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## Quasi-particle properties of Fermi gases close to unitarity.

Ultracold atomic Fermi gases have been widely studied from both theoretical and experimental point of view during the last decades. In the low density regime, the two-body interaction between the constituents is well described by the leading order of the $s$-wave scattering channel and can be fine tuned from weak to strong coupling by applying an external magnetic field. Such systems are remarkable laboratories to test and design many-body theories. In particular, the low density limit of strong coupling for which the $s$-wave scattering length $a_s$ is infinite, namely the unitary gas limit, has recently received a special and growing interest in nuclear physics due to the presence of anomalously large scattering length $a_s \sim -20$ fm$^{-1}$. Especially the perturbation expansion of observables fails for density $\rho \gtrsim 10^{-7}\rho_0$ where $\rho_0$ is the saturation density. Resummation techniques have been investigated in Effective Field Theory (EFT) framework for infinite matter by summing up all orders in perturbation of a certain class of Feynman diagrams to describe properties of strongly interacting Fermi systems. These resummations result in compact expressions of the energy as a function of low energy constants and density.

The aim of this work is to propose a non-empirical density functional theory for ultracold atoms based on resummation techniques keeping the information on the interaction. In this presentation, I will first introduce resummation theory for ultracold atoms and present simplified density functionals obtained describing remarkably well the thermodynamic properties of Fermi gas from small scattering length to unitarity. Then I will discuss the possibility to use resummation for the self-energy that encodes the quasi-particle properties. I will show, as an illustration, the resummed effective mass and effective potential extracted from the self-energy and discuss the link with Landau Fermi liquid theory and perspectives for density functional approaches.

*Mercredi 19 Dec. 2018, 11h30*

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