ELASTIC SCATTERING OF DEUTERONS BY NITROGEN, OXYGEN, AND ARGON

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Angular distributions are obtained for 13.6-MeV deuterons scattered by nitrogen, oxygen, and argon nuclei. A gas target was employed. The particles were identified by the E, dE/dx method. The angular distributions have a pronounced diffraction structure.

THE optical model of the nucleus has led recently [1] to much progress in explaining the elastic scattering of deuterons by medium and heavy nuclei. Attempts to employ the optical model to explain the angular distributions of deuterons elastically scattered by light nuclei have shown [2] that agreement over the entire region of angles is apparently difficult to attain. However, the amount of experimental information is patently insufficient to draw any definite conclusions concerning the applicability of the optical model in this region of the nuclei.

To obtain additional information, we investigated the angular distributions of deuterons elastically scattered by N, O, and Ar. A 13.6-MeV deuteron beam was guided by a system of diaphragms to the center of a 1.5-meter scattering chamber containing a gas target and a spectrometer. The gas target was a round cylinder 40 mm in diameter, sealed in annealed copper foil 18 mg/cm^2 thick. The gas pressure in the target was 1.3—1.4 atm and was monitored with a calibrated manometer accurate to $\pm 3\%$. The beam diameter was 4.5 mm at the entrance of the target and 5 mm at the exit.

For selective detection of the deuterons, a telescope of two scintillation counters was used, which measured simultaneously the specific ionization losses and the total particle energy [3]. The particles were identified by the E, dE/dx method. The pulses were multiplied by an electronic circuit. A typical pulse spectrum with deuteron selection is shown in Fig. 1.

In order not to register the deuterons scattered by the walls of the target, a long collimator was placed ahead of the entrance into the spectrometer. The resultant change in the gas target thickness is connected with the change in the effective volume and is determined by the shape of the collimating

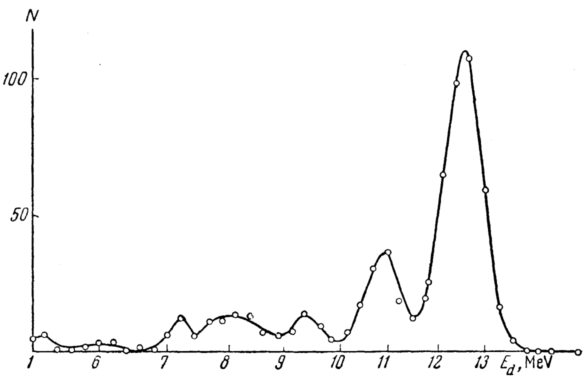

FIG. 1. Spectrum of deuterons from the reaction Ar^{40} (d, d′), $\theta = 70°$.

slots. If the entrance to the spectrometer is rigidly collimated with round diaphragms of radius R, and the beam incident on the target has a diameter r, then the effective volume of the gas target is

$$V = \frac{2\pi k^2 R^3}{\sin\theta}\left[1 - \frac{k}{2}\left(\frac{1}{4} + \frac{k}{32} + \frac{5k^2}{16\cdot 32} + \ldots\right)\right],$$

where $k = r/R$. If the beam incident on the target is collimated by a rectangular slot of width 2r (height of the slot larger than 2R), then $V = 2\pi k^2 R^3/\sin\theta$. Thus, the measured and the effective differential cross sections are connected by the simple relation

$$(d\sigma/d\Omega)_{\text{expt}} = k\sin\theta\,(d\sigma/d\Omega)_{\text{meas}}.$$

The geometrical factor $k \sin\theta$ can be obtained from a comparison of the angular distributions of the deuterons elastically scattered by carbon contained in acetylene (gas target) or polystyrene (solid target). We determined $k\sin\theta$ from data [4] on the elastic scattering of deuterons by C^{12}. The beam was monitored by a Faraday cylinder with a current integrator and a scintillation counter.

The experimental data obtained are shown in

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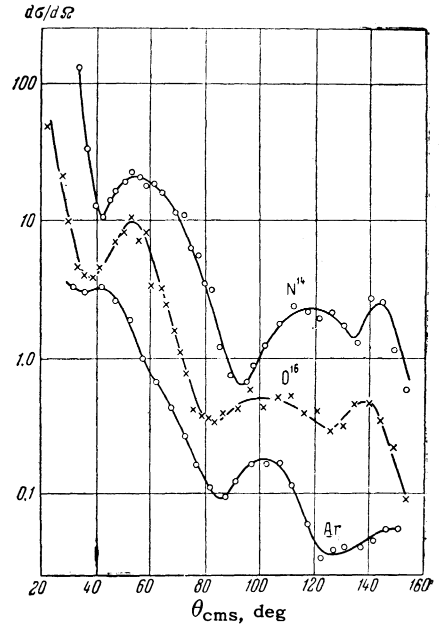

FIG. 2. Angular dependence of the relative differential cross section of elastic scattering.

Fig. 2. The form of the angular distributions for N^{14} is close to the form of analogous curves for C^{12} [4], and the angular distribution for Ar is similar in form to the angular distribution for Ca.

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