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Production of nuclei and hypernuclei in relativistic ion reactions

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We review the main mechanisms leading to the production of light and intermediate mass nuclei and hypernuclei in relativistic nuclei collisions. We demonstrate that in these many-body phenomena one can separate and describe the processes characterising excited nuclear matter properties which have a primary importance for nuclear/particle physics and astrophysics. Such deep-inelastic high-energy collisions do lead to the fragmentation (multifragmentation) of nuclear matter and, in addition, the hyper-fragments can be abundantly produced [1,2]. The binding energies of hyperons can be determined from the correlated hypernuclei yields [3,4], and this gives a chance to evaluate experimentally the hyperon effects in nuclear matter. The promising process for such a research is the disintegration of large excited nuclear and hyper-nuclear residues produced in peripheral nucleus-nucleus collisions. In central collisions, we prove a novel mechanism responsible for combining nucleons and hyperons into large clusters [5]: These cluster can be formed by the residual nuclear interaction at a low sub-nuclear density when the nuclear matter expands. One can describe this process within the statistical approach as a disintegration of the excited finite clusters of low (freeze-out) density. In the same time we have obtained the limitation on the temperature of such clusters which is important for all statistical nucleation processes in the expanding matter. Our approach is able to describe the FOPI experimental data measured in central collisions, in particular, nuclei yields, nuclei kinetic energies, and the modification of the nuclear isotope yields with increasing the beam energy. Previously, it was not possible with other models. This novel mechanism leads to the correlations of the produced nuclear species and to producing unstable hypernuclei states that can be used for the nuclei/hypernuclei identification. The transport and statistical models are used to describe the whole reaction. Concerning to hypernuclei studies we demonstrate the advantages of such reactions over the traditional hypernuclear methods: A broad distribution of predicted hypernuclei in masses and isospin allows for investigating properties of exotic hypernuclei. We point at the abundant production of multi-strange nuclei that will give an access to multi-hyperon systems and strange nuclear matter. The realistic estimates of hypernuclei yields in various collisions are presented.

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Author: BOTVINA, Alexander (ITP, University of Frankfurt am Main)

Co-author: BLEICHER, Marcus

Presenter: BOTVINA, Alexander (ITP, University of Frankfurt am Main)

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