

Paradoxes within Physical Theory at the Human Scale

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Abstract: Three paradoxes within physical theory at the human scale are discussed. These paradoxes are 1) the paradox of static virtual fields, 2) the paradox of the missing negative mass/energy and 3) the paradox of instantaneous virtual field propagation. Logical possible resolutions to these paradoxes are outlined. The possible significance of these paradoxes to the future evolution of physical theory is discussed.

Keywords: paradox, virtual field, negative mass, symmetry, asymmetry, arrow of time

Introduction

Although modern physics has not failed us when it comes to predicting human-scale objective phenomena², there are paradoxes presented by current physical theory that suggest that physics in its current state may not be a complete explanation of the phenomena we experience at the human scale. A clearly stated paradox presents an opportunity for a deeper understanding based on a unification, or synthesis, that resolves the paradox. Three of the paradoxes apparent in current physical theory are 1) the identification of electrostatic and magnetostatic fields as virtual/imaginary fields, 2) the missing negative mass/energy at the human scale, and 3) the instantaneous propagation of changes in virtual/imaginary field strength. In this paper we will briefly discuss these paradoxes and outline a logical possible resolution to each paradox.

Before proceeding with this discussion, it is critical to clarify that these paradoxes are not inherent in the physical phenomena themselves, but are only a property of the physical theory we have adopted to describe the phenomena. In other words, an alternative historical development of physical theory (albeit one that could be difficult for us to imagine) may not present any paradoxes related to these physical phenomena. When a paradox does present itself within theory, there is good reason to attempt to resolve the paradox, even if the paradox does not appear where the theory has difficulties. Current physical theory does not have practical difficulties at the human scale - the difficulties are at the macro (cosmic) and micro (quantum) limits of the universe, and in reconciling the theoretical models at these two limits. However the paradoxes considered in this paper did not exist when general relativity and quantum theory were first formulated - they have

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² Practical descriptions of systems that are *chaotic* or *turbulent* can be found numerically, but a complete predictive theory of such systems is not yet known.

only been revealed within the expansion of our quantum and cosmological understanding. Therefore these paradoxes developed while our attention was elsewhere, and it may now be time to refocus our intellect closer to home (the human scale and human experience) and consider the significance of these paradoxes.

The Paradox of Static Virtual Fields

For internal consistency within the quantum-electrodynamic model of photons, it is necessary to define the photons associated with electrostatic and magnetostatic fields as *virtual*, in contrast to the *real* photons associated with electromagnetic waves [1]. In other words, the mass/energy of a real photon is a real number, whereas the mass/energy of a virtual photon is an imaginary number³. Although the virtual/imaginary status of electrostatic and magnetostatic fields may not raise any further questions, the fact that electrostatic and magnetostatic are static *and* imaginary is a paradox, because a quantity can only be imaginary with respect to some other quantity with which it is in relative harmonic motion. For example, a simple pendulum has a kinetic energy and a potential energy, each of which can be measured as a real quantity. However if the pendulum is swinging back and forth, the potential and kinetic energy are imaginary *with respect to each other*. Similar examples can be given for the quantities that describe anything that is rotating, oscillating, or vibrating. Therefore it is a paradox that electrostatic and magnetostatic fields are static *and* imaginary. The implication of this paradox is that if we are measuring a quantity that is static and imaginary, then we as observers, or something about the act of observing, must be characterized by a motion that is rotating, oscillating, or vibrating (in spite of the fact that we are not conscious of such a motion in our normal sensory observation of the world). The notion of a hidden harmonic motion is reinforced by the fact that current physical theory tells us unequivocally that we are bounded by harmonic motion: at the quantum scale, everything is characterized by vibration; at the speed of light, only lightwaves exist; and at the cosmic scale, there appears to be a beginning and an end to spacetime itself, perhaps in a repeating fashion, where the end of one universe in a singularity may be the beginning of another universe [2].

³ Just as the mathematics of general relativity predicts the existence of negative mass/energy, the mathematics of quantum electrodynamics predicts the existence of imaginary mass/energy, even though mass/energy that is not positive-real may seem strange. Specifically, the energy of any photon is given by $E=hf$, which may be rewritten as $E=hkc$, where “k” is the wavenumber, which may be complex. In the case of real photons the wavenumber is purely real, whereas in the case of virtual photons (such as evanescent waves or electrostatic/magnetostatic fields) the wavenumber is imaginary. Hence the energy of virtual photons must be imaginary. Incidentally, the enormous zero-point energy density predicted by quantum mechanics is sometimes referred to as the “quantum catastrophe” since this energy density is not observed, however this label is based on the prejudice that quantum vacuum energy fluctuations are “real”. The “catastrophe” is nullified by recognizing that virtual particles have imaginary energy, and are hence non-observable unless they cohere into real particles.

The Paradox of the Missing Negative Mass/Energy

Negative mass/energy is often referred to as “exotic mass/matter” because it is never directly observed, even though its existence is necessitated by our physical models. Specifically, quantum theory predicts that negative mass/energy is present in equal amounts with positive (normal) mass/energy at the Planck scale - the scale at which quantum vacuum fluctuations comprise the vast majority of the mass/energy calculated to exist at any instant⁴. At the cosmic scale, the most current measurements of the expansion rate of the universe tell us that the universe is essentially flat [3], meaning that the positive spacetime curvature correlated with observed positive mass/energy must be balanced by the negative spacetime curvature of unobserved negative mass/energy. This doesn't mean there are unobserved “chunks” of negative mass/energy floating out in some hidden corner of universe - it means that the overall *shape* of the universe, as a whole of spacetime, must have balanced positive and negative curvature. Furthermore, if anti-photons are the same thing as negative photons (this is currently unresolved, but quantum mechanics does define photons and anti-photons are the same thing) then anything moving at lightspeed is balanced positive and negative energy. Therefore, not only are we hemmed in on all sides by vibration, including an oscillation inherent in our act of observation we haven't identified; we are also hemmed in by balanced positive and negative mass/energy. The paradox of the missing human-scale negative mass-energy would be resolved if we identified a negative mass-energy at the human scale that balances the positive mass/energy we observe through the senses.

The Paradox of Instantaneous Virtual Field Propagation

It is well known that nothing with real mass/energy can travel faster than the speed of light. If any real thing were to travel faster than the speed of light, it would violate causality i.e., a logical, coherent order of cause and effect in the universe. However it may not be well known that changes in imaginary fields do propagate instantaneously. This has been demonstrated in frustrated internal reflection experiments [4], [5]. Such changes in purely imaginary fields do not constitute radiated light - they are fields locally associated with a physical object. Such fields are equivalently virtual photons, which within the framework of quantum mechanics are equivalently the electrostatic and magnetostatic fields. The paradox these instantaneous field changes present is related to causality. We have grown accustomed to instantaneous quantum effects over distance, such as quantum tunneling and quantum coupling. These instantaneous quantum effects are understood *not* to violate causality because the states on either side of the effect (such as the states of the two quantumly-coupled particles) are mutually causal i.e., they cannot be known independently. Therefore the resolution to the paradox of instantaneous changes in imaginary field strength must be that a mutually causal relationship exists at the human scale, between physical objects that possess these fields, and some other unobserved mass/energy.

⁴ Quantum vacuum fluctuations are composed of *virtual particles*, which, though technically neither positive nor negative energy, do reflect a balance between positive and negative energy.

Further Thoughts

A common theme to each of the suggested resolutions to these paradoxes is that an unobserved mass/energy exists in some form of harmonic relationship with the observed mass/energy comprising the objects of our sensory experience. In other words, these resolutions suggest a hidden symmetry that balances the asymmetries highlighted by these paradoxes. Symmetry is the philosophical aim of physical theory, and mass/energy is generally described by models that behave symmetrically. The primary exception to symmetry as an essential principle of physical theory is the second law of thermodynamics, which describes all processes we observe at a human scale as evolving along an irreversible (asymmetric) arrow of time. All symmetric processes governing mass/energy are harmonic, whereas the unidirectional entropic process is not harmonic. Therefore, a synthesis with physical theory that resolves the paradoxes discussed in this paper may yield a higher-order symmetry that encompasses the arrow of time.

Works Cited

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