

DNP19-2019-020003

Abstract for an Invited Paper
for the DNP19 Meeting of
the American Physical Society

Learning about Dense Neutron-rich Matter with Gravitational Waves

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Astronomical observations of neutron stars inform our understanding of dense matter at the highest densities. In 2017, the first gravitational-wave signal from a neutron-star coalescence was observed by LIGO and Virgo. I will describe how we have used its gravitational-wave data to constrain the equation of state of dense matter in neutron stars, by exploring the effect of tidal interactions on the neutron-star coalescence and then translating tidal information from the signal into other properties of the component stars. A new observing run began in April 2019, and LIGO and Virgo have already sent public alerts for new neutron-star merger candidates. I will discuss prospects for learning about matter with gravitational waves in the current Advanced-detector era and outline how next-generation observatories can map the phase diagram of dense neutron-rich matter.