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Finding hyperons and quarks in neutrons stars using gaussian processes

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Functional forms of the neutron star Equation of State (EoS) are required to extract the viable EoS band from neutron star mergers. Typically, one of three methods are used– spectral functions, piecewise polytropes, or gaussian process estimations. However, realistic nuclear EoS, containing deconfined quarks or hyperons, present nontrivial features in the speed of sound such as bumps, kinks, or plateaus. These features in the speed of sound cannot be captured well by the currently used methods for the functional forms [1]. We modify gaussian processes by introducing spikes and plateaus in the speed of sound and combine our new EoS method with an active learning framework to quickly rule out EoS that do not fit within constraints from NICER and gravitational waves. We find these new features play a role in understanding ultra-heavy neutron stars that support stellar masses compatible with GW190814.

[1] Tan et al, Phys.Rev.Lett. 125 (2020) 26, 261104

Present via

Authors: MROCZEK, Débora (University of Illinois at Urbana-Champaign); NORONHA-HOSTLER, Jacquelyn (University of Illinois Urbana Champaign); MILLER, M. Coleman (University of Maryland); YUNES, Nicolas

Presenter: MROCZEK, Débora (University of Illinois at Urbana-Champaign)

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