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Equation of State and in-medium nuclear structure in heavy-ion collisions

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Heavy-ion collisions provide unique access to nuclear structure properties away from saturation density and at finite temperatures. Such structure properties are determined by the equation of state (EoS) and the symmetry energy of nuclear matter that can in turn be studied under laboratory controlled conditions. Such conditions are encountered in neutron stars and in core collapse supernovae explosions. Alpha clustering phenomena in nuclear matter under such extreme conditions [1] are indeed relevant to the neutrinosphere of core collapse supernovae where the opacity of dilute and hot nuclear matter to outgoing neutrinos determines the explosion dynamics and the nucleosynthesis of medium heavy elements. By means of single particle observables and multi-particle correlation measurements [2] with 4π detectors and high resolution correlators one can measure nuclear structure properties, such as spin and branching ratios of unbound states in stable and exotic nuclei, while controlling the temperature and density of the nuclear medium where such nuclei are produced. Experimental results from such measurements performed with the INDRA and LASSA detectors at different beam energy regimes will be presented [3-5]. Among them we mention the possibility to determine properties of astrophysically important states in ^{8}B, decaying into proton+^{7}Be [3], as well as probes of the decay branching ratios of the Hoyle state in ^{12}C, decaying into three alphas either via a direct or a sequential mechanism [4]. Such decays occur in a nuclear medium whose density and temperature are extracted via intensity interferometry techniques (similar to those used in astronomy to determine the size of stars) and the measurement of relative population of states in unbound nuclei [2].
The perspectives offered by the coming up FAZIA [6] campaigns at GANIL, in coupling to the INDRA 4π array, aimed at studying the density dependence of the symmetry energy in the nuclear EoS, including its interplays with in-medium nuclear structure and clustering , will be presented and discussed.

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