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Probing the symmetry energy of dense neutron-rich matter with terrestrial experiments and astrophysical observations

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Neutron-rich matter exists naturally in neutron stars and some nuclei. It can also be created during mergers of neutron stars in space and collisions between two heavy nuclei in terrestrial nuclear laboratories. The nature and Equation of State (EOS) of such matter are still very poorly known while they have broad impacts on many interesting issues in both astrophysics and nuclear physics. In particular, nuclear symmetry energy encoding the energy cost to make nuclear matter more neutron rich has been the most uncertain part of the EOS of dense neutron-rich nucleonic matter. It affects the masses, radii, tidal deformations, cooling rates and frequencies of various oscillation modes of isolated neutron stars as well as the strain amplitude and frequencies of gravitational waves from neutron star mergers. In this talk, we will discuss several outstanding issues and recent progresses in probing the symmetry energy of dense neutron-rich matter as well as its impacts on properties of nuclear reactions and neutron stars.

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