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New constraints on the nuclear equation of state from the thermal emission of neutron stars in quiescent low-mass X-ray binaries

In the last decades, nuclear equation of state has been a dealing problem. Measuring neutron stars (NSs) radii can bring a key information on nuclear matter properties at very high densities. We employ an empirical parameterization of the equation of state with a Markov-Chain Monte Carlo approach in a Bayesian framework, to consistently fit the spectra of 7 selected NSs. Despite previous analyses predicting low NS radii, we show that it is possible to reconcile the astrophysical data with nuclear physics knowledge, with or without including a prior on the slope of the symmetry energy Lsym. With this empirical parameterization of the equation of state, we obtain radii of the order of about 12 km without worsening the fit statistic. More importantly, we obtain the following values for the slope of the symmetry energy, its curvature Ksym, and the isoscalar skewness parameter Qsat: Lsym = 37.2(+9.2,−8.9) MeV,
Ksym = −85(+82,−70) MeV, and Qsat = 318(+673,−366) MeV. These are the first measurements of the empirical parameters Ksym and Qsat. Their values are only weakly impacted by our assumptions, such as the distances or the number of free empirical parameters, provided the latter are taken within a reasonable range. We also study the weak sensitivity of our results to the set of sources analyzed, and we identify a group of sources that dominates the constraints. The resulting masses and radii obtained from this empirical parameterization are also compared to other measurements from electromagnetic observations of NSs and gravitational wave signals from the NS-NS merger GW 170817.

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