Journal of Physics: Conference Series **668** (2016) 012106 doi:10.1088/1742-6596/668/1/012106

Study of clusters and hypernuclei production with the NICA/MPD experiment

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Abstract. We report on the first results on the dynamical modeling of cluster formation with the combined PHSD+SACA model at Nuclotron and NICA energies. Based on present predictions of the combined model we study the possibility to detect such clusters and hypernuclei in the BM@N and MPD/NICA detectors.

PHSD+SACA model

The Parton-Hadron-String Dynamics (PHSD) [1] is a microscopic off-shell transport approach that describes the full evolution of heavy-ion collision at relativistic energies. The Simulated Annealing Clusterisation Algorithm (SACA) [2] is based on the search for nucleon configurations with a minimal binding energy; SACA takes randomly one nucleon and adds it to another fragment until the most bound configuration is found. For our studies, we combine the PHSD and SACA approaches; PHSD produces hadrons and stops at a certain time, and then SACA takes over and forms clusters and hypernuclei. It is very important to choose an appropriate starting time for the clusterisation algorithm.

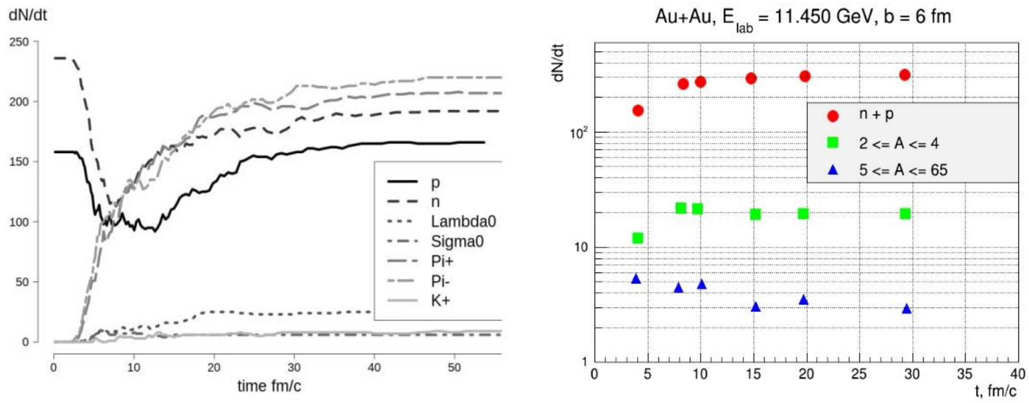

Fig.1. (left) Hadrons multiplicity over PHSD evolution time; (right) multiplicity of fragments over selected starting times.

In the left panel of Fig.1, particles multiplicity over PHSD evolution time is shown. For our studies we chose starting time t = 4, 8, 10, 15, 20, and 30 fm/c. In the right panel, the multiplicity of different kind of particles and fragments for selected times is shown. After 15 fm/c, multiplicity is almost stable, so we decided to choose t = 15 fm/c as a starting time for SACA simulations at 11.45 GeV. Fig. 2 shows the comparison of PHSD+SACA predictions with dN/dy distributions - for protons (left panel) and deuterons (right panel) - measured at the AGS by the E-802 experiment [3] for central Au+Au collisions at 11.45 AGeV. As one can see, the combined model reproduces the experimental data well.

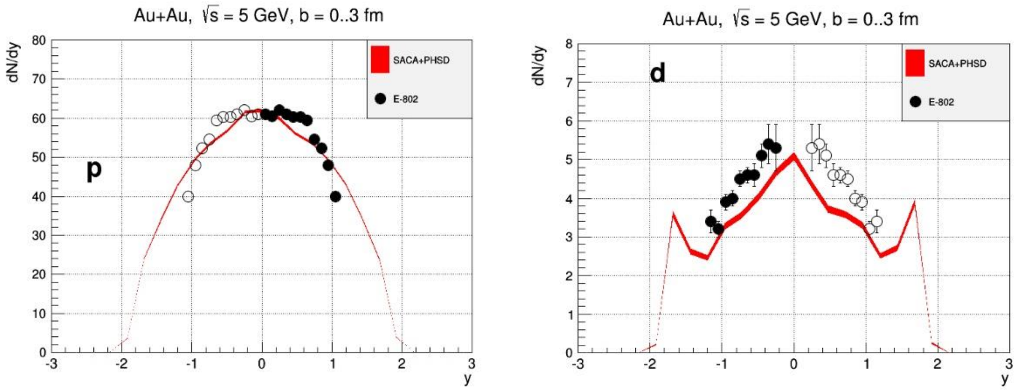

Fig.2. dN/dy distributions for protons (left panel) and deuterons (right panel) in the central Au+Au collisions at 11.45. Lines are PHSD+SACA predictions; black filled circles are the E-802 experimental data; black open circles are the mirrored data.

Multi-Purpose Detector feasibility study

One of the tasks of the Multi-Purpose Detector [4] is to study the strangeness production. The left panel of the Fig. 3 shows the yields of hypernuclei and hyperons of PHSD+SACA model for Au+Au collisions at 11.45 GeV. Preliminary results of the MPD feasibility study for hypertrinon are shown in the right panel. Hypertriton signal is clearly viewed, with a Signal-to-Background ratio of 3.3, and an efficiency of about 0.4%.

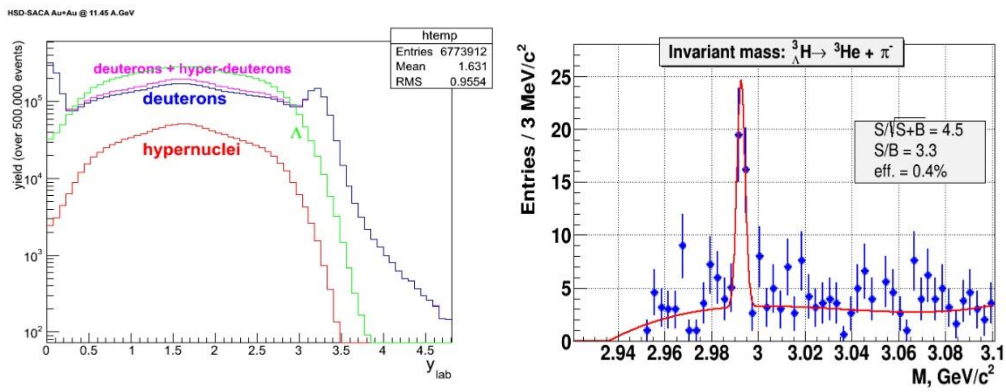

Fig.3. (Left) Yields of hypernuclei and hyperons in PHSD+SACA model, central Au+Au collisions at 11.45 GeV; (right) Invariant mass distribution for He3 and π-.

Conclusion

PHSD+SACA model can produce clusters and hypernuclei and reproduce experimental data for 11.45 GeV; these predictions have already been used for MPD performance studies. PHSD+SACA model is actively developing, and there is some polishing work to do.

Acknowledgments

I am very thankful to A. Le Fevre, E. Bratkovskaya, J. Aichelin and Y. Leifels for their assistance and comments.

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