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Recently, the secondary beams of $^{15}$O were produced using the reaction ($^{15}$N, $^{15}$O) on the H$_2$ gas target on a heavy ions scattering beam course in the Cyclotron and Radioisotope Center. The low-energy $^{15}$O beams of about 60 and 70 MeV were produced utilizing the inversion kinematics. A test of the measurement for the elastic scattering using this beam have been performed on $^{28}$Si target.

Properties of nuclear structure and reaction mechanism in relation to different interactions between nuclei have so far been studied via stable nucleus-nucleus collisions. However, it is significant to extend the studies to the nuclear scattering and reactions using radioactive beams. In particular, low-energy radioactive beams provide a great scope for studies of the properties which enhance the effect of strong absorption, fusion, isospin-dependence, coupled channels transfer reaction so on. Therefore, this test is significant for future projects of measurements of elastic cross sections using radioactive beams.

The $^{15}$O beam produced at an incident energy of 61.7 MeV was elastically scattered by the $^{28}$Si target. Beam intensity was about $10^3$ particles / sec on the target and the size of beam on the target was about $6 \times 8$ mm$^2$ and was not collimated. The target was a self-supporting natural Si metal, 0.5 mg / cm$^2$ in thickness which was prepared by an evaporation. A detection counter system consists of two 25 $\mu$m totally depleted surface barrier type silicon detectors and a 240 $\mu$m position sensitive silicon detector. Two $\Delta$E detectors were placed in parallel with the position sensitive detector, i.e., this counter has two telescope $\Delta$E1 - E and $\Delta$E2 - E. Each telescope was mounted by a tantalum plate with three slits in front of the E detectors. Therefore, the spectra can be measured at six angles at the same time. The each slit aperture of detector system is 2 mm wide and 8 mm high.

Typical spectra of $^{15}$O elastically scattered from $^{28}$Si are shown in Fig. 1. The measured angle was 4.0° in the laboratory system. The overall resolution, including a beam emittance and fluctuation of energy loss in the target, was about 1 MeV. The differential cross sections at 10 angles were measured in a range of $\theta_{lab} = 4.0 - 19.1^\circ$. These results are plotted in Fig.
2. A solid curve indicates the calculated Rutherford scattering cross sections. Diffraction patterns in the angular distribution could not be observed because of the poor statistics, however, a gross angular dependence of the differential cross sections reproduced the Coulomb scattering cross sections.

A quality and intensity of the secondary beam are much improving for the elastic scattering experiments.

Reference

Fig. 1. Energy spectra of the elastically scattered $^{15}$O at $\theta_{\text{lab}} = 4.0^\circ$ in the system $^{15}$O + $^{28}$Si.

Fig. 2. Angular distribution of the elastically scattered $^{15}$O from $^{28}$Si. A solid curve shows Coulomb scattering cross sections.