Explaining Low Mass Compact Objects Using Kaon Condensates

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The recent observation of the compact star XTE J1814-338 with a mass of $M = 1.2^{+0.05}_{-0.05}$ $\mathrm{M}_\odot$ and a radius of $R = 7^{+0.4}_{-0.4}$ km, together with the HESS J1731-347, which has a mass of $M = 0.77^{+0.20}_{-0.17}$ $\mathrm{M}_\odot$ and a radius of $R = 10.4^{+0.86}_{-0.78}$ km, they provide evidence for the possible presence of exotic matter in the core of neutron stars and significantly enhance our understanding of the equation of state for the dense nuclear matter. In the present study [1, 2], we investigate the possible existence of negative charged kaons and neutral antikaons in neutron stars by employing the relativistic mean field model with first order kaonic (K^- and $\bar{K^0}$) condensates. This represents a first alternative attempt aimed to explain the bulk properties of the XTE J1814-338 object and at the same time the HESS J1731-347 object, using a mixture of kaon condensation in dense nuclear matter. The kaon potential is further found to be compatible with values obtained using kaonic atoms. In addition, we compare our analysis approach with the recent observation of PSR J0437-4715 and PSR J1231-1411 pulsars, proposing that to simultaneously explain the current variety of astrophysical objects, it is essential to resurrect a scenario of two distinct branches, each corresponding to a different composition of nuclear matter.

References

[1] M. Veselský, P.S. Koliogiannis, V Petousis, J. Leja, Ch. Moustakidis, *Phys. Lett. B* **860** (2025) 139185.

[2] M. Veselský, V. Petousis, P.S. Koliogiannis, Ch. Moustakidis, J. Leja, *Phys. Rev. D* **111** (2025) L061308.