Probing the symmetry energy in heavy-ion collisions

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In this talk an overview of the present status in symmetry energy research in nuclear dynamics of heavy-ion collisions (HIC) will be presented. This research field is currently attracting strong interest due to is relevance to both nuclear physics and astrophysics [1]. As of today, the density dependence of the symmetry energy is poorly constrained [1]. New insights have been possible due to the availability of facilities capable of accelerating nuclei with very large neutron/proton N/Z asymmetries. Such high N/Z asymmetries amplify the effects induced by the density dependence of the symmetry energy on nuclear reaction dynamics and help studying the equation of state of asymmetric nuclear matter under laboratory controlled conditions [2].

A number of different observables have been used and will be discussed. The link of experimental measurements to fundamental information about the density dependence of the symmetry energy and the isospin dependence of nucleon-nucleon cross section is commonly provided by quantitative comparisons to transport model simulations [1, 2, 3, 8, 9]. The observables currently used in the intermediate beam energy domain (E/A<100 MeV) are aimed at probing the symmetry energy at sub-saturation densities [1, 2, 4, 5, 6]. Among them, we mention isotopically resolved fragment yields, pre-equilibrium emission ratios (n/p, t/3He, etc.), isospin diffusion/equilibration phenomena, isospin stopping, nucleon-nucleon correlation functions. Supra-saturation densities are accessible in HIC at medium energies, E/A>100 MeV. In this case observables presently under investigation include collective flow, pion and kaon emissions [7, 8, 9].

The results obtained in the last decade and the availability of the future accelerator facilities and new detector equipments in China, Europe, Japan and USA are expected to allow us making progress in understanding the equation of state of asymmetric nuclear matter with its fundamental links to neutron stars and supernovae.

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