Quantum fluid description of non-ideal dense plasmas

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A large scale simulation of quantum plasmas with correlated electrons is challenging and, currently, a formidable task. *Ab initio* methods such as Quantum Monte-Carlo and Kohn-Sham density functional theory (DFT) are severely limited by the number of electrons and ions which can be simulated [1]. Hence, the orbital-free formulation of DFT has undergone rapid development in recent years [2]. However, the OFDFT is limited to the static case. Therefore, in this work, we present our recent result on the development of quantum hydrodynamics (QHD) of correlated electrons in dense plasmas; which e.g., can be used for the description of the dynamics of the electrons around a mean distribution obtained from the OFDFT and, thereby, can be a reliable tool for a large scale simulation of a quantum plasma dynamics [3].
We have derived the closure relations which allow to go beyond of previously used QHD models. The main features of the developed QHD theory are the following: it can be used at finite temperatures, the agreement with the random phase approximation is guarantied in the non-interacting limit, the effect of correlations is taken into account via the local filed corrections, and can be used for the weakly non-uniform case. On the basis of the obtained closure relations, previous results on the fluid description of the non-interacting quantum electrons have been revised and, in part, improved. The non-ideality effect is discussed for both static and dynamic cases employing local field corrections [4-7]. Finally, the extension to the case of a quantum plasma in an external magnetic field is presented.

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