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, ^{3}He 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 47A MeV ^{40}Ar and ^{64}Zn projectiles with ^{112}Sn and ^{124}Sn 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. 1**08**, 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 ^{40}Ar + ^{112}Sn ,^{124}Sn and ^{64}Zn + ^{112}Sn , ^{124}Sn. The yields of d, t, ^{3}He, and ^{4}He have been determined at ρ = 0.002 to 0.03 nucleons/fm^{3} 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, ρ, 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)).