Contribution ID: **177** Type: **Oral Presentation**

Vacuum Energies and Frequency Dependent Interactions

Friday, 11 July 2014 10:20 (20 minutes)

Abstract content
   (Max 300 words)
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In the case of static field configurations that have frequency independent interactions with the quantum fluctuations, the vacuum polarization (or Casimir) energies are straightforwardly computed from scattering data. In particular the derivative of the phase shift with respect to the frequency is central because the analytic properties of scattering data relate this derivative to a spatial integral of the Green's function at coincident points. In more complicated frameworks, however, the interaction of the quantum fluctuations is frequency dependent. Such a scenario is actually typical for effective models. Then the above mentioned relation must be modified. This modification may or may not additionally contribute to the vacuum polarization energy. In this presentation I will discuss several examples that naturally induce frequency dependent interactions. (I) Scalar electrodynamics with a static background potential. (II) An effective theory that emerges from integrating out a heavy degree of freedom. (III) Quantum electrodynamics coupled to a frequency dependent dielectric material[1]. In cases (II) and (III) any omission of the frequency dependence would severely violate the renormalizability of the theory. For case (III) I will point out an ambiguity that arises because the introduction of a dielectric function comes at the expense of lacking a canonical Lagrangian formulation for the interaction of the photons with the constituents of the material[2]. The physically motivated choice for the Hamiltonian leads to an attractive self-stress of a dielectric sphere[1].

[1] N. Graham, M. Quandt and H. Weigel, Phys. Lett. B726 (2013) 846.
[2] N. Graham, M. Quandt and H. Weigel, in preparation.

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Session Classification: Theoretical

Track Classification: Track G - Theoretical and Computational Physics