over the energy range of interest and subtracted from all ground state neutron measurements. The energy-dependent neutron detection efficiencies of the scintillators were determined by means of the $^3H(p, n)^3He$ reaction, normalized to an absolute flux by a proton recoil telescope counter whose absolute efficiency is known. The target chamber [8]) and three detector systems [1]) are discussed elsewhere.

3. Target thickness and absolute cross-section determination

Targets of ^{29}Si were prepared by evaporating 2–5 mg of enriched silicon dioxide onto tantalum backings by electron bombardment. To determine the thickness of the targets used in this experiment, the 0° and 160° excitation functions for the $^{29}Si(\alpha, n)^{32}S$ reaction were measured over a nearly isolated resonance at $E_\alpha = 4.020$ MeV with two targets, one of which was thicker than the other. Consider the experimental width at half maximum for a sharp resonance as expressed by Richards [9])

$$W^2 = \Gamma^2 + d^2 + \Delta T^2 + t^2, \tag{3}$$

where Γ is the natural width of the resonance; d is the Doppler broadening due to thermal motion of target nuclei; ΔT is the energy spread of the incident beam, and t is the average energy loss in the target. Since accelerator settings were identical for the "thin" and the "thick" target measurement it can be assumed that Γ, d and ΔT remain constant. Therefore, the difference between the experimental widths of the resonances determined by the thick target (W_1) and those determined by the thin target (W_2) is given by

$$W_1^2 - W_2^2 = t_1^2 - t_2^2. \tag{4}$$

The thin target measurements also displayed a resonance at 3.865 MeV that had the smallest width at half maximum of any resonance and which was assumed to be approximately equal to t_2. From the 160° data the following values were obtained: $W_1 = 25$ keV, $W_2 = 18$ keV, $t_2 = 10$ keV, giving $t_1 = 20$ keV. This result means that the energy loss in the thick target can be as much as 20 keV (if $t_2 = 10$ keV) and not less than 17.5 keV (if $t_2 = 0$). Comparison of integrated thin and thick target yields for the 4.020 MeV resonance gives a calculated value of t_2 within 11 % of the 10 keV estimate. This target thickness was converted to the number N of ^{29}Si nuclei/cm^2 establishing the on-resonance laboratory differential cross section at $E_\alpha = 4.020$ MeV,

$$\left.\frac{d\sigma}{d\Omega}\right|_{lab} = \frac{Y}{\Delta\Omega \varepsilon I N},$$

where Y is the experimental yield previously corrected for background, ε the neutron detection efficiency, I the total number of impinging particles and $\Delta\Omega$ the solid angle subtended by the effective center of the scintillator detector. The 0° and 160° excitation functions were thus normalized to an absolute cross-section scale from an averaged value of t_2 incorporating both 0° and 160° data.

On-resonance angular distributions were placed on an absolute cross-section scale with these excitation functions. Absolute differential cross sections are assigned a ±25% uncertainty whereas angular distribution data were ordinarily reproducible to within ±3%. The α-beam energy was calibrated with the $^{7}Li(\alpha, n)^{10}B$ reaction having a threshold at $E_\alpha = 4.3843$ MeV.

4. Elastic scattering of α-particles from ^{29}Si

Excitation functions for $^{29}Si(\alpha, \alpha)^{29}Si$ measured in energy steps of 250 keV at angles from 50° to 165° in 15° steps are presented in figs. 1 and 2. Angular distributions also measured at 3.0, 4.5 and 5.5 MeV in angular steps of 5° are shown in fig. 3. The code ABACUS [10]) was used in conjunction with the Woods-Saxon volume absorption potential,

$$V = 190 \text{ MeV}, \quad W_v = 10 \text{ MeV},$$

$$R = R_v = 1.176(4^{\frac{1}{3}} + A^{\frac{1}{3}}) \text{ fm},$$

$$a = a_v = 0.576 \text{ fm},$$

to calculate elastic cross sections. This potential proved consistent with the four $(\alpha, \mathcal{N})$ reactions and elastic scattering from ^{13}C, ^{19}F, ^{29}Si and ^{31}P targets with the exception that the imaginary potential was reduced to 6 MeV in the ^{13}C case. These calculated cross sections for ^{29}Si, plotted as solid curves in figs. 1–3, display agreement on the average with the experimental data.

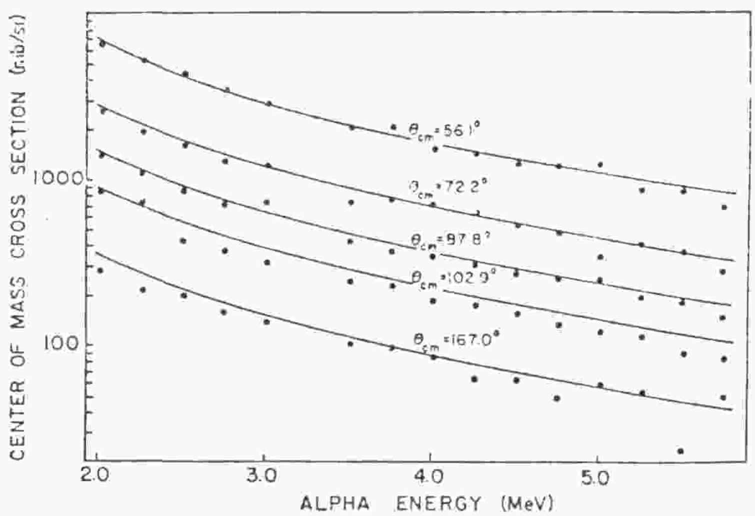

Fig. 1. Excitation functions measured for $^{29}Si(\alpha, \alpha)^{29}Si$ at 56.1, 72.2, 87.8, 102.9 and 167.0° c.m. angles. The curves are calculated with the code ABACUS incorporating a volume absorption Woods-Saxon type potential $V = 190$ MeV, $W_v = 10$ MeV, $R = R_v = 1.176(4^{\frac{1}{3}} + A^{\frac{1}{3}})$ fm and $a = a_v = 0.576$ fm.