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Constraints on the neutron star properties from the relativistic energy density functional

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Recent developments of the relativistic nuclear energy density functional (RNEDF) provide a self-consistent framework for the description of a variety of nuclear properties of astrophysical relevance, including the nuclear matter equation of state, and various neutron star properties. The RNEDF is supplemented with the covariance analysis in order to assess statistical uncertainties of calculated quantities and correlations between relevant quantities. Recently a method has been introduced that establishes relations between the properties of collective excitations in finite nuclei and the phase transition density and pressure at the inner edge separating the liquid core and the solid crust of a neutron star. A theoretical framework that includes the thermodynamic method, the RNEDF, and the quasiparticle random-phase approximation has been employed in a self-consistent calculation of the neutron star core-to-crust transition density and pressure. This approach crucially depends on the experimental results for collective excitations in nuclei that constrain the symmetry energy in nuclear matter, in particular excitation energies of giant resonances, energy-weighted pygmy dipole strength, and dipole polarizability. The RNEDF framework also provides an insight into the neutron star mass-radius relationship.

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