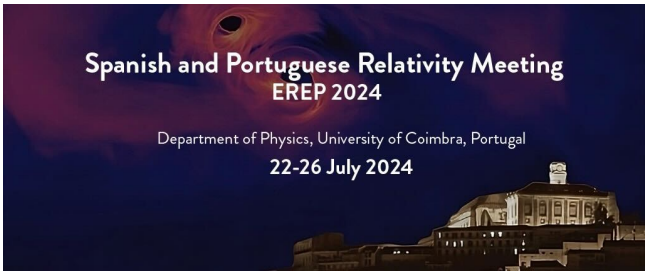

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Non-Parametric Constraints on the Neutron Star Equation of State with Multi-messenger Data

Wednesday 24 July 2024 14:45 (15 minutes)

The behaviour of extremely dense cold nuclear matter is still an open question due to intrinsic modelling difficulties of such extreme environments as the hearts of Neutron Stars (NS), but also to the non-trivial connection between the macroscopic observables and microscopic behaviour. In this work, we utilize the now substantial amount of astrophysical data provided by NS observations, along with constraints from chiral effective field theory(χEFT) and perturbative QCD (pQCD) theoretical calculations to directly constrain the NS Equation of State (EoS). To this end, we employ a non-parametric EoS prior construction with Gaussian Processes that is trained on 75 theoretical EoSs with varying phenomenology and creates both a model-agnostic and model-informed prior. These priors are then utilized in a Bayesian updating scheme by first performing a complete analysis of the BNS event GW170817 with minimal assumptions, and then sequentially adding information from the other NS data streams along with theory constraints. Besides providing standard constraints, such as the pressure at twice nuclear saturation density $P(2\rho_0) = 3.64^{+0.40}_{-0.29} \times 10^{34}$ *dyne cm*$^{-2}$ for the model agnostic prior, our methodology also aims to constrain EoS properties such as phase transitions and differentiation between quark, hyperonic or hadronic models.

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