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Renormalized Perturbative Corrections to Casimir Energies due to the Roughness of aDielectric Plate and Finite Temperature – an Effective Field Theory Approach[1] MARTIN SCHADEN, HUA-YAO WU, Rutgers University — We present a systematic perturbative approach to the interaction of the electromagnetic field with stochastically rough surfaces. Spurious perturbative short wavelength contributions are renormalized by modeling the scattering matrix for long wavelengths. Scattering off a rough plate at long (transverse) wavelengths is described by scattering off an effectively flat plate with the inclusion of the plasmon correction. Any roughness profile$h(x_\perp)$ with standard deviation small compared to the wavelength of the electromagnetic radiation may be considered and in particular roughness profiles with a correlation, such as$\langle h(x_\perp)h(y_\perp)\rangle = \sigma^2 \exp(-|x_\perp - y_\perp|/\ell)$, with a finite derivative at the origin. These would lead to a divergent scattering matrix in a conventional (un-renormalized) perturbative approach. We obtain perturbative roughness corrections to the Casimir energy of dielectric plates at finite temperature using Drude- and plasma- models for the dielectric permittivity. Up to a shift in the effective separation, the Casimir energy between a rough and a flat plate for decreasing correlation length approaches that between two flat plates - in agreement with intuition and non-perturbative results for corrugated plates. Our perturbative calculation reproduces exact calculations for a plate with one-dimensional periodic corrugation in the limit$\sigma \ll a$. These results are used to estimate roughness corrections to precision Casimir measurements.

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