Elastic scattering measurement using ^{10}Be at well above the Coulomb barrier

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Introduction

In recent years, heavy ion reactions study with projectile nuclei near the drip-line (^{6}He, ^{9,11}Li, ^{10,11,14}Be, ^{8}B, ^{17,19}B, ^{9,10}C *etc.*), is being given a great deal of attention to probe the internal structure of the nuclei by studying the break-up coupling effects on various reaction channels. Such reactions are also important for exploring the various phenomena occurred in astrophysical sites such as formation of elements in the universe and supernovae explosions. Unlike stable nuclei, radioactive nuclei are normally weakly bound and can be seen as consisting of a core nucleus and a valence particle (a single nucleon or a cluster). With small binding energies, these valence particles may have very extended radial distributions outside the composite nuclei [1, 2]. Elastic scattering is one of the most important channel which can be easily measured for studies of nuclear structure. Which can be used to constrain the optical model potentials (OMPs) that are necessary for generating the distorted waves of the entrance and exit channels. Interesting features have been discovered in the study of the elastic scattering induced by light radioactive ion beams. Strong Coulomb rainbow (Coulomb-nuclear interference peak) suppressions are found for neutron halo nuclei such as ^{11}Be,^{11}Li and ^{6}He elastic scattering from heavy targets at energy near the Coulomb barrier. However, elastic scattering with proton halo nuclei does not reveal Coulomb rainbow suppressions showing small break-up coupling effects on elastic scattering at an energy about three times the Coulomb barrier. Under this scenario, a systematic study on elastic scattering at well above the Coulomb barrier energy is required to unfold the new observations in the reactions with near drip-line nuclei [4, 5].

In the present work, experimental measurement was performed for ^{10}Be+^{208}Pb reaction at three times above the Coulomb barrier energies with an aim to carry out elastic scattering angular distributions.

Experimental Details

The measurement was carried out at incident energy of 122MeV. The secondary beams of radioactive isotopes were produced by the fragmentation of ^{16}O primary beam on $2652\mu m$ Be target, separated by their mag-

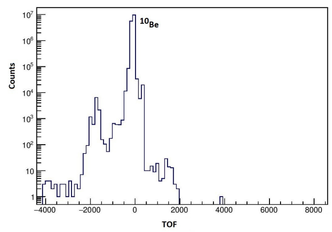

FIG. 1: Time-of-flight (TOF) spectrum showing the ^{10}Be beam used in the present experiment.

netic rigidity using HIRFL. Self supporting foil of ^{nat}Pb with a thickness of 4.2mg/cm^2 was used. The target had the following isotopic composition: ^{208}Pb 52.3%, ^{207}Pb 22.6%, ^{206}Pb 23.6% and ^{204}Pb 1.48%. The typical primary beam current was 200enA, giving typical secondary beam rates for 3x10^3 particles per second. The spot size of beam on target was about 30mm in diameter. Time-of-flight (TOF) with a flight path of 17m was used for the beam particle identification. Fig. 1 shows the TOF spectrum for ^{10}Be beam which was used in the offline analysis by putting cut on the peak. Two position-18 sensitive Parallel-Plate Avalanche Counters (PPACs) with a position resolution of 1mm were used to reconstruct the position and incident angle of the incoming beam at the target event by event. Each PPAC has 80 gold-plated tungsten wires, 20m in diameter, in both X and Y directions and therefore the sensitive area is 8080mm^2. The PPACs distances from the target were 500mm and 100mm, respectively. The scattered particles were detected by four sets of ΔE-E detector telescopes. Each telescope consists of one double-sided silicon strip ΔE detector (DSSD) of 150m in thickness and 4848mm^2 in area, and Quarter Silicon Detector (QSD) 4848mm^2 in area. Each DSSD has 16 strips on both sides and the orientations are perpendicular to each other. The DSSDs were used to determine the energy loss and the position of the particles passing through the detector with an accuracy of 33mm^2. The QSDs were used to detect the remaining energy.

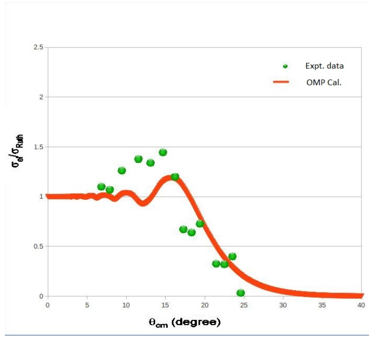

FIG. 2: Experimental elastic scattering cross sections normalized to the Rutherford cross sections as a function of $\theta_{c.m.}$ for the ^{10}Be+^{208}Pb system at E$_{lab}$ =122MeV. The continuous line shows result from the Optical Model (OM) calculation using Sau Paulo Potential(SPP).

From the Fig. 2, one can see that measured angular distribution of the differential cross section doesn't show suppression in the Coulomb-nuclear interference peak (CNIP)for this system, in contrast to what was observed in the scattering of neutron halo nuclei by heavy targets at energies around the Coulomb barrier [4, 5]. The optical model calculation using a double-folding type potential, has also been performed to interpret the experimentally obtained elastic scattering angular distribution. It should be noted that the obtained results are preliminary and further analysis need to be done in order to get concrete observations on suppression of CNIP for ^{10}Be+^{208}Pb reaction.

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