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# Cluster-virial expansions for correlated matter

The properties of strongly interacting Fermi systems are influenced by the formation of bound states. The mass-action law applies in the low density range. At a fixed temperature, a Fermi liquid consisting of quasiparticles is obtained at high density. A phase transition can occur in between. Analytical approaches such as the Matsubara-Green function method are based on perturbation theory and only provide accurate results in some limiting cases, e.g. in the case of virial expansions. The Beth-Uhlenbeck equation for the second virial coefficient is discussed and generalisations, for instance the cluster-Beth-Uhlenbeck equation, are considered. Numerical approaches such as density functional theory or path-integral Monte Carlo simulations provide results for strongly interacting systems that go beyond perturbation theory. Examples are strongly coupled Coulomb systems, especially warm dense matter, and nuclear systems, especially in nuclear reactions and in astrophysics. We discuss the thermodynamic properties of the homogeneous electron gas and transport processes in hydrogen plasmas. For nuclear matter, the composition, the Pauli blocking effect, properties of nuclei and applications in astrophysics are discussed.

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