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Modeling hybrid stars and hot matter

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The recent spectacular observation of neutron star mergers underlines the importance of developing strong interaction models that can cover the whole range of densities and temperatures, which can be reached in compact stars as well as heavy-ion collisions. As the temperatures in the merger might reach 80 MeV or more, these events connect conditions of compact star physics and of the fireball created in a heavy-ion collision.
To this end we present a newly developed unified flavour SU(3) description of the hadronic and quark matter based on the parity-doublet description of chiral symmetry breaking. We adjust the parameters to describe nuclear ground state isospin symmetric as well as asymmetric matter, and properties of finite nuclei. In addition, lattice results for thermodynamic quantities as well as susceptibilities at vanishing chemical potential are well reproduced. The QCD phase diagram exhibits a first-order liquid-gas as well as a deconfinement transition with a critical endpoint at large chemical potential. We will present the resulting neutron stars that agree with observed heavy neutron star masses and the deformability of the stars are in accordance with the gravitational wave signal from the merger. The compact stars have small radii and consist mainly of a mixed quark-hadron phase.
Furthermore, we will discuss consequences of the model for the matter created in a neutron star merger and how the properties of hot as well as dense matter are interconnected.

Content type

Theory

Collaboration

Centralised submission by Collaboration

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