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Hints of the momentum-dependent nucleon effective mass splitting via heavy ion collisions

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The neutron-proton effective mass splitting (Δm^{np}) is investigated through analyses of heavy-ion collisions using the improved quantum molecular dynamics (ImQMD) model with both standard and extended Skyrme interactions. We find a strong correlation between the slope of the neutron-to-proton yield ratio with respect to the kinetic energy (i.e., $S_{n/p}$) and Δm^{np} , with correlation coefficients exceeding 0.80. For the $^{124}\text{Sn} + ^{124}\text{Sn}$ system, this correlation reaches 0.928. By comparing theoretical predictions with experimental data, we reveal a novel dependence of the neutron-proton effective mass splitting on momentum: at low kinetic energies, the data favor $m^{n} > m^{p}$, which is consistent with the nucleon-nucleus scattering analysis, while at high kinetic energies, they favor $m^{n} < m^{p}$, which is an extended understanding of effective mass splitting at high kinetic energy region. This finding provides the first direct evidence that the momentum-dependent symmetry potential likely decreases initially and then increases with momentum.

Consent

Yes

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