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Quantum Criticality of Charged Particles in Polar Liquids
SHAHRIAR SHADKHOO, ROBIJN BRUINSMA, University of California, Los Angeles, Department of Physics and Astronomy — We propose a general theory for the interaction of electrons with polarizable media for which the dynamical structure factor for charge fluctuations is known. The theory is based on a generalization of Leggett's method for the construction of path integral functionals for electrons in dissipative media. We apply the method to the case of electrons in polar liquids using a dynamical structure factor obtained by numerical simulations. The functional integrals are approximated using Feynman's variational method. At low temperatures, a dynamical structure factor with local spatial structure along with a Debye-like decaying frequency dependence, as suggested by the simulations, produces a first-order transition at a critical coupling constant. This is in contrast with the Feynman polaron theory, which does not have local structure formation, where no transition takes place. We also find a line of continuous quantum criticality.

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