19th International Conference on QCD in Extreme Conditions (XQCD 2023)

Contribution ID: **103** Type: **Talk**

Is matter inside massive neutron stars not hadronic?

Wednesday 26 July 2023 14:00 (25 minutes)

The behavior of the nuclear equation of state (EOS), which plays a crucial role in describing the properties of neutron stars (NSs), is extensively investigated using a Bayesian approach applied to various classes of relativistic mean field models. These models encompass density-dependent meson couplings (DDH), interactions with non-linear characteristics, and the Chiral Mean Field (CMF) Model. By employing Bayesian analysis, we explore the parameter space of these models and assess their compatibility with observational data. The Bayesian framework employed in this study incorporates a few essential nuclear saturation properties, such as binding energies, symmetry energy as well as constraints from the observation of neutron stars with masses exceeding 2M⊠. Furthermore, the equation of state at low densities, specifically the pure neutron matter EOS, is included by utilizing a precise N3LO calculation within chiral effective field theory.

One of the key aspects examined in this investigation is the possible presence of hyperons within neutron stars and how different sets of models account for their onset. Hyperons are exotic particles containing strange quarks that may appear at high densities. By comparing the predictions of various models, we can discern whether hyperons are likely to exist within neutron stars and assess their influence on the EOS.

Our approach based on microscopic models of hadronic matter allows us to discuss the composition of neutron stars and to establish a reference with respect to agnostic descriptions of the equation of state connecting the low-density EoS to perturbative quantum chromodynamics (pQCD) results, which aim at identifying signatures of deconfinement.

We analyze the compatibility of the different models considered with pQCD, which provides a framework for understanding the strong nuclear force at high energies. We can evaluate the degree to which the hadronic models studied are aligned with fundamental particle physics principles by looking at the agreement between them and pQCD. Additionally, measures of conformality and the normalized trace anomaly are calculated for the model sets under consideration.

The findings of our study indicate that pQCD favors models that exhibit a substantial contribution from the nonlinear vector field term or incorporate hyperons. This suggests that the inclusion of these features in the models leads to better agreement with fundamental principles and observations. We consider that a thorough discussion of the hadronic EOS will help identify a deconfinement phase transition.

Author: MALIK, TUHIN (CFisUC - University of Coimbra)

Co-authors: PROVIDÊNCIA, Constança (CFisUC - University of Coimbra); DEXHEIMER, Veronica (Kent State University)

Presenter: MALIK, TUHIN (CFisUC - University of Coimbra)

Session Classification: Parallel session A