Elastic scattering of α particles from spin-polarized ^{3}He at E=300 MeV.

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For studies on the optical spin-orbit potential in the elastic scattering of α+ ^{3}He at intermediate bombarding energies, we have developed a spin-polarized ^{3}He gas target system [1]. In the previous measurement [2], only a ^{3}He gas-filled glass cell of the target system was used for the studies on methods to distinguish ^{3}He elastic scattering from ∼1000 times larger background caused by the reactions with oxygen and silicon consisting of the glass cell in which the ^{3}He gas is filled. The elastic scattering of ^{3}He was clearly identified using a double slit. Owing to the good separation the angular distribution in the elastic scattering of α from ^{3}He at E=300 MeV has been determined at the angle $\theta_{\rm CM}$=17.0 ∼ 37.9°.

We here report on a recent result obtained in an experiment carried out at RCNP using the spin-polarized ^{3}He gas target system. A beam of E=300 MeV α particles was used to bombard a truncated-cone-shaped glass cell of 6 cm long and 0.5 mm thickness in which a ^{3}He gas under a pressure of 3.1 atm at room temperature was filled. The spin polarization was produced by means of the spin-exchange optical pumping method [3], in which ^{3}He nuclei were polarized by spin-exchange collisions with optically pumped Rb atoms coexisting in the cell [4]. In the target system, a static magnetic field $B_0 \sim 20$ Gauss was applied with a Helmholtz coil of 90 cm diameter to preserve the spin polarization. Temperature of the cell was kept at ∼ 170 °C with a heater to realize appropriate number density of Rb.

For the present experiment, the scattering chamber conventionally used in WS Course was replaced with the gas target system. Two slits of 0.5 and 2.0 mm widths were located at 326 and 606 mm downstream of the gas target, respectively, so that only α particles scattered from ^{3}He were accepted by the magnetic spectrometer Grand RAIDEN [5]. Then the scattered α particles were momentum-analyzed, while the beam was stopped and its current was measured with a Faraday cup placed at 0°. The beam current was also measured from the counts of the kinemaltical coincidence using the beam-line polarimeter apparatus placed upstream of the ^{3}He target. Thus the elastically scattered α particles were counted in coincidence with the recoil protons emitted from a thin plastic target of 0.5 mm thickness. The energy of scattered α particles was measured by using the MWDC system located at the focal plane. An obtained typical spectrum at the angle θ=10° is shown in Fig. 1.

The analyzing power $A_{\rm y}(\theta)$ for a measured scattering angle θ can be determined with

$$A_{\rm y}(\theta) = \frac{1}{P_{^3{\rm He}}} \cdot \frac{(Q^{\downarrow}_{\rm beam} \cdot N^{\uparrow} - Q^{\uparrow}_{\rm beam} \cdot N^{\downarrow})}{(Q^{\downarrow}_{\rm beam} \cdot N^{\uparrow} + Q^{\uparrow}_{\rm beam} \cdot N^{\downarrow})}, \quad (1)$$

where up and down arrows show the direction of the ^{3}He polarization towards the reaction plane, N is the total number of counts in a peak identified as the ^{3}He events, $Q_{\rm beam}$ is the

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integrated beam current, and $P_{^3\mathrm{He}}$ is a magnitude of the spin-polarization of ^{3}He. The value of $P_{^3\mathrm{He}}$ was determined by means of the adiabatic fast passage NMR method [6] with a reference NMR signal of a water sample in a glass cell with the same size and shape. Typical NMR spectrum of ^{3}He obtained in the experiment is shown in Fig. 2.

The data analysis is in progress.

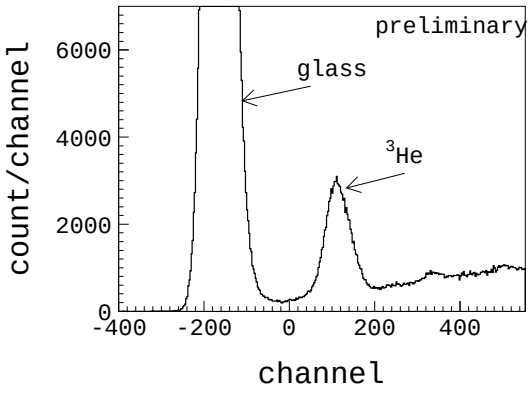

FIG. 1. An obtained typical energy spectrum of α particles at the scattering angle θ_{L}=10° and the bombarding energy E=300 MeV. The peaks corresponding to the elastic scattering from the ^{3}He target and the glass consisting of the ^{3}He-gas cell are indicated.

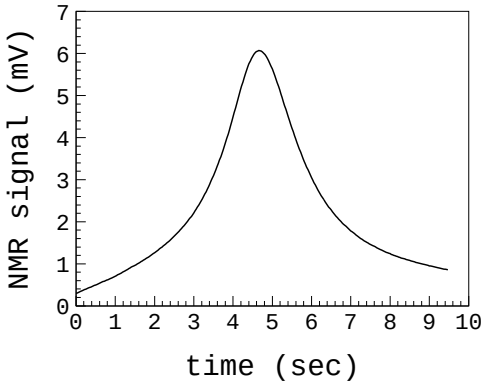

FIG. 2. A typical NMR spectrum of the polarized ^{3}He gas target system obtained in the present experiment. In the this method of NMR, the magnetic field was swept and the signal shown by the curve represents the transverse polarization which appears when the resonance condition has met. The horizontal axis shows the sweeping time of the magnetic field. The polarization was determined to be $\sim$ 5 %. from the signal corresponding to the peak position with a help of the reference signal of proton.

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