Mesoscopic models for electromagnetic fluctuations in and near conducting media

Carsten Henkel

University of Potsdam, Institute of Physics and Astronomy, Karl-Liebknecht-Str. 24/25, 14476 Potsdam, Germany

Dispersion interactions between polarisable objects arise from rectified electromagnetic fluctuations of both quantum and thermal origin. A commonly used framework is fluctuation electrodynamics, as developed by the Rytov school [1] and upgraded to macroscopic quantum electrodynamics by Welsch, Scheel, and Buhmann [2,3]. It explains the long-range tails of van der Waals and Casimir-Polder interactions, including their dependence on temperature and material properties. The talk discusses deviations between the theory and some experimental data that appear when both finite temperature and finite electric conductivity are relevant [4]. The idea is explored that electrons in metallic conductors may have a response to e.m. fields that resembles that of a superconductor, provided the length scales are below the mean free path. This is motivated by coherent electron interference in mesoscopic structures like rings where persistent currents have been observed [5, 6]. We thus extend the Rytov theory to conductors where fluctuating sources have correlation lengths in the 10 nm range.

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