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Applications of Chiral Forces to Nuclear Matter and Neutron Stars

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The equation of state of (isospin-)asymmetric nuclear matter is a key quantity for nuclear astrophysics. In this talk, we discuss recent progress of microscopic calculations based on nuclear forces derived within chiral effective field theory and many-body perturbation theory. We focus in particular on applications of our improved normal-ordering method which enables the treatment of general three-body (3N) interactions starting from a partial-wave-decomposed form. Specifically, chiral 3N forces up to next-to-next-to-next-to-leading order (N^3LO) are now accessible in partial-wave based frameworks.

Applying these density-dependent effective two-body potentials to matter of arbitrary proton fractions, we show results for the equation of state, symmetry energy, incompressibility in conjugation with empirical parametrizations including the quadratic expansion in isospin-asymmetry. Furthermore, we elaborate on constructing equations of state up to the high central densities typically realized in neutron stars. These can then be used to constrain, e.g., mass-radius relations. Remarkably tight constraints have been obtained with our state-of-the-art equations of state.

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