# Effects of four-body breakup on $^{6}$Li elastic scattering near the Coulomb barrier

Shin Watanabe[1], T. Matsumoto[1], Kosho Minomo[1], Kazuyuki Ogata[2], and Masanobu Yahiro[1]

[1] *Department of Physics, Kyushu University, Fukuoka 812-8581, Japan*

[2] *Research Center for Nuclear Physics (RCNP), Osaka University, Ibaraki, Osaka 567-0047, Japan*

Many light nuclei are well described by a three-cluster model. For example, low-lying states of $^{6}$He and $^{6}$Li are explained by $N + N + {}^{4}$He three-body models, where $N$ stands for a nucleon. Properties of these three-cluster configurations should be confirmed by measuring scattering of the nuclei and analyzing the measured cross sections with accurate reaction theories. The reactions are essentially four-body scattering composed of three constituents of projectile and a target nucleus. Accurate theoretical description of four-body scattering is thus an important subject in nuclear physics. The continuum-discretized coupled-channels method (CDCC) [1] is a fully quantum-mechanical method that treats breakup effects of the projectile non-perturbatively. In Ref. [2], CDCC was extended to treat breakup of three-body projectiles; four-body CDCC was thus established. So far, however, four-body CDCC was applied to only $^{6}$He scattering.

In the present work, as the first application of four-body CDCC to $^{6}$Li scattering, we investigate projectile breakup effects on $^{6}$Li+$^{209}$Bi elastic scattering near the Coulomb barrier. A $p + n + {}^{4}$He three-body model with proper interactions for the subsystems is adopted and the Gaussian expansion method (GEM) is used to obtain wave functions of the ground state and pseudostates of $^{6}$Li. In the reaction calculation, we use phenomenological nucleon-$^{209}$Bi and $^{4}$He-$^{209}$Bi optical potentials. In Fig. 1, we show the result of four-body CDCC (solid line) at 29.9 MeV (left panel) and 32.8 MeV (right panel). One sees four-body CDCC agrees

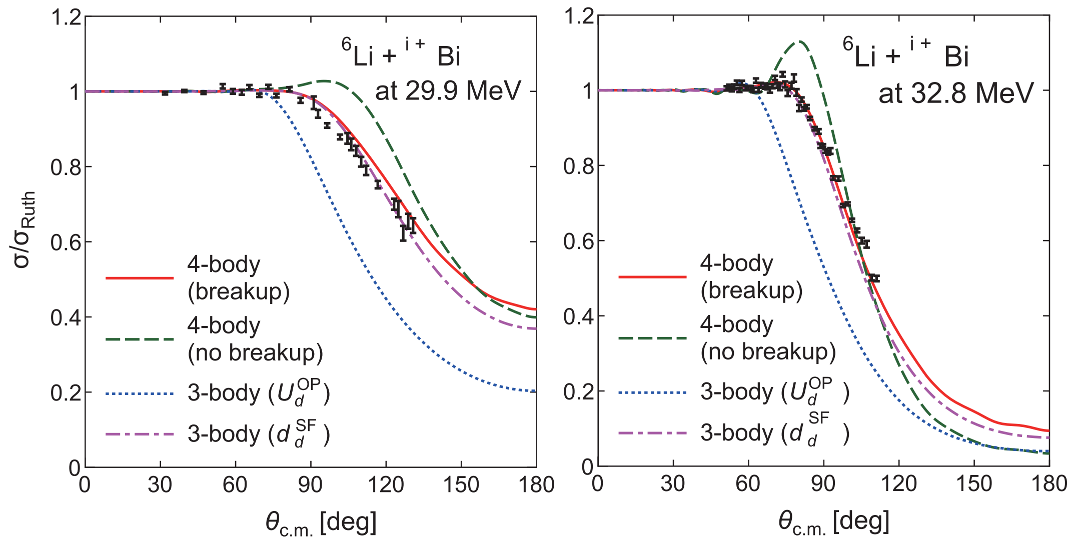


Figure 1: Angular distribution of the $^{6}$Li elastic scattering (ratio to Rutherford) at 29.9 MeV (left panel) and 32.8 MeV (right panel). See the text for detail.

very well with the experimetal data [3] at both energies. The dashed lines show the results without breakup channels. The difference between the solid and dashed lines clearly shows the importance of breakup channels in the description of elastic scattering. Another interesting finding is that if we adopt a $d + {}^{4}$He two-body model for $^{6}$Li, the result of the calculation (dotted line) deviates from the data; we use a deuteron-$^{209}$Bi optical potential in this case. Meanwhile, if we evaluate the deuteron-$^{209}$Bi potential by a single folding model based on nucleon-$^{209}$Bi optical potentials, the result (dash-dotted line) reasonably agrees with the solid line. This suggests that $d$-breakup is strongly suppressed in the $^{6}$Li scattering. For more detailed discussion, see Ref. [4]

## References

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