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# Spectator nucleons in ultracentral $^{208}$Pb–$^{208}$Pb collisions as a probe of nuclear periphery

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As known, nuclear periphery in heavy nuclei is enriched by neutrons. Neutron-to-proton ratio is especially high in a very thin (<0.5 fm) surface layer of such nuclei termed neutron skin (NS). The difference between RMS radii of neutron and proton density distributions is also subtle and difficult to measure. The results obtained with different theoretical and experimental methods are characterized by large uncertainties and sometimes contradict each other. In this work we propose a new method to constrain the parameters of neutron skin by investigating the composition of spectator matter in ultracentral collisions of heavy relativistic nuclei. The yields of spectator neutrons and protons in ultracentral $^{208}$Pb–$^{208}$Pb collisions at the CERN SPS and LHC were calculated within a new version of Abrasion-Ablation Monte Carlo for Colliders model (AAMCC-MST) with accounting for preequilibrium break-up of spectator matter (prefragment) due to its irregular half-moon shape. AAMCC-MST modeling of each collision event was proceeded in several stages. Firstly, the size and shape of spectator prefragments from both colliding nuclei were defined using Glauber Monte Carlo model. Secondly, the excitation energy of the prefragments was calculated. Thirdly, the minimum spanning tree (MST) clustering algorithm was applied to both prefragments to define secondary clusters with their excitation energy estimated depending of their size. Finally, cluster decays were simulated with Fermi Break-up model from Geant4 toolkit. It is found that the simulations of ultracentral $^{208}$Pb–$^{208}$Pb collisions with accounting for NS demonstrate a modest 10% increase of the cross sections to produce a given number of spectator neutrons in comparison to calculations without NS. Similar cross sections, but calculated for events without spectator protons, demonstrate a prominent increase up to 50% due to accounting for NS. The impact of NS on the events with given numbers of spectator protons ($N_p$=1,2,3) is also investigated. The dependence of the considered cross sections on the parameters of density distributions of neutrons and protons in $^{208}$Pb has been studied. The considered effects of NS can be studied at the ALICE experiment at the LHC providing that the measurements of neutron and proton yields are properly corrected for the acceptance and efficiency of forward hadronic calorimeters.

**Primary author:** KOZYREV, Nikita (Moscow Institute of Physics and Technology)

**Co-authors:** Mr SVETLICHNYI, Aleksandr (INR RAS, MIPT); Mr NEPEYVODA, Roman (MIPT); PSHENICHNOV, Igor (Russian Academy of Sciences (RU))

**Presenter:** KOZYREV, Nikita (Moscow Institute of Physics and Technology)

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