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Probing Nuclear properties of Imbalanced Fermi Systems with Quasi-free Proton Knock-out Reactions

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Quasi-free knockout reactions in inverse kinematics offer great opportunities to probe the mean-field properties of imbalanced nuclei. We have developed a reaction model for quasi-free A(p, pN)B reactions with unstable nuclei. Such a model makes it possible to connect experimental data from (p, pN) measurements in inverse kinematics at radioactive-beam facilities [1], to the mean-field properties (spectroscopic factors and single-particle wave functions).
The cross sections are calculated in a factorised way, following the approach developed in Refs. [2] and [3]. The general idea in this approach is to calculate the hard scattering part as a free pN scattering cross section with a phase-space correction, multiplied by the momentum probability distribution for the struck nucleon.
To incorporate the effect of the soft initial- and final-state interactions, a Relativistic Multiple Scattering Glauber Approximation (RMSGA) is used [3]. In the RMSGA, these soft interactions are calculated in an eikonal approximation using the free scattering cross sections. The role of charge-exchange effects is computed in a semi-classical way. The single-particle wave functions used to calculate the momentum distributions are from a mean-field shell-model calculation.

The results of the model are compared to the momentum distributions obtained at the HIMAC accelerator in the National Institute of Radiological Sciences in Chiba, Japan [4]. In this experiment, the momentum distributions for (p, 2p) Reactions on 9–16C isotopes at 250 MeV/A were measured for the knock-out of both s-state and p-state protons. By comparing the theoretical cross sections to these distributions, we can study the evolution of the shell-model parameters as a function of Z/N . The model that is developed can serve to analyse the resulting data from experiments with relativistic radioactive beams [1] conducted at GSI.

References

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