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Optical Potentials of Exotic Nuclear Systems Studied by Transfer Reactions

Since the optical model was first applied to describe nuclear scattering and absorptions of neutron on a variety of target nuclei, it has been extensively utilized with great success for the last seven decades and is now considered as one of the most fundamental reaction models in nuclear physics. In general, optical model potentials (OMPs) are extracted by fitting the angular distribution of elastic scattering. However, at energies close to and below the barrier, the distributions become flat and not enough information can be extracted. For reactions induced by unstable nuclei, the situation becomes even dire due to limitations of the intensity and/or the phase-space qualities of radioactive ion beams (RIBs). In view of this fact, a transfer reaction method was proposed to study the OMPs of halo systems by the utilization of a stable beam, which can yield fairly precise results. With this novel method, the energy dependence of the OMPs of 6He+64Zn and 209Bi have been investigated intensively, by measuring the single proton transfer reactions 63Cu(7Li,6He)64Zn and 208Pb(7Li,6He)209Bi at the HI-13 tandem accelerator at CIAE (China Institute of Atomic Energy). For the case of 6He+209Bi, an abnormal behavior was observed in the imaginary potential: it increases first with energy decreasing below the barrier and then falls quickly down to 0. It is the first time the threshold of the imaginary potential has been determined in an exotic nuclear system. Moreover, the experimental results indicate that the dispersion relation is not applicable for this system, which may be a common phenomenon for exotic nuclear systems. Some possible explanations for such a peculiar behavior are discussed, but further study is still desired for the underlying physics.

Summary

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