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Chiral mirror-baryon-meson model and nuclear matter beyond mean-field

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We describe the liquid-gas transition of nuclear matter together with chiral symmetry restoration in the high baryon-density phase considering a chiral baryon-meson model for nucleons and their parity partners in mirror assignment interacting with pions, sigma and omega mesons.
The model is known to provide a phenomenologically successful description of nuclear matter properties within the mean-field approximation. Here, we go beyond this approximation and include mesonic fluctuations by means of the functional renormalization group.
We concentrate on cold nuclear matter in the vicinity of the nuclear-matter transition but also consider finite temperatures to study the full phase diagram of the model.
While including beyond mean-field fluctuations does not lead to major qualitative changes in the phase diagram of the model, in the vacuum one is no longer free to adjust the parameters so as to reproduce the binding energy per nucleon, the nuclear saturation density, and the nucleon sigma term all at the same time.
However, the prediction of a clear first-order chiral transition at low temperatures inside the high baryon-density phase appears to be robust.
Moreover, combining an extended mean-field approximation for the grand potential in the vacuum with thermal fluctuations at finite density provides a promising approach to explore the phenomenological consequences of the chiral transition of this model inside the high baryon-density phase for an equation of state of neutron matter and the mass-radius relation of neutron stars.

On behalf of collaboration:

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