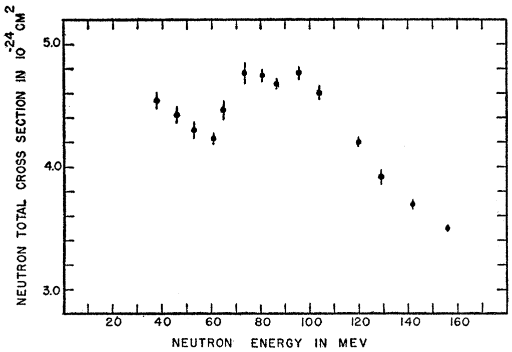


FIG. 1. The variation with energy of the neutron total cross section for lead. The cross sections have been corrected for forward scattering, and the errors shown are standard deviations based upon total counts.

bardment of internal targets in the 110-inch Harwell cyclotron, and were collimated by small diameter holes in the concrete shielding. The apparatus, neutron attenuators and geometrical layout were similar to those used in earlier measurements at this laboratory.[1] A triple coincidence proportional counter telescope was used to detect the protons recoiling from a polyethylene disk placed in the collimated neutron beam. By putting absorbers between the counters a lower energy limit was set for the detected recoil protons, and hence there was a lower energy limit to the neutrons used in the determination. The upper energy limit was governed by the position of the target in the cyclotron, the value of the magnetic field, and the threshold energy for production of neutrons by protons. It was therefore possible to use a small band of neutron energies in any measurement. Further, since the majority of the neutrons were detected as recoil protons coming from the hydrogen content of the polyethylene disk, the effective neutron energy could be calculated with an error dependent upon the accuracy of a range-energy relation. This error was estimated to be about 1 Mev at the lowest energies and about 3 Mev at the highest. The band of energies used varied from about 10 Mev at the lowest energy measured to about 20 Mev at the highest.

The values of the total cross section for lead at the various energies are presented in Fig. 1. The difference between the value at 81 Mev and the minimum value at 61 Mev is 10 times the standard deviation on either point.

A similar dip has been found in cadmium and in copper at lower energies.

The results for the whole investigation will be reported more fully elsewhere.

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[1] Taylor, Pickavance, Cassels, and Randle, Phil. Mag. **42**, 20 (1951); **42**, 328 (1951); **42**, 751 (1951); **42**, 1336 (1951).

## Size Effects in the Superconductivity of Cadmium

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As part of a program to study electrical and magnetic properties of matter below 1°K, we have investigated the critical magnetic fields of various sized particles of superconducting cadmium. The experimental arrangement used for these measurements was similar to that of Daunt and Heer[1] except that we used a lead wire (0.025 cm in diameter and 50-cm long) as the heat switch. With such a switch it took from 40-60 minutes for the system to warm up from 0.1° to 1.2°K. To date we have obtained results for two different sizes of cadmium. Both specimens consisted of spheres of cadmium made by stirring the molten metal with a high boiling silicone oil.[2] The cadmium used for the preparation was spectroscopically pure material obtained from Johnson-Matthey. The pills were pressed into cylindrical form (diameter 1.75 cm, length about 2.2 cm) from a mixture of chromium potassium alum and the cadmium particles. Specifications are given below:

| Pill No. | Cadmium particle size (radius in cm) | Wt. of cadmium (grams) | Wt. of salt (grams) |
|---|---|---|---|
| 1 | $2.2\text{–}3.1\times10^{-3}$ | 2.2 | 6.7 |
| 2 | $6\text{–}12\times10^{-2}$ | 1.2 | 7.0 |

The critical fields, obtained from the warm up curves, are shown in Fig. 1. The dashed curve shows the results obtained by

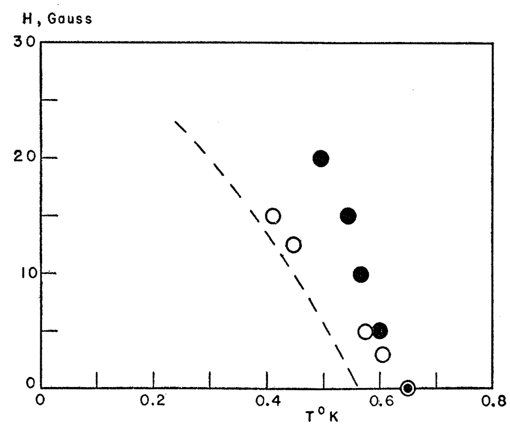


FIG. 1. Magnetic threshold for Cd as a function of temperature. ●—Pill No. 1; ○—Pill No. 2. Dashed curve shows data of Goodman and Mendoza.

Goodman and Mendoza[3] using another method and bulk cadmium. We obtained a zero field transition temperature of 0.65±0.02°K for both specimens. This is somewhat higher than the value 0.56°K reported by the Cambridge workers. Since our experiments with superconducting zinc and ruthenium gave transition temperature in good agreement with other workers, we believe that this difference in $T_c$ for cadmium is a real one. It may be associated in some way with our method of preparing the spheres. Aside from that factor the data reveals a definite increase in the critical fields for the smaller particles. If this is interpreted in light of the particle size becoming comparable to $\lambda$ the penetration depth, one can estimate that $\lambda_0 \sim 10^{-4}$ cm for cadmium. This value is a factor of ten larger than penetration depths for such elements as indium, tin and lead.[4] It may be significant to note that the suggested large value of $\lambda_0$ for cadmium is qualitatively consistent with the empirical observation that $\lambda_0$ increases as $T_c$ decreases.[4]

A detailed account of the work reported above, as well as experiments in progress at this date, will be given in subsequent publications.

[1] J. G. Daunt and C. V. Heer, Phys. Rev. **76**, 1324 (1949).
[2] M. C. Steele, Phys. Rev. **78**, 791 (1950).
[3] B. B. Goodman and E. Mendoza, Phil. Mag. **42**, 594 (1951).
[4] J. M. Lock, Proc. Roy. Soc. (London) **A208**, 391 (1951).