the end of the curve is not complete enough to obtain an accurate threshold energy, but an approximate value of 3.4 Mev is assigned to it. There is no way of determining whether this last rise is due to a resonance level or not. The fast neutron yield curve[13] referred to above does not reach this energy.

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Alpha-Particle Range-Energy Curve for Kodak NTA Emulsions*

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THE range-energy curves for Ilford B1 emulsions reported by Lattes, Fowler, and Cuer[1] have been used as standards for several years. Recent observations, however, indicate that the alpha-particle curve rises too steeply at the higher energies. Berlman[2] has modified the proton curve for use with alpha-particles and obtained a curve suitable for Ilford E1 plates. A modified curve has been derived for Kodak NTA emulsions at this laboratory.

The stopping power of the emulsion relative to air for alpha-particles was calculated as a function of the energy by using the procedure outlined by Webb.[3] The emulsion is approximated by a homogeneous compound having the composition given by Rotblat.[4] The atomic stopping powers used were interpolated from plots of stopping power *versus* atomic number and energy, as constructed from Bethe's[5] semi-empirical tabulation. This data was then combined with Bethe's[6] range curves for air, and the resultant curve of range in emulsion *versus* alpha-particle energy

TABLE I. Calculated and observed α-particle ranges.

Calculated		Observed		
Alpha-energy Mev	Range microns	Source	Energy Mev	Range microns
2.07	6.88	Po	5.30	21.2
3.00	10.44	ThC	6.06	26.8
4.00	14.50	ThC′	8.78	47.1
5.00	19.6	$Al^{27}(d, \alpha)Mg^{25}$		
6.00	25.6			
7.00	32.2	(0) 124°	13.77 ±0.08	91.3
8.00	39.5	(I) 90°	13.83	96.6
9.00	47.3	(I) 89°	13.87	97.4
10.00	55.6	(0) 90°	14.34	101.6
11.00	65.0	(I) 60°	14.36	103.9
12.00	74.9	(0) 89°	14.38	103.0
13.00	85.2	(0) 60°	14.87	109.9
14.00	96.4			
15.00	108.7			

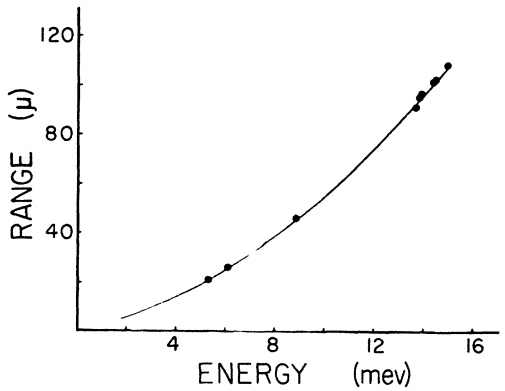

FIG. 1. Calculated alpha-particle range-energy curve for Kodak NTA emulsions, with experimental check points.

shown in Fig. 1 was obtained. Points were calculated at 0.5-Mev intervals, representative values being given in Table I. The curve rise is less steep than indicated by Lattes, Fowler, and Cuer, and there appears to be good agreement with the recent work of Rotblat. The agreement of this curve with experimental data has been obtained in this laboratory, extending the accurate measurement of tracks to 14.9 Mev. Experimental points were taken using natural alpha-particles from polonium and thorium-active deposit sources and the two long-range alpha-groups in the $Al^{27}(d, \alpha)Mg^{25}$ reaction, observed at various angles under Bethe's conditions of good geometry. The Q-values[7] and deuteron energy are known by magnetic analysis to 10 and 40 kev, respectively. The angle of observation was accurate to 15 minutes. Data obtained using this curve agree very well with published work using aluminum foils and counters.[8] Curves showing some of the alpha-groups obtained

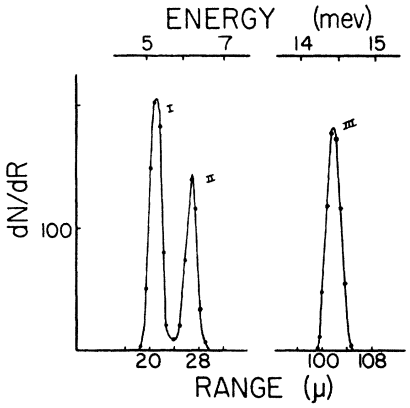

FIG. 2. Typical data obtained from plates. Peak I, Po; II, ThC; III, $Al^{27}(d, \alpha)Mg^{25}$. The energy scale is plotted above for comparison.

in these experiments are given in Fig. 2. The calibration points on the range-energy curve were obtained by taking the average value from several plates to obtain good statistics. The position of the peaks was observed not to shift as a function of time of exposure in vacuum over the range of several minutes to one hour.

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