FAKULTÄT für PHYSIK
LUDWIG-MAXIMILIANS-UNIVERSITÄT
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PHYSIK-DEPARTMENT
TECHNISCHE UNIVERSITÄT MÜNCHEN
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Garchinger Maier-Leibnitz-Kolloquium

Donnerstag, 02.05.2024, 16^{15} Uhr

Hörsaal der LMU in Garching, Am Coulombwall 1
Treffen zum gemeinsamen Kaffee 16 Uhr

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Constraints on phase transitions in neutron star matter

Recent inference results for the sound velocity of matter in the cores of neutron stars are summarized. Implications for the equation of state and the phase structure of highly compressed baryonic matter are discussed. In view of the strong constraints imposed by the heaviest known pulsars, the equation of state must be very stiff in order to ensure the stability of these extremely massive objects. The required stiffness limits the possible appearance of phase transitions in neutron star cores. For example, a Bayes factor analysis quantifies strong evidence for squared sound velocities $c_s^2 > 0.1c^2$ in the cores of 2.1 solar-mass and lighter neutron stars. Only weak first-order phase transitions with a small phase coexistence density range $\Delta n/n < 0.2$ (at the 68% level) in a Maxwell construction still turn out to be possible within neutron stars. The central baryon densities in even the heaviest neutron stars do not exceed five times the density of normal nuclear matter. In view of these data-based constraints, much discussed issues such as the quest for a phase transition towards restored chiral symmetry and the active degrees of freedom in cold and dense baryonic matter, are reexamined. Finally, a novel method is presented to derive the full posterior distribution of the equation of state directly from neutron star observations. This method relies on the use of neural likelihood estimation, in which neural networks use samples of simulated data to learn the likelihood of neutron star observations. It can significantly reduce the numerical cost of the inference procedure, making the method more scalable to the growing number of neutron star observations expected in the coming years.

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