Collectivity in Nuclei: π and K^+ Fusion in Subthreshold pA and AA Collisions.

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The study of many-body forces and correlations in nuclei is presently under intensive investigation. One promising way to approach this topic is to test the nucleus under extreme conditions: i. e. the fusion of proton-nucleus or, even more striking, nucleus-nucleus system into an exclusive two-body meson-nucleus final state around or slightly above the meson threshold. It is expected that under these conditions, both the large momentum transfer of more than 1 GeV/c and the conversion of the kinetic energy in the initial state into a single mesonic final state is a sensitive test for collective effects among many cooperating nucleons [1,2] We investigate different szenarios:
- Center-of-mass correlations: " trivial" correlations induced by the coupling of the center-of-mass of the fragments in the initial to the final nuclear state, which correlate all interacting nucleons by basically kinematical constraints [3];
- ground state correlations: both long- and short range correlations introduce the correlation of bound nucleons in the nuclear ground state, providing nuclear structure beyond the mean field. Mesonic fusion in the subthreshold regime, i. e. beyond the meson-threshold in the free NN system, can then be envisioned as the collision (and possibly knock-out) of the projectile with a bound cluster from many nuclei [1];
- correlations in the nuclear continuum: in the fused intermediate nuclear medium, the large energy and momentum in the system is shared among active nucleons via multiple meson-exchange forces, accompanied by the excitation of the kinematically appropriate baryon resonances. Such studies provide interesting information on the distribution of the energy-degree of freedom in hadronic many-body systems [4].
We investigate these various szenarios, particularly the first and last approach, in simple meson-exchange models, parametrizing the elementary far-off shell NN amplitude via correlated 2π or π rescattering either in the zero-range limit or in a Gaussian form, which allows for harmonic shell-model single particle wave functions, an analytical evaluation of the cross section, attempting a semiquantitative understanding of collective phenomena for forthcoming fusion experiments (to name only pionic fusion [4] or the (high-spin) production of hypernuclei).

References

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