Clusterization in low density nuclear matter

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During the past year we completed three experimental investigations of low density nuclear matter. Papers on the first two have been published in Physical Review Letters. A paper on the third is in press in Physical Review C.

1. Experimental determination of in-medium cluster binding energies and Mott points in nuclear matter

In medium binding energies and Mott points for d, t, 3He and α clusters in low density nuclear matter have been determined at specific combinations of temperature and density in low density nuclear matter produced in collisions of 47 A MeV 40Ar and 64Zn projectiles with 112Sn and 124Sn target nuclei. The experimentally derived values of the in medium modified binding energies are in good agreement with recent theoretical predictions based upon the implementation of Pauli blocking effects in a quantum statistical approach (Phys. Rev. Lett. 108, 062702 (2012)).

2. Laboratory tests of low density astrophysical equations of state

Clustering in low density nuclear matter has been investigated using the NIMROD multi-detector at Texas A&M University. Thermal coalescence modes were employed to extract densities, ρ, and temperatures, T , for evolving systems formed in collisions of 47 A MeV 40Ar + 112Sn, 124Sn and 64Zn + 112Sn, 124Sn. The yields of d, t, 3He, and 4He have been determined at ρ = 0.002 to 0.03 nucleons/fm³ and T= 5 to 11 MeV. The experimentally derived equilibrium constants for α particle production are compared with those predicted by a number of astrophysical equations of state. The data provide important new constraints on the model calculations (Phys. Rev. Lett. 108, 172701 (2012)).
3. The nuclear matter symmetry energy at $0.03 \leq \rho / \rho_0 \leq 0.2$

Measurements of the density dependence of the Free symmetry energy in low density clustered matter have been extended using the NIMROD multi-detector at Texas A&M University. Thermal coalescence models were employed to extract densities, $\rho$, and temperatures, $T$, for evolving systems formed in collisions of 47 A MeV $^{40}$Ar + $^{112}$Sn, $^{124}$Sn and $^{64}$Zn + $^{112}$Sn, $^{124}$Sn. Densities of $0.03 \leq \rho / \rho_0 \leq 0.2$ and temperatures in the range 5 to 10 MeV have been sampled. The Free symmetry energy coefficients are found to be in good agreement with values calculated using a quantum statistical model. Values of the corresponding symmetry energy coefficient are derived from the data using entropies derived from the model (Phys. Rev. C (in press)).