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Production of hypernuclei and properties of hyper-nuclear matter

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The research for hypernuclei and their production mechanisms open new opportunities for nuclear/particle physics and astrophysics. The hyperons influence many nuclear properties in finite nuclei and in neutron stars (infinite nuclear matter). In particular, hypernuclei allow to explore the many-body aspects of the strong three-flavor interaction at low energies. We review the main processes leading to the production of hypernuclei in nuclear reactions: In violent high-energy interactions leading to fragmentation and multifragmentation of nuclear matter they can be abundantly produced [1,2]. The binding energies of hyperons influence the hypernuclei formation [3] and this gives a chance to evaluate experimentally the hyperon effects in nuclear matter. The most promising process for such a research is a disintegration of large excited hyper-nuclear residues produced in peripheral relativistic nucleus-nucleus collisions. Besides, there is a coalescence of hyperons with other baryons into light clusters. We use the transport, coalescence and statistical models to describe the whole process, and demonstrate the important regularities of the hypernuclei formation and 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, as well as the hypermatter both at high and low temperatures. We point at the abundant production of multi-strange nuclei that can give an access to multi-hyperon systems and strange nuclear matter. The realistic estimates of hypernuclei yields in various collisions are presented. There is a saturation of the hypernuclei production at high energies [1], therefore, the optimal way to pursue this experimental study is to use the accelerator facilities of intermediate energies, like FAIR (Darmstadt) and NICA (Dubna).

[1] A.S. Botvina, et al., Phys. Rev. C95, 014902 (2017).

[2] A.S. Botvina, et al., Phys. Rev. C94, 054615 (2016).

[3] N. Buyukcizmeci, et al., Phys. Rev. C98, 064603 (2018).

Collaboration name

Track

Others

Primary authors: BOTVINA, Alexander (ITP and FIAS, University of Frankfurt am Main); Prof. BLEICHER, Marcus (ITP and FIAS, University of Frankfurt am Main)

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

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