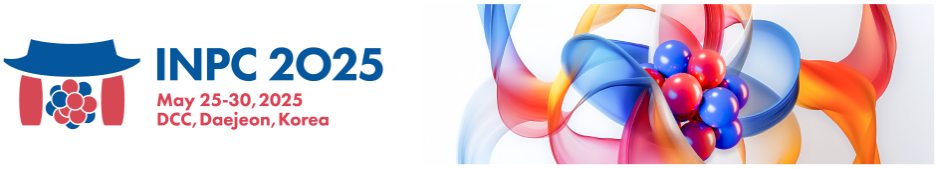

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Probing the Equation of State of Neutron Stars with heavy ion collisions

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The equation of state (EOS) is a fundamental property of nuclear matter, crucial for understanding the structure of systems as diverse as atomic nuclei and neutron stars. The importance of studying neutron stars has grown recently due to the observation of gravitational waves from neutron star mergers.

Nuclear reactions involving heavy-ion collisions in laboratories can create nuclear matter similar to that found in neutron stars. However, the density and momentum dependence of the EOS of asymmetric nuclear matter—particularly the symmetry energy term—remains largely unconstrained. Laboratory studies of neutron-deficient and neutron-rich heavy-ion collisions have already provided initial constraints on the EOS of neutron-rich matter at sub-saturation densities.

To establish constraints at higher densities, new experimental measurements and advancements in the theoretical modeling of nuclear collisions and neutron star properties are essential. In this context, we present results from a recent experiment conducted at the National Superconducting Cyclotron Laboratory, which focused on studying the EOS through observables involving charged particles and neutrons, such as neutron-to-proton spectral ratios. We compare the experimental results with various transport model calculations, emphasizing their sensitivity to the density and momentum dependence of the nuclear symmetry potential and their implications for understanding the EOS in neutron star mergers.

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