Contribution ID: **2** Type: **not specified**

A novel nuclear EDF for nuclear matter and finite nuclei

Starting from observation in a pionless EFT, we establish an expansion scheme for the nuclear energy density functional (EDF) in infinite nuclear matter. We obtain terms up to N3LO, and the parameters of the functional are fitted to the equation of state (EoS) obtained from the microscopic calculations of symmetric nuclear matter (SNM) and pure neutron matter (PNM). Nuclear EDF thus determined is used in the calculation of the EoS of PNM far below the saturation density, and the mass-radius relation of the neutron star. In the low-density regime our model gives behavior consistent with the results of Quantum Monte Carlo calculation at densities much below the fitting data points. Mass-radius relation with our model exhibits behavior consistent with the most updated observation data, which implies that the EoS at high densities is also compatible with empirical constraints. Finally we apply the model to the calculation of static properties of spherical nuclei, and obtain agreement as good as existing Skyrme force models.

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