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Electron Liquid Beyond the Random Phase Approximation

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Abstract: A deeper understanding of low-dimensional and small-scale electronic systems requires an accurate characterization of the many-electron effects. Based on the electron liquid (EL) model, these many-body effects in the three-dimensional (3D) and two-dimensional (2D) electronic systems are dealt going beyond the random phase approximation within the zero-temperature framework. The dielectric formulation of the many-body problem is recapitulated and the longitudinal dielectric function of the EL is obtained using the self-consistent local-field correction scheme, known as STLS, under a general spin-valley degeneracy. Extensive explicit expressions are provided for the use of other researchers. The performance of this formalism is compared in both 3D and 2D by the quantum Monte Carlo data and the pseudopotential approach introduced by Pines and co-workers. STLS is observed to be a highly satisfactory technique, with some reservations on the long-wavelength behaviour. Ground-state energy, correlation energy and the isothermal compressibility of the 2D EL are computed using a variety of approaches. Negative compressibility and overscreening are discussed in the light of the recent experiments.

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