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Impact of Multiple Phase Transitions in Dense QCD on Compact Stars

This talk covers several recent developments in the physics of dense QCD with an emphasis on the impact of multiple phase transitions on astrophysical manifestations of compact stars. It is conjectured that pair-correlated quark matter in β-equilibrium is within the same universality class as spin-imbalanced cold atoms and the isospin asymmetrical nucleonic matter. This then implies the emergence of phases with broken space symmetries and tri-critical (Lifshitz) points. We construct an equation of state (EoS) that extends the two-phase EoS of dense quark matter within the constant speed of sound parameterization by adding a conformal fluid with a speed of sound c_conf=1/√3 at densities ≥10 n_sat, where nsat is the saturation density. With this input, we construct static, spherically symmetrical compact hybrid stars in the mass-radius diagram, recover such features as the twins and triplets, and show that the transition to conformal fluid leads to the spiraling-in of the tracks in this diagram. Stars on the spirals are classically unstable with respect to the radial oscillations but can be stabilized if the conversion timescale between quark and nucleonic phases at their interface is larger than the oscillation period. Finally, we review the impact of a transition from high-temperature gapped to low-temperature gapless two-flavor phase on the thermal evolution of hybrid stars.

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