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Correlations and Semi-Universal Relations Connecting Nuclear Matter and Neutron Stars

The close correspondence between neutron star matter pressure near the saturation density and the radii of typical neutron stars is an example of a semi-universal relation, as is the Yagi-Yunes I-Love relation connecting the moments of inertia and the tidal deformability of neutron stars. These relations are valid for all or nearly all equations of state to high precision. Using an extensive database of hundreds of Skyrme- and RMF-type nuclear interactions proposed over the last several decades, I will demonstrate several additional relations that could prove valuable in interpreting astronomical observations of neutron stars. For example, the central energy density and pressure of the maximum mass star are highly correlated with the maximum mass, the radius of the maximum mass star, and the radius of the star with half the maximum mass. Other relations can be found that are able to predict the central energy density and the pressure of smaller mass stars using mass-radius information only. Such relations may allow the semi-analytic inversion of the mass-radius diagram.

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