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First Elastic Scattering Measurement of ^{8}Li on ^{209}Bi at the Australian National University

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Abstract. The effects of unusual structures of nuclei, such as neutron halos, on nuclear reaction mechanisms are not well understood, particularly at near barrier energies. Using the SOLEROO Radioactive Ion Beam facility at the Australian National University, below-barrier reactions with ^{8}Li incident on ^{209}Bi have been performed. Beam purities of about 95% are achieved by rejecting unwanted beam species using a solenoidal separator along with tracking and tagging the secondary beam with two parallel plate avalanche counters (PPACs) placed immediately after the solenoid. However, the radioactive ion beam exiting the solenoid is not parallel to the primary beam axis. To obtain a precise angular distribution of elastic scattering, the tracking facility is used to deduce the true scattering angle on an event-by-event basis. The elastic cross-section for ^{8}Li on ^{209}Bi is then extracted, verifying the capability of the facility to perform precise cross-section measurements.

1 Introduction

A suppression of complete fusion at above barrier energies has been observed in reactions with light, weakly bound nuclei. A series of fusion cross-section measurements performed for ^{9}Be bombarding on ^{208}Pb and ^{209}Bi [1–4], ^{6,7}Li on ^{209}Bi [2, 3, 5] and ^{9,10,11}Be on ^{209}Bi [6] indicate that the complete fusion cross-sections at energies around and above the barrier are suppressed by 30%, compared with reactions of nuclei having a high energy threshold against breakup [2]. Many measurements have also been performed to understand the role of breakup in suppression of fusion cross-sections [7, 8]. However, the impact of breakup on fusion with weakly bound radioactive nuclides is not yet clear.

In exotic nuclei such as ^{8}Li or ^{6}He, containing weakly bound neutrons around a relatively tightly bound core, the nucleon density distribution has an extensive tail which may help the attractive nuclear forces begin to act at large distances between the projectile and the target. This may lower the barrier and enhance fusion cross-sections, particularly in the sub-barrier energy region [9, 10]. However, these nuclei are weakly bound and it is quite possible that their interaction with the target may cause them to breakup. In turn, this may prevent or hinder complete fusion of the projectile with the target [11, 12].

To achieve a better understanding about these exotic nuclei, the SOLEROO Radioactive Ion Beam (RIB) facility has been developed at the Australian National University [13]. Here, we first briefly describe SOLEROO RIB facility. This has been used to study ^{8}Li elastic scattering from ^{209}Bi as a first step towards measuring reaction cross-section of the above system. To extract a reliable angular distribution, the trajectories of the ^{8}Li ions onto the secondary target have been reconstructed. From the reconstructed quantities, the true scattering angle of the scattered ^{8}Li has been obtained for each incident event. The importance of obtaining the true scattering angle is then discussed.

2 The Radioactive Ion Beam Facility at ANU

The SOLEROO RIB facility at the Australian National University is based on a super-conducting solenoidal separator [14–17] which produces RIBs by in-flight transfer reactions via interactions with a primary target. The primary

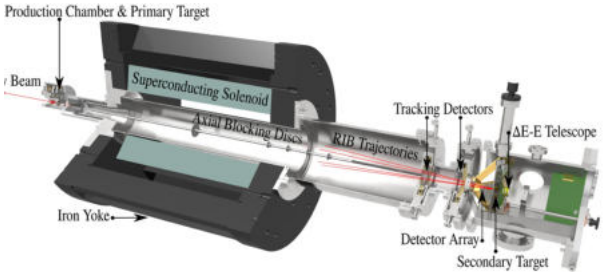

Figure 1. RIB trajectories from the primary target chamber on to the secondary target [18].

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