together with the first term in the series expansion and Belenky's original result.

It can be seen from the figure that the Landau approximation introduces an error of about 25 percent at small angles. The "modified Landau approximation" with $E_s=19$ Mev fits more closely but still does not reproduce accurately the shape of the curve near the origin. It should be noted that although the "exact" curve is considerably steeper at the origin than the approximate ones, there is still no singularity there. This work will be published later in more detail.

We would like to thank Dr. J. Nishimura for communicating to us that he has recently carried out calculations along similar lines.

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Elastic Scattering of 19-Mev Alpha Particles by Al and Cu†

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THE elastic scattering of alpha particles in the 10- to 40-Mev range has been investigated recently by various authors for heavy elements.[1–3] The cross section is found to be equal to the Rutherford cross section as long as the classical distance of closest approach is large compared to the nuclear radius; for smaller values, σ/σ_R first increases slightly, then drops sharply. This monotonic decrease of σ/σ_R with increasing angle is in striking contrast to the diffraction patterns found in the scattering of 22-Mev protons.[4] It was thought that a diffraction pattern for alpha particles might also be found with lighter nuclei and that it might give the basis for an optical-model type of analysis.

For an exploratory investigation, the scattering of 18.9-Mev alpha particles from 0.0001-inch Al and Cu foils was measured. The beam of the 37-inch cyclotron was focused with the aid of a pair of quadrupole magnets into a 10-inch diameter scattering chamber located outside the main cyclotron water tank shield. The scattered particles were detected with a NaI scintillation spectrometer of 6% resolution.

To differentiate between the scattered alpha particles and protons produced in (α,p) reactions, the pulse-

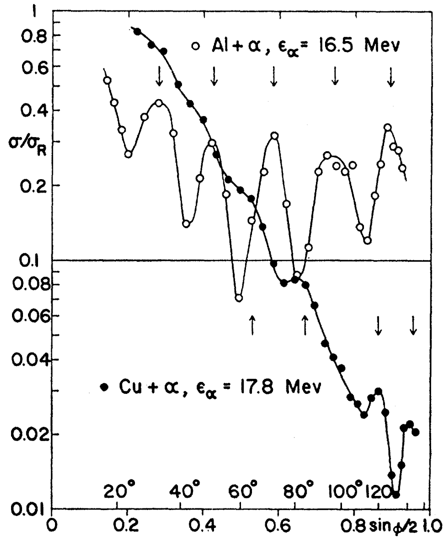

Fig. 1. Elastic scattering of alpha aprticles from Al and Cu.

height spectra were taken with and without a 19 mg/cm² Al absorber. The alpha peak was shifted considerably without much change in the proton spectrum. After applying a small corrective shift, the latter is subtracted from the distribution measured without the absorber in order to obtain the pulse-height distribution of the alpha particles.

No monitor was used; the beam current was integrated with an instrument of the type described by Higinbotham and Rankowitz.[5]

Figure 1 gives the ratio of the observed to the Rutherford cross section as a function of $\sin(\varphi/2)$ where φ is the scattering angle in the center-of-mass system. No corrections have been applied for the finite angular resolution (maximum deviations: $\pm 3.7°$ at 45° and 135°, $\pm 2.6°$ at 90°). The gross behavior for Cu is similar to that observed for the heavy elements, the cross-section ratio dropping from ~1 below 20° to ~0.02 at large angles. There are, however, indications of diffraction effects with maxima at 64°, 84°, 120°, and ~144°. For Al, the pattern is quite similar to that observed in the elastic proton scattering. For angles above 30° the cross-section ratio fluctuates about a mean value of ~0.2, with observed ratios of 3 to 4 between maxima and minima. The maxima appear at angles of 32.5°, 50°, 71.5°, ~96°, and 126°. They are nearly equidistant in the $\sin(\varphi/2)$-scale [$\Delta \sin(\varphi/2) \approx 0.15$].

No analysis of the data has been made yet. For a crude interpretation one may set $2kR\Delta \sin(\varphi/2)=\pi$ to obtain an estimate of the interaction radius of Al. Depending on whether one uses the internal or the external alpha-particle wavelength one finds $R\approx 4$ or 6×10^{-13} cm for Al, which is the correct order of magnitude. In the case of Cu, no such interpretation is possible since the maxima are far from equidistant.

For an evaluation of the Al data in terms of an optical model it will be important to know the depth of the minima which now are undoubtedly too shallow because of the poor angular resolution. The measurements will be repeated using a proportional counter-NaI telescope to distinguish between the protons and the alpha particles. This will permit the use of better angular resolution because of the gain in statistical accuracy achieved by eliminating the subtraction procedure employed.

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Elastic Scattering of 40-Mev Alpha Particles from Al†

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RECENT experiments have investigated the angular distributions for the elastic scattering of alpha particles from heavy elements at 22 Mev and 40 Mev.[1,2] At small angles the cross sections are found to agree with the Coulomb cross section. In the region of some critical angle, the cross sections rise slightly and then drop monotonically with increasing angle to values less than 1/1000 of the Coulomb cross section.

This letter is to report that the elastic scattering of 40-Mev alpha particles from Al shows a pronounced diffraction pattern, in qualitative distinction from the heavy element case. Similar results for the elastic scattering of 18-Mev alpha particles from Al were recently reported by Bleuler and Tendam.[3]

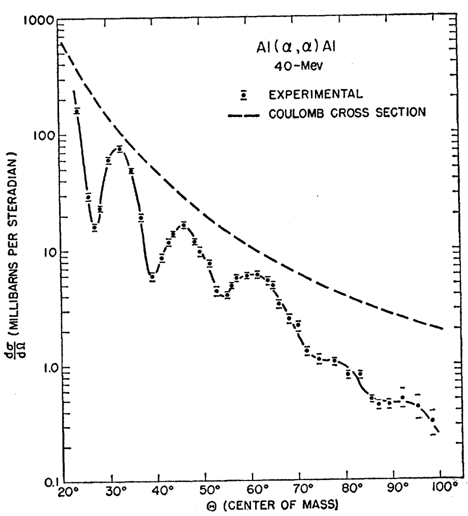

FIG. 1. Angular distribution for the elastic scattering of 40-Mev α particles from aluminum.

Figure 1 shows the angular distribution for the elastic scattering of 40-Mev alpha particles from Al. The energy in the center-of-mass system is 34.8 Mev. The abscissa is center-of-mass scattering angle, and the ordinate is absolute differential cross section in the center-of-mass system. The dashed curve gives the computed Coulomb cross section. Scattered alpha particles were detected in a thin NaI scintillation counter. The experimental techniques are similar to those described in a previous paper,[2] except that in this experiment absolute cross sections were measured. The energy resolution of the detector was 4 percent, and the angular resolution was ± 1.0 degree. The errors indicated for each point are due to counting statistics. In addition, 10 percent uncertainty in the scale factor of the ordinate is introduced by the error in determining the absolute cross section.

The magnitude of the (α,n) cross section for heavy elements indicates that heavy nuclei are opaque to 40-Mev alpha particles.[2] Consequently, it is reasonable to analyze the Al angular distribution in terms of scattering from an opaque disk. From the separation of the maxima in the diffraction pattern, this analysis leads to a value of 13.8 for kR. If k is set equal to the free-space center-of-mass wave number, then R is equal to 5.4×10^{-13} cm. This is consistent with current ideas of the size of the nucleus and the size of the alpha particle.

† Work performed under the auspices of U. S. Atomic Energy Commission.

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Electronic Detection of Heavy Mesons*

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AN experiment has been carried out to detect the decay of heavy mesons produced by cosmic rays, by means of scintillation and Čerenkov counters and fast electronic circuitry. This experiment was performed at Echo Lake, Colorado, at an altitude of 3300 meters.

The disposition of the counters is shown in Fig. 1. The apparatus is designed to detect events in which a heavy meson is produced in an interaction in the lead roof, the particles from the interaction triggering some of the Geiger counters and producing a pulse in the scintillators. If the heavy meson then stops in the region of the Čerenkov detectors and the secondary from its decay passes through the Čerenkovs in an upward direction, a delayed pulse is produced. Čerenkov