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Consistent description of mean-field instabilities and clustering phenomena within a unified dynamical approach

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Nuclear matter at subsaturation densities is expected to be inhomogeneous, owing to the existence of many-body correlations, which constitutes an essential feature for the construction of a reliable equation of state. A first emergent phenomenon related to this aspect is the fragmentation process, experimentally observed in heavy-ion collisions at intermediate energies as the result of mechanical (spinodal) instabilities driven by the mean-field, in connection to the occurrence of a liquid-gas phase transition. On the other hand, at even smaller densities, owing to residual few-body correlations, also the formation of light clusters as deuterons, or particularly strongly bound alfa particles, which dissolve with increasing density due to the Pauli principle, is considered well established in the thermodynamical properties and isotopic composition of the subsaturated matter.

A consistent description of light clusters at low densities and the formation of heavy fragments through spinodal instabilities within the same theoretical approach is however still missing nowadays. In this talk, we propose then a novel approach to include light clusters degrees of freedom within a non-relativistic kinetic theory based on energy density functionals, providing a unified dynamical framework to account at once for both phenomena, when out of equilibrium processes, as they occur in nuclear reactions, are considered. Implications for general aspects of reactions dynamics and in the widest scope of astrophysical applications are envisaged and will be discussed.

session

I. Nuclear Structure and Reactions

Primary authors: Dr COLONNA, Maria (INFN - LNS); Dr WANG, Rui (INFN - Catania); BURRELLO, Stefano (INFN - LNS)

Presenter: BURRELLO, Stefano (INFN - LNS)

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