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Quasi-particle properties of strongly interacting Fermi systems

At low density, Fermi systems can be described within Effective Field Theory (EFT) simply using a contact s-wave interaction. Due to the presence of anomalously large scattering length in nuclear physics, perturbation theory is valid at extremely low density and the description of the nuclear systems require non-perturbative methods.

The unitary limit for which the scattering length is infinite, has recently received a special and growing interest in nuclear physics. Such systems have been widely studied and recent progress have allowed to determine its equation of state [1]. It was used to constraint the nuclear symmetry energy [2] which plays a determinant role in the description of neutron star mergers, heavy-ion collisions and neutron-rich nuclei physics to determine the thicknesses lower limit to the neutron-skin.

We have investigated non-perturbative resummation techniques in EFT framework for infinite systems. These result in compact expressions of the energy as an explicit function of low energy constants and density making at the same time connection with energy density functional (EDF) theory.

In this presentation, we propose a non-empirical EDF for Fermi systems based on resummation techniques for which unitary gas was used as a guide to design the theory. I will first present simplified EDF obtained describing well the thermodynamics and linear response of neutron matter [3,4]. Then I will discuss the possibility to use resummation for the quasi-particle properties. I will show the resummed effective mass extracted from the self-energy and discuss the link with the Fermi liquid theory and perspectives for nuclear EDF approaches [5].

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