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Impact of first-principles calculations on the QCD phase diagram and equation of state

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We compare two first-principles calculations of the QCD equation of state (EOS): the weak-coupling results and the recent lattice QCD data at finite isospin density.
Because both finite-baryon-density QCD and finite-isospin-density QCD have the same weak-coupling expansion, we can learn about the former case from the latter, in which the lattice data is available, and in this talk, we particularly discuss the effects on (1) the QCD phase diagram and (2) the EOS of neutron star matter.
Firstly, the weak-coupling results give a small (~ a few MeV) value for the color-superconducting gap at quark chemical potential of a GeV order and this implies that the color-flavor locked phase may not be the ground state even in the perturbative regime of QCD.
Secondly, we discuss the weak-coupling results as the input to the EOS inference for neutron stars. In such weak-copuling input, there is an undetermined constant (the renormalization scale), which gives rise to a large uncertainty. We introduce a new prescription to reduce the ambiguity in the choice of the renormalization scale and discuss its relevance to neutron-star phenomenology.

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