THE CHINESE UNIVERSITY OF HONG KONG
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Constraining Neutron-Star Matter with Microscopic and Macroscopic Collisions

by

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ALL INTERESTED ARE WELCOME
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Abstract

Interpreting high-energy, astrophysical phenomena, such as supernova explosions or neutron-star collisions, requires a robust understanding of matter at supranuclear densities. However, our knowledge about dense matter explored in the cores of neutron stars remains limited. Fortunately, dense matter is not probed only in astrophysical observations, but also in terrestrial heavy-ion collision experiments. Here we use Bayesian inference to combine data from astrophysical multi-messenger observations of neutron stars and from heavy-ion collisions of gold nuclei at relativistic energies with microscopic nuclear theory calculations to improve our understanding of dense matter. We find that the inclusion of heavy-ion collision data indicates an increase in the pressure in dense matter relative to previous analyses, shifting neutron-star radii towards larger values, consistent with recent observations by the Neutron Star Interior Composition Explorer mission. Our findings show that constraints from heavy-ion collision experiments show a remarkable consistency with multi-messenger observations and provide complementary information on the nuclear matter at intermediate densities. This work combines nuclear theory, nuclear experiment, and astrophysical observations, and shows how joint analyses can shed light on the properties of neutron-rich supranuclear matter over the density range probed in neutron stars.