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Neutron Stars Structure in the Era of Multi-Messenger Astronomy

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The first direct detection of gravitational waves from the binary collision of two black holes and the first detection of gravitational waves from GW170817, a binary neutron star merger in association with its electromagnetic counterpart, launched the new era of gravitational-wave astronomy. Two years after GW170817, the LIGO-Virgo collaboration continues to mesmerize the physics community when they recently reported the detection of gravitational waves from the coalescence of a binary system, GW190814, with the most extreme mass ratio ever observed: a 23 solar mass black hole and a 2.6 solar mass "compact" object. Besides gravitational waves, the ground- and space-based telescopes operating at a variety of wavelengths have already been providing a treasure trove of insights into the nature of dense matter comprising stellar objects. And together, these observations are answering some of the most fundamental questions concerning neutron stars: What is the nature of dense matter found in neutron stars? What is the maximum mass of a neutron star? How compact are compact objects? In this plenary session, I will discuss recent progress in constraining the bulk properties of neutron stars from gravitational waves and electromagnetic observations. In particular, I will present our work on constraining the equation of state of dense matter from these observations, and our finding on the upper limit of the neutron-star radius as imposed by the tidal polarizability inferred from the gravitational wave observations. I will also discuss our recent findings on the maximum theoretical neutron star mass as predicted by the state-of-art equation of state from covariant density functional whose model parameters are constrained by the latest nuclear experimental data. Finally, I will discuss some possible tension arising between theoretical model predictions and astrophysical observations of neutron stars.

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