Mean Excitation Potentials*

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Previous experimental data of Sachs and Richardson on the most probable energy loss of 18-Mev protons on passing through thin foils have been used in connection with the theory of Symon to calculate the mean excitation potential I. The result for aluminum is $I=164\pm3$ electron volts.

IN the work of Sachs and Richardson[1] on the energy loss of 18-Mev protons in passing through thin foils of various materials, the quantity measured by their apparatus was the most probable energy loss. When calculating the mean excitation potentials they assumed that the most probable energy loss and the mean energy loss were the same for their measurements within their expected error. It has recently become possible, however, to evaluate I directly from the most probable energy loss as the result of the work of K. R. Symon quoted by Rossi.[2]

The values of the physical constants used in the calculations are those of DuMond and Cohen.[3] Values of C_k were obtained from the work of Walske,[4] and the atomic weights were obtained from the 1952 Revision of International Atomic Weights.

Table I presents the results of these calculations for the case of aluminum. The difference between the most probably energy loss and the mean energy loss is seen to vary with the foil thickness in the expected way, namely from 2.6 percent for the thinnest foil to 0.23 percent for the thickest foil. The weighted average of these results is $I_{Al}=164\pm3$ electron volts[5] compared to 168 ev from the previous approximate calculations.

Similar calculations were carried through for the experimental results on other materials as shown in Table II. No corrections for nonparticipating electrons are available (to our knowledge) for these materials. Such corrections would tend to lower the values of the mean excitation potentials.

TABLE I. Mean excitation potential of aluminum.

Surface density (mg/cm²)	Most probable energy loss (Mev)	Mean energy loss (Mev)	Mean excitation potential (ev) (with probable error)
7.153	0.153	0.157	156.2±18.8
14.054	0.301	0.305	169.0±12.7
21.432	0.465	0.469	164.7± 8.2
21.532	0.470	0.474	159.6± 9.1
33.875	0.737	0.741	170.7± 6.8
38.395	0.839	0.843	169.4± 4.9
47.457	1.048	1.052	165.1± 8.1
57.493	1.276	1.280	165.8± 5.8
67.294	1.515	1.519	158.6± 5.3
76.849	1.737	1.741	159.9± 4.0

TABLE II. Weighted averages of the mean excitation potentials (uncorrected for nonparticipating electrons).

Element	Weighted average uncorrected mean excitation potential (ev)
Ni	398
Cu	419
Rh	778
Ag	760
Cd	753
Sn	818
Ta	1100
Au	1306

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[1] D. C. Sachs and J. R. Richardson, Phys. Rev. **83**, 839 (1951) and **89**, 1163 (1953).

[2] B. Rossi, *High Energy Particles* (Prentice Hall Publishing Company, Inc., New York, 1952).

[3] J. W. M. DuMond and E. R. Cohen, American Scientist **40**, 447 (1952).

[4] M. C. Walske, Phys. Rev. **88**, 1283 (1952).

[5] *Note added in proof.*—The measurement of the range of 18-Mev protons in Al reported by E. L. Hubbard and K. R. MacKenzie in Phys. Rev. **85**, 107 (1952), when corrected for multiple scattering, yields a value of $I_{Al}=165$ from the more accurate relation given by D. H. Simmons in Proc. Phys. Soc. (London) **A65**, 454 (1952).