Contribution ID: **148** Type: **Contributed talk**

CFL quark cores in low-mass neutron stars via sexaquark condensation

Monday, 8 July 2024 15:15 (20 minutes)

We propose a scenario where the existence of a scalar, electrically neutral flavor-singlet three-diquark bound state, the light sexaquark S(uuddss), with a mass well below the double-Λ threshold M_{ΛΛ} = 2231.4 MeV entails the gravitational instability of low-mass neutron stars due to its Bose-Einstein condensation (BEC) [1]. Since in this state the neutron star core loses the pressure support against gravity, the resulting density pileup inevitably triggers the Mott dissociation of the S into its diquark constituents which in turn form a Bardeen–Cooper–Schrieffer (BCS) type BEC state of diquark Cooper pairs in the color superconducting color-flavor-locking (CFL) phase. Within this scenario the deconfinement of the CFL quark matter is a special kind of BEC-BCS transition and its onset density is controlled by the sexaquark mass. Remarkably, the most up-to-date results on the sexaquark mass assume an early deconfinement of SQM in NS with masses about 1 M_sun. Furthermore, we discuss the phenomenological consequences of the presence of the CFL SQM in NS [2]. We analyze the present observational and multi-messenger data in order to constrain the parameters of the CFL quark matter. This analysis independently leads to the conclusion about an early onset of SQM and assumes all the medium mass NS with masses M=1 −1.4 M_solar to have a quark core. We also demonstrate that such an early deconfinement scenario naturally explains the nature of the recently observed enigmatic HESS J1731-347 compact object [3]. Another intriguing consequence of the CFL color-superconductivity corresponds to the possibility of absolutely stable of SQM. We investigate the parameter space of SQM, which is consistent with the present observational and multi-messenger constraints and simultaneously provides its absolute stability. Finally, given the fact that the performed study is based on a chiral model of SQM with non-local interaction, which by construction exhibits an asymptotically conformal behavior, we consider the question of approximately conformal quark matter in NS and demonstrate that it is an unlikely scenario. Instead, we argue that a pronounced peak of squared speed of sound reaching about 0.6 corresponds to the quark boundary of quark-hadron mixed phase.

[1] D. Blaschke, O. Ivanytskyi, M. Shahrbaf, Quark deconfinement in compact stars through sexaquark condensation, Contribution to the Book "New Phenomena and New States of Matter in the Universe. From Quarks to Cosmos" edited by C. A. Z. Vasconcellos, P. O. Hess and T. Boller, World Scientific (2023), pp. 317-342.

[2] David Blaschke, Udita Shukla, Oleksii Ivanytskyi, Simon Liebing, Phys. Rev. D 107, 6, 063034 (2023).

[3] Violetta Sagun, Edoardo Giangrandi, Tim Dietrich, Oleksii Ivanytskyi, Rodrigo Negreiros, Constança Providencia, Astrophys. J. 958, 1, 49, (2023)

session

H. Equation of State and Neutron Stars

Primary author: IVANYTSKYI, Oleksii (University of Wroclaw)

Presenter: IVANYTSKYI, Oleksii (University of Wroclaw)

Session Classification: H. Equation of State and Neutron Stars