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Spectator nucleons in most central Au—Au collisions at NICA

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Collisions of ^{197}Au nuclei with the center-of-mass energy $\sqrt{s_{NN}}$ from 4 to 11 GeV will be studied in the MPD (MultiPurpose Detector) experiment at NICA collider, which is presently under construction. In the BM@N experiment at the same facility nuclear beams interact with fixed targers. The NICA facility is designed for the investigations of baryon-rich strongly-interacting nuclear matter of high density and temperature. The formation of a new kind of matter known as the Quark-Gluon Plasma (QGP) is more likely in central collisions of heavy nuclei due to their compelete overlap.
The most central collisions are usually selected in experiments by the requirement of the highest muliplicity of produced secondary particles. In such collisions the number of participating nucleons in both of the colliding nuclei also reaches it maximum because of the largest overlap of these nuclei. In the case of central ^{197}Au—^{197}Au collisions one can naively expect zero number of non-participating (spectator) nucleons which otherwise continue to propagate strictly in the forward direction after the collision. However, several experiments at the CERN SPS, RHIC and LHC which employed
forward hadronic calorimeters to detect spectator nucleons clearly demonstrated their presense even in the most central collisions of equal nuclei, like ^{208}Pb or ^{197}Au.

In this work we study the properties of spectator matter in most central (of 0-5% centrality) ^{197}Au—^{197}Au and ^{208}Pb—^{208}Pb collisions at NICA and the CERN SPS, respectively. We use a recently developed Abrasion-Ablation Monte Carlo Model for Colliders (AAMCC). AAMCC is based on the version 3.0 of the GlauberMC model, which estimates the volume of spectator matter from both colliding nuclei on the event-by-event basis. This matter is considered in the form of two excited prefragments with excitation energies depending on their sizes. Their exctations and decays are modeled on event-by-event basis by means of the evaporation, Fermi Break-up and SMM models from Geant4 library.

We demonstrate that the calulated numbers of spectator neutrons and protons in most central collisons of equal heavy nuclei are non-zero and they are sensitive to (1) the specific procedure used to calculate the excitation energy of prefragments; (2) the presence of neutron-skin in initial nuclei. We argue that the rates of events with unequal numbers of spectator neutrons and protons (e.g., a single proton and several neutrons and vice versa) in central collisions are especially sensitive to these effects.

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