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Sound velocity peak driven by the chiral partner in dense two-color QCD

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Recent studies suggest that the presence of a peak structure in the sound velocity would be essential for reproducing the observed mass-radius relation of neutron stars. To investigate the existence of the sound velocity peak in baryonic dense matter, the chemical potential dependence of the sound velocity has recently been evaluated via lattice simulations of two-color QCD, rather than simulations of real-world QCD with three colors. The results indicate the emergence of a peak in the sound velocity. However, the chiral perturbation theory (ChPT), which serves as a low-energy effective model for the lightest hadrons, fails to reproduce this peak at finite quark chemical potential in two-color QCD with two quark flavors.
In this talk, I present an effective model to describe the sound velocity peak. I first extend the ChPT to incorporate excited hadrons into the effective theory by employing the linear sigma model, where the sigma meson is identified as the chiral partner of pions. Within the mean field approximation, I show that the contribution from the chiral partner leads to the sound velocity peak. In addition, I discuss the correlation between the sound velocity and the trace anomaly in dense two-color QCD.

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