Eikonal reaction theory for two-neutron removal reactions

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Nucleon removal reactions are a quite useful tool for investigating structure of valence nucleons in weakly bound nuclei. The Glauber model is often used to describe removal reactions but the model cannot treat nuclear and Coulomb breakup processes consistently. The eikonal reaction theory (ERT) [1] is a method to calculate one-neutron removal reactions in which the nuclear and Coulomb breakup are treated accurately within the continuum discretized coupled-channels method (CDCC) [2]. In this work, we extend ERT to two-neutron removal reactions [3].

We consider ^{6}He scattering as a test calculation to show the validity of ERT. In ERT, ^{6}He is described by the $n+n+^4$He three-body model. Scattering of three-body projectiles can be described by the four-body model composed of three constituents of projectile and a target. The essence of ERT is separation of scattering matrix S. For ^{6}He scattering, S is devided into the neutron part S_n and ^{4}He part $S_{^4\mathrm{He}}$,

$$S = S_n S_n S_{^4\mathrm{He}}. \tag{1}$$

S_n and $S_{^4\mathrm{He}}$ can be obtained by the four-body CDCC calculation.

In the actual calculation, the optical potentials for n- and ^{4}He-target systems are a key input. We use the microscopic optical potentials obtained with the folding model, hence the present framework has no adjustable parameters.

Figure 1 shows the elastic breakup (σ_{br}), one-neutron stripping ($\sigma_{1n\,\mathrm{str}}$), two-neutron stripping ($\sigma_{2n\,\mathrm{str}}$), two-neutron removal ($\sigma_{-2n}$), and total reaction cross sections (σ_{R}) for ^{6}He scattering off ^{12}C (left panel) and ^{208}Pb (right panel) targets at 240 MeV/nucleon. The present framework was successful in reproducing measured one- and two-neutron removal cross sections with no free parameter. In particular, for ^{208}Pb target in which the Coulomb breakup process is important, ERT yields much better agreement with the measured cross sections than the Glauber model. ERT is highly reliable for describing one- and two-neutron removal reactions.

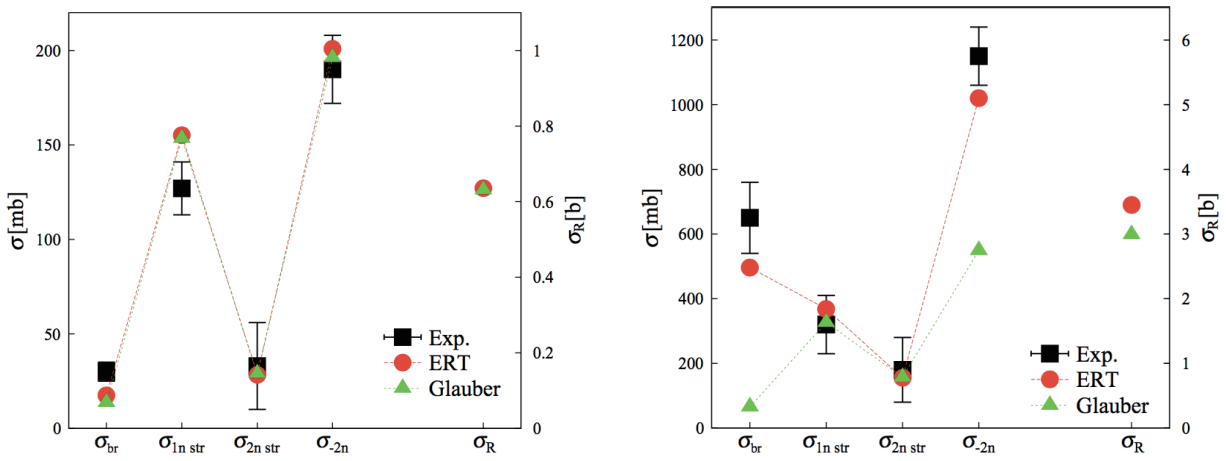

Figure 1: Calculated and measured cross sections of ^{6}He scattering from ^{12}C (left panel) and ^{208}Pb (right panel) at 240 MeV/nucleon. The right vertical axis stands for σ_{R}, whereas the left one does for σ_{br}, $\sigma_{1n\,\mathrm{str}}$, $\sigma_{2n\,\mathrm{str}}$, and σ_{-2n}. The ERT and Glauber-model results are shown by the circles and triangles, respectively. The experimental data are taken from Ref. [4].

References

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