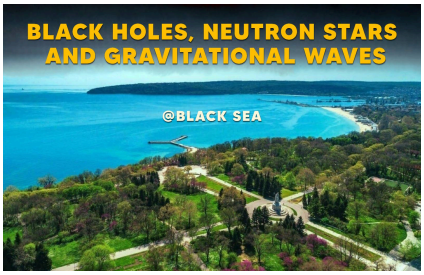

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Why is CFL quark matter in neutron stars non-conformal?

We propose a three-flavor nonlocal Nambu–Jona-Lasinio model of quark matter with attractive scalar and diquark, and repulsive vector interaction channels to study the question whether an approximately conformal behavior of the strongly interacting quark matter in neutron star interiors is possible. The model qualitatively agrees with the perturbative quantum chromodynamics (pQCD), which predicts asymptotically conformal behavior of quark matter. In particular, the color-flavor-locked (CFL) color superconducting state is shown to be the ground state at asymptotically high densities. The conformal limit for the speed of sound and the dimensionless interaction measure is also shown to be reached from below and above, respectively. The developed equation of state is constrained by the results of a physics-informed Bayesian analysis using modern multi-messenger neutron star observations. It is shown that in the phenomenologically relevant range of parameters the model exhibits a narrow interval of densities close to the central densities of the heaviest neutron stars, where the speed of sound and dimensionless interaction measure simultaneously attain almost conformal values. A microscopic quantity, which characterizes single particle excitations of quarks and quantifies deviation from the conformal behavior of quark matter, is constructed to test the hypothesis of approximately conformal behavior of quark matter in neutron stars. Analysis of this quantity does not support the assumption about the nearly conformal behavior of quark matter even in the mentioned density range. Therefore, the apparent behavior of speed of sound and dimensionless interaction measure is denoted as pseudoconformal behavior.

[1] O. Ivanytskyi, Asymptotically conformal color-flavor-locked quark matter within a nonlocal chiral quark model, Phys. Rev. D 111 (2025) 034004.
[2] A. Ayriyan et al., Bayesian analysis of neutron star EOS with asymptoticaly conformal color-flavor-locked quark cores, in preparation (2025).

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