Zero-Point Energy, Fluctuations, and Dissipation: A (Mostly) Quantum-Optical Perspective

Following a brief review of how the concept of zero-point energy first appeared in quantum theory, I will describe some of the evidence for electromagnetic zero-point energy and quantum field fluctuations. Attention will then be focused on fluctuation-dissipation relations which allow different physical interpretations of effects usually associated with changes in zero-point field energy, and which bear on the question of whether equations of motion determine commutation relations. Quantum Langevin equations with zero-point fluctuations and dissipation will be shown to lead straightforwardly to expressions for quantized electromagnetic fields in dissipative media. Implications of vacuum field fluctuations and zero-point energy will be discussed in the context of recent experiments on spontaneous parametric down-conversion and for a proposed experiment probing Planck-scale physics.

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