



Probing neutron-skin thickness with free spectator neutrons in ultracentral high-energy isobaric collisions

Tuesday 14 June 2022 17:12 (1 minute)

We propose that the yield ratio of free spectator neutrons produced in ultracentral $^{96}\text{Zr}+^{96}\text{Zr}$ to $^{96}\text{Ru}+^{96}\text{Ru}$ collisions is a robust probe of the neutron-skin thickness Δr_{np} and the slope parameter L of the symmetry energy. The idea is demonstrated based on the proton and neutron density distributions of colliding nuclei from the Skyrme-Hartree-Fock model, and a Glauber model that provides information of spectator matter, where free neutrons are produced from the deexcitation of heavy clusters through the GEMINI model and direct ones that have not coalesced into light clusters through a Wigner function approach. A larger Δr_{np} associated with a larger L value increases the isospin asymmetry of spectator matter and thus leads to more free neutrons, especially in ultracentral collisions where the multiplicity of free neutrons are not affected by uncertainties of cluster formation and deexcitation. The ratio of neutron multiplicities in isobaric collision systems reduces the theoretical and experimental uncertainties, and is insensitive to the nuclear deformation effects.

Present via

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Session Classification: Poster

Track Classification: Other topics