

NEUTRON STARS

State secrets revealed

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Geert Raaijmakers and colleagues have followed up on their earlier work on the properties of the matter (more specifically, its equation of state (EoS)) inside neutron star PSR J0030+0451 with a more detailed study that draws in additional information from the GW170817 binary merger EoS. The refined method allows for not only the joint analysis of EoSs from two different sources, but presents a general framework for the combined study of EoSs from anticipated future multi-messenger observations, and the additional constraints provided by massive pulsars. To demonstrate the flexibility of the approach, Raaijmakers et al. consider the GW170817 event both as a binary neutron star (NS–NS) merger and a neutron star–black hole (NS–BH) merger.

Interestingly, the study shows that the most informative data for determining the EoS comes from ultra-heavy pulsar mass measurements, such as that reported [recently](#) by the NANOGrav collaboration. The constraints from binary merger events have a comparatively small effect, and when one assumes a NS–NS over a NS–BH merger there is only a small difference in EoS that stems from the lack of tidal deformation of the black hole. The choice of priors and the adopted parameterizations are key factors for the modelling itself, along with assumptions about geometry and spin. Although the recent [Neutron Star Interior Composition Explorer](#) (NICER) observations of PSR J0030+0451 have narrowed the potential EoS parameter space, it is further observations of pulsars in the radio and X-ray regimes that will allow model assumptions to be tested and refined.

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