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Constraining the isovector effective mass with neutron to proton ratio Rn/p from heavy-ion collisions

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The momentum-dependent potentials for neutrons and protons at energies well away from the Fermi surface cause both to behave as if their inertial masses are effectively 70% of the vacuum values. This effective mass describes the non-locality both in space and in time of the nuclear effective interactions and the Pauli exchange. This similarity in effective masses (isoscalar effective mass) may not be true in neutron-rich matter because of the momentum dependence of the symmetry (isovector) potential in nucleonic matter. Today the sign of the effective-mass splitting Delta(m_np) = m_n − m_p and the dependences of the mass splitting on density ρ and on the asymmetry remain poorly constrained. This is an important parameter in dense neutron-rich regions within neutron stars, core-collapse supernovas, and nuclear collisions. There differences in the momentum-dependent symmetry potentials may cause neutron and proton effective masses to differ significantly.
To investigate this effect, measurement of the energy spectra of neutrons, protons, and charged particles emitted in 112Sn+112Sn and 124Sn+124Sn collisions at Ebeam/A = 50 and 120 MeV has been performed and the double neutron to proton ratio DRn/p was built in order to cancel out the efficiency effect. The double ratio was compared to model with very different values of the neutron and proton effective masses.
The single neutron to proton ratio Rn/p should be more sensitive to the isovector effective mass. However in order to be able to use this ratio, one has to carefully correct for the detec- tion efficiency for neutrons and the light charged particles especially at high energies where the efficiency of detecting the full energy of the particle decreases because of multiple scattering and nuclear reactions occurring in the detector material. In my presentation, I will show particle energy spectrum that has been corrected from such an effect. Sophistical statistical tools (bayesian analysis) will be used to constrain the effective mass and the slope of the symmetry energy using the single Rn/p ratios and transport models.

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