NewCompStar STSM scientific report

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STSM topic: Role of higher quark interactions in the mass-radii relation of hybrid stars

Host: David Blaschke

This STSM was focused on the role of higher quark interactions in the description of quark matter equation of state and its application to hybrid stars. We have employed the $SU(2)$ chiral Nambu-Jona-Lasinio (NJL) model where, besides the traditional 4-quark interactions, also 8-quark interactions were introduced in the Lagrangian. We call this model the h(igher)NJL model. This model has been introduced in [1] where it was shown by construction that with 8-quark interactions one is able to verify the recent 2 solar mass constraint.

The hNJL model allows us to provide very stiff quark matter equations of state in a self-consistent treatment. It has been shown [2, 3] that a very stiff quark matter equation of state was one pre-requisite of the high-mass twin phenomenon (HMTP). Since the quark matter model used in [2] was not based on a microphysical approach and the one in [3] employed an *ad hoc* interpolation procedure, it was important to investigate the HMTP in the present project within the hNJL model.

The work carried out during the STSM was the construction of a hybrid equation of state and the calculation of the static mass-radii sequences. Nuclear matter was described with the DD2 equation of state. The composite nature of the nucleon was taken into account via the excluded volume. For the quark matter equation of state we have used the hNJL model. The most important result of this STSM was the proof that the HMTP can be obtained also in the hNJL model.

The HMTP has a rich phenomenology. On the theoretical side it is connected to the large latent heat at the hadron-quark interface, occurring due to a strong first-order transition in the QCD phase diagram. On the experimental side, the HMTP provides a remarkable goal for future observations of masses and radii of neutron stars. Experimental missions such as LOFT and NICER will hopefully yield sufficiently precise radii measurements enabling a test of the HMTP.

Given these important implications of the HMTP, we anticipate one publication as a direct result of this STSM by the end of this year.

References

[1] S. Benic, Eur. Phys. J. A **50** (2014) 111; [arXiv:1401.5380 [nucl-th]].

[2] D. E. Alvarez-Castillo and D. Blaschke, arXiv:1304.7758 [astro-ph.HE].

[3] D. Blaschke, D. E. Alvarez-Castillo and S. Benic, PoS CPOD **2013** (2013) 063; [arXiv:1310.3803 [nucl-th]].