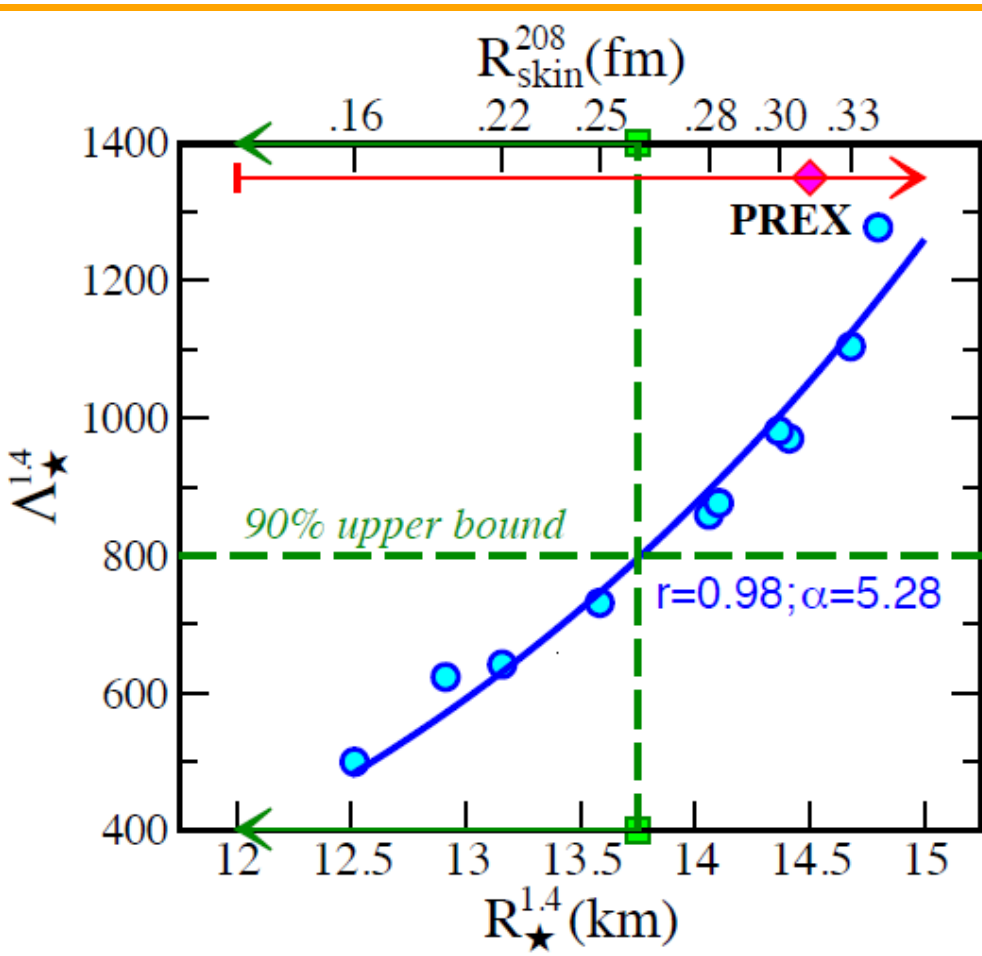
Connecting Neutron Skins to Gravitational Waves

Objectives

- Use a set of realistic equation-of-state (EOS) models to confront their predictions against tidal deformabilities extracted from the gravitational-wave (GW) data of binary neutron star merger GW170817.
- Given the sensitivity of GW data to the EOS, find constraints on the neutron star radius.
- Explore density dependence of the nuclear symmetry energy and analyze the impact of this measurement on the neutron skin thickness of ^{208}Pb.



Model predictions for tidal deformability as a function of the neutron star radius and the neutron skin thickness of ^{208}Pb.

Impact

- Based on the GW data we deduced an upper limit on the neutron star radius of a 1.4 solar-mass neutron star: $R \lesssim 13.76$ km.
- We inferred a corresponding upper limit on the neutron skin thickness of ^{208}Pb: $R_{skin} \lesssim 0.25$ fm.
- Relying on experimental lower bound of $R_{skin}(^{208}\text{Pb})$ as measured by the PREX Collaboration, we were able to provide the lower limit on the tidal deformability $\gtrsim 490$.
- If the upcoming experiment measures a thicker skin, this may be evidence of a softening of the symmetry energy at high densities, or indicative of a phase transition in the interior of neutron stars.

Accomplishments

- Publication: F. J Fattoyev, J. Piekarewicz, and C. J. Horowitz, Phys. Rev. Lett. 120, 172702 (2018).
- Highlighted as Editors' Suggestion.
- Featured in Physics (phys.aps.org) as Synopsis: Gravitational Waves Shed Light on Dense Nuclear Matter.
- Featured by Physics Today, Inside Science, Physics World, Sky & Telescope, and several international news outlets.