From atomic nucleus to neutron star: the nuclear equation of state and the density dependence of the symmetry energy

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The equation of state of isospin asymmetric (N/Z > 1) nuclear matter is a fundamental quantity that determines the properties of systems as small and light as the atomic nucleus, and as large and heavy as the neutron star. The key ingredient for constructing the nuclear equation of state is the basic nucleon-nucleon interaction. Until now our understanding of the nucleon-nucleon interaction has come from studying nuclear matter that is symmetric in isospin (neutron-to-proton ratio, N/Z ~1) and that found near normal nuclear density (ρ_0 ~ 0.16 fm^{-3}) . It is not know how far this understanding remains valid as one goes away from the normal nuclear density and symmetric nuclear matter. Theoretical studies based on microscopic many-body calculations and phenomenological approaches predict various different forms of the nuclear equation of state and the density dependence of the nuclear symmetry energy. Measurement of fragment yields in multifrgamentation reaction can be used to determine the form of the density dependence of the symmetry energy which is important for studying the structure of neutron-rich nuclei and studies relating to astrophysical origin, such as the structure of neutron stars and the dynamics of supernova collapse.

In this talk, I will present recent experimental constraint on the density dependence of the symmetry energy, and their implications for experiments probing the properties of nuclei using beams of neutron-rich nuclei.