental variational structure of two fields propagating in space. Second, because free light, which is light not produced or confined in experimental conditions such as those described above for the Casimir effect and for superluminal signal velocity, maintains its speed through different transformations, e.g. gravitational fields, including lenses, the governor of its velocity must be impervious to whatever transitions light experiences in those fields. Third, because light is a measurable excitation above the ground state of the vacuum (Wen 4), and because the vacuum is the constant condition of light propagation, the characteristics of light must differ from but reflect in some way those of the vacuum. Fourth, since the vacuum does not transmit sound but does transmit light (Setterfield 1), there must be some structural connection between the vacuum and light. Fifth, since there is a universal Zero Point Field (ZPF) acting on everything (Ibid. 5), light's characteristics must be bound in some way(s) by the characteristics of that action. (That is, we may consider the variational principle developed here equivalent in action to zero-point energy (ZPE) originating in the turbulence of Planck particle-antiparticle pair separation and spin (Setterfield 16-18)).

## VII. Conclusion.

The procedure for unifying physics around a variational principle of energy compression and expansion was started by Einstein in his project to establish "a generalization of the theory of the gravitational field" (45). The position of this article agrees with the two steps in which he concludes, first, that "the symmetrical tensor field must be replaced by a nonsymmetrical one," and that the "combination of the two parts of the field can only be shown to be a natural procedure if in the formalism of the theory only the total field plays a role, and not the symmetrical and antisymmetrical parts separately" (45). My argument asserts though that the total field is characterized fundamentally and pervasively by variation on all scales of the physical universe. This implies that special and general relativity must be seen as limiting cases. This implication also reconnects us with the "useful story" above. The most that a variational principle allows is combinations of repetition and variation so it would not be possible, given a system of equations devised to express the variational principle, "to determine the system of equations uniquely" (45) or to show that the system of equations was not unique. The uniqueness claim that every monotheism makes about its (version of the) universe can only be seen, in this light, as an artifact of faith, not a consequence of knowledge.

Waves, matter waves, and vibrational frequencies must all be seen as verbal approximations of a compression/expansion rhythm operative on all scales of the physical universe. Propagation is expansion; gravitation is compression; inertia is compression; standing matter/energy waves are expansion always conditioned by compression; the equivalence of mass and energy is the capacity of all compressed matter/energy to expand and of all expanded matter/energy to compress.

With regard to the cosmological constant, it follows that it is the presence and effect of space itself. There is no "unnatural relation" involved in solving "the mystery" (Abbot 79) of the cosmological constant. The expected large-scale effect from the constant is the slipperiness of space. Large perceptual distortions at close terrestrial

distances (Ibid., 77-8) are not predicted on this view because space is porous to not cumulative on its own conditions. This version of the cosmological constant could be deduced from the “known” and unknown parameters” (79) governing quantum mechanics. To do so, fundamental quantum conditions such as Heisenberg’s indeterminacy must be understood as a physical expression of an underlying certainty, that is, the certainty of the principle of variation. A quantitative expression of this certainty would be Planck’s constant interpreted as the range of possible values of the smallest possible natural variation. From here, the next step would be to understand key empirical results, such as electron scattering and diffusion, as expressions of ground state—vacuum—stability with respect to electromagnetic flexibility, that is, coupling of electromagnetism with vacuum characteristics. This coupling allows both discontinuity in electron behavior and continuity in electron integrity. In such a manner, the principle of variation here developed conceptually could contribute to a unification of the various branches of physics.

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