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Optimal neutron-star mass ranges to constrain the equation of state of nuclear matter with electromagnetic and gravitational-wave observations

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Exploiting a very large library of physically plausible equations of state (EOSs) containing more than 10^7 members and yielding more than 10^9 stellar models, we conduct a survey of the impact that a neutron-star radius measurement via electromagnetic observations can have on the EOS of nuclear matter. Such measurements are soon to be expected from the ongoing NICER mission and will complement the constraints on the EOS from gravitational-wave detections. Thanks to the large statistical range of our EOS library, we can obtain a first quantitative estimate of the commonly made assumption that the high-density part of the EOS is best constrained when measuring the radius of the most massive, albeit rare, neutron stars with masses $M > 2.1M$. At the same time, we find that radius measurements of neutron stars with masses $M \sim 1.7 - 1.85M$ can provide the strongest constraints on the low-density part of the EOS. Finally, we quantify how radius measurements by future missions can further improve our understanding of the EOS of matter at nuclear densities.

Keywords

Nuclear Theory

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