A Proposed Treatment of the Vacuum as a Field of Bosonic Virtual Particles

Abstract

This article explores the possibility of modeling the vacuum as a bosonic field near equilibrium in the absence of classical fermions. As a bosonic field comprised of virtual particles arising from vacuum energy fluctuations, the vacuum bosons would not be subject to the Pauli Exclusion Principle and, consequently, would not violate Michelson – Morely [1]. In the presence of fermions, the bosonic vacuum would be perturbed through interactions of the vacuum bosons with fermions, giving rise to gradients in vacuum energy which could be measured as force fields. The gradients in vacuum energy would result in spatial and temporal effects that, on a statistical basis, would be consistent with the curvature tensors. A quantized form of the stress tensor is provided based on such vacuum theories.

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In the standard treatment of quantum mechanics, the widely held model of force is that forces between classical fermions arise as an exchange of bosons between the fermions [2]. Following the publication of Special Relativity [3] and the Michelson-Morley experiment [1], ether models of force were largely discredited. Relativity was further developed in [4] to include a tensor description of space-time to explain gravity.

The early developments in Relativity theory preceded the development of quantum mechanics, including the development of the Copenhagen interpretation in 1929. The development of quantum theory included the formulation of the Pauli Exclusion Principle which stated that no two fermions could have the same quantum numbers [5]. Bosons, however, as force-bearing particles were not subject to the Pauli Exclusion Principle. Forces between fermions were explained as a result of exchange of bosons between fermions.

Further developments in two theories, Relativity and Quantum Field Theory, since the Copenhagen tradition have yet to produce a general field theory consistent with both. In this paper, description of the vacuum as a bosonic field of virtual particles (i.e., vacuum bosons) is proposed as one component of possible theories to resolve the two theories. In such a model, excitation/de-excitation of bosonic virtual particles by interactions with fermions may provide a means of understanding the two competing views of Relativity and Quantum Field Theory.

Such a field model would need to be consistent with the famous Michelson – Morley experiment. Noting that bosons are not subject to the Pauli-Exclusion Principle, an argument is presented that an ether wind would not arise in a model of vacuum bosons. Similarly, non-local behavior is admitted with a bosonic field model of the vacuum.

A few papers, [6], [7], [8], presented basic field equations and Feynman diagrams providing an outline of the proposed vacuum field model. In a strict development of quantum field theory, a term for the vacuum energy is required but usually neglected [2]. Usually the vacuum energy is taken as zero. Such an assumption of zero vacuum energy would be expected where the vacuum energy is roughly near equilibrium in the neighborhood of the locus of observation of events of particle interactions because the gradient in the vacuum energy is near zero. The treatment of vacuum energy contributions provided in [6] and [7], however, may lead to a test by which the vacuum may be manipulated using the Casimir force to produce a vacuum energy gradient [8].

A model of vacuum boson field theory would require tensor differential forms that include Christoffel terms that would yield Ricci curvature tensors, similar to those provided in [8], and [9]. Statistical treatment of vacuum boson field, based on such a model should, should yield the large-scale structure of space-time per [10]. Quantization of stress tensor would be required for a complete theory.

The stress tensor of General Relativity is usually formulated as:

$$T^{\mu\nu} = (\rho + p/c^2)u^\mu u^\nu - pg^{\mu\nu} \qquad (1)$$

As an ansatz, a quantized form of the stress tensor is presented as:

$$T_{\mu\nu} = \delta_\mu{}^\sigma \delta_\sigma{}^m \delta_m{}^l \{(\frac{\rho_l}{c^2} - i\hbar \nabla_l)\phi_\sigma \phi_\nu{}^\dagger - hk_l g_{\sigma\nu}\} \qquad (2)$$

In Equation (2), ρ would be identified as a vector bundle representation of the energy density at the locus of a fermion, including the vacuum energy density.

Although statement of energy as a vector field is usually prohibited by widely used mathematical conventions, [8] and [9] provide operators which obtain a vector representation of energy. An example includes a transform of the 4-factor momentum as cp_μ.

By reference to Equation (2), and identifying the metric, $g_{\mu\nu} = \phi_\mu \phi_\nu{}^\dagger$, and $g_{\mu\nu}(-) = i\phi_\mu i\phi_\nu{}^\dagger$, it may be possible to find a truly quantized form of Einstein's famous equation:

$$T^{\mu\nu} = G^{\mu\nu} \qquad (3)$$

Such a quantized form of the stress tensor would be fully consistent with a bosonic field model of the vacuum.

References:

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