Alpha-Alpha Scattering at 7.56 Mev

N. Berk, F. E. Steigert, and G. L. Salinger
Yale University, New Haven, Connecticut
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Alpha particles scattered from a helium gas target at an incident energy of 7.56 Mev have been observed in nuclear emulsions. The differential cross sections measured can be fitted with phase shifts of $\delta_0=70°$ and $\delta_2=100°$.

The problem of the interactions of two alpha particles has been of interest for many years. Its current status has been well discussed by Nilson and co-workers.[1] The present work was undertaken to obtain information in the gap between the data below 6 Mev taken at Rice and the data above 12 Mev analyzed at Illinois.

A beam of 8.1-Mev alpha particles from the Yale cyclotron was magnetically analyzed and then collimated by two 2-mm circular slits. The first slit was covered with a $\frac{1}{4}$-mil Mylar foil window to retain the helium gas in the scattering volume. The scattered particles were detected in Ilford E-1 nuclear emulsions arranged at 5° intervals on either side of the beam axis. The scattering angle was defined by a system of three 1-in. by $\frac{1}{16}$-in. collimating slits. The plane of the emulsions was inclined at an angle of 5° relative to that of the slits. The beam collimation allowed extreme trajectories of $\pm\frac{1}{2}°$. The scattering angles likewise were defined by the particle slits to within extreme values of $\pm\frac{1}{2}°$.

The beam was monitored by means of a Faraday cage external to the scattering volume. A dc bias of 190 volts was used to suppress secondary electrons from leaving the monitor and also from reaching it from the exit window of the scattering chamber. Gas pressures of the order of 0.1 atmosphere were used. The actual values were determined to about 1% by means of an oil manometer.

The beam energy at the scattering center was determined by measuring the alpha ranges in the emulsion at each angle and correcting for gas absorption prior to detection. The range distributions obtained were not significantly broader than expected for straggling alone. This would indicate a beam spread of no more than about 160 kev. In addition to this the uncertainties in the absorber correction limit definition of the mean incident energy to of the order of ±20 kev. The purity of the scattering gas was also checked by the range distribution, since all contaminants except hydrogen will give rise to significantly more energetic recoils. At no angle was such a longer range group observed which accounted for more than 1% the total tracks measured. Nevertheless only tracks clearly in the helium scattering distributions were accepted. At the forwardmost angles the groups were not clearly distinct and a correction was attempted based on the symmetry of the distribution. No protons were observed, ruling out hydrogen containing contamination. The ranges were measured and tracks counted using a microprojector system previously described.[2] The counting statistics were in all cases at least 2%. Two runs were made under equivalent conditions using exposures differing by a factor of about 100 in order to obtain data as far forward as possible. This resulted in plates with sufficient track density to duplicate data at angles from 15° to 22°.

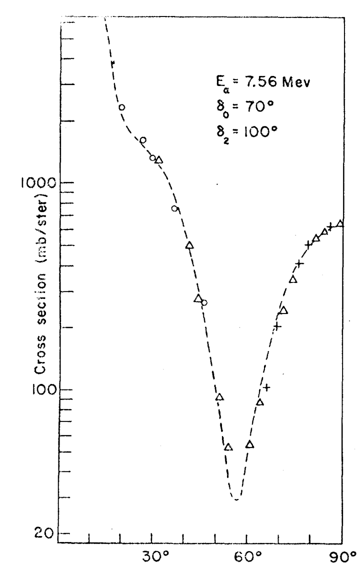

Fig. 1. Cross section *vs* center-of-mass angle. (○) denotes points from short forward angle run; (△) forward angles, long run; (+) backward angles, long run.

The data obtained, after conversion to center of mass and correction for varying target thickness, are given in Fig. 1. The points for lab angles backward of 45° have been folded onto those for the forward angles. It should be remembered that the points represent in each case an average over about 1° in lab angle and probably 100 kev in incident energy. The relative cross sections are probably accurate to ±2%. The absolute values, however, could be systematically off by as much as 6%. The curve plotted is the expected yield for the phase shifts given. Actually almost no perceptible difference of fit was obtained for variations of the indicated phase angles by ±5°. The center of the region of close fit was chosen. These values agree reasonably well with the general trend indicated by Nilson *et al.*[1]

[1] Nilson, Jentschke, Briggs, Kerman, and Snyder, Phys. Rev. **109**, 850 (1958).

[2] H. S. Plendl and F. E. Steigert, Rev. Sci. Instr. **27**, 239 (1956).