section (4.6×10^{-24} cm^2), the triplet amplitude of the first set would have been -4.49×10^{-13} cm. The theoretical triplet amplitude increases in magnitude with increasing range and has the value

$$-1/\alpha(=(\hbar^2/M|E_0|)^{\frac{1}{2}})=-4.37\times10^{-13}\text{ cm}$$

for zero range. Thus to within the statistical uncertainty of the observations the two admissible values of a_1 are (I) $a_1=-1/\alpha$, (II) $a_1=-2/\alpha$. These correspond, respectively, to (I): zero range, (II): a rectangular-well range $\sim8\times10^{-13}$ cm. Both values are theoretically untenable, the expected range being $\sim2.8\times10^{-13}$ cm. A further difficulty is revealed by computing the cross section for slow neutron scattering by free protons, *viz.:*

$$\tfrac{3}{4}\sigma_1+\tfrac{1}{4}\sigma_0,$$

which may be written

$$\tfrac{1}{4}\pi[(3a_1+a_0)^2+3(a_1-a_0)^2]=16.6\times10^{-24}\text{ cm}^2.$$

This result is considerably less than the directly measured value[7] of $(20\pm1)\times10^{-24}$ cm^2.

The consequences of these ortho-para measurements are at such complete variance with present theoretical concepts that it would be highly desirable to repeat these measurements and search for possible systematic errors.

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[1] F. G. Brickwedde, J. R. Dunning, H. J. Hoge, and J. H. Manley, Phys. Rev. **54**, 266 (1938).

[2] L. W. Alvarez and K. S. Pitzer, Cf. accompanying note.

[3] This situation is realized in the scattering of slow neutrons by helium. The cross section (1.5×10^{-24} cm^2) obtained by H. Carroll and J. R. Dunning, Phys. Rev. **54**, 541 (1938), is not the true cross section σ but σ_{eff} averaged with respect to the thermal energy distribution of the neutrons. The corrected value is $\sigma=1.25\times10^{-24}$ cm^2.

[4] $\Phi(\xi)=2\pi^{-\frac{1}{2}}\int_0^\xi e^{-x^2}dx.$

[5] J. Schwinger and E. Teller, Phys. Rev. **52**, 286 (1937).

[6] M. Hamermesh and J. Schwinger, Phys. Rev. **55**, 679 (1939).

[7] V. W. Cohen, H. H. Goldsmith and J. Schwinger, Phys. Rev. **55**, 106 (1939); H. B. Hanstein, Phys. Rev. **57**, 1045 (1940).

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Spectroscopically Pure Mercury (198)

For some time, spectroscopists in the national laboratories have been searching without much success for a line more nearly monochromatic than the red line of cadmium, to use as a standard of length. Professor W. E. Williams pointed out to us that if it were ever possible by some means to separate the isotopes of mercury, the green line λ5461 produced by one of the even isotopes would be admirably suited for the purpose. There would be no hyperfine structure, no isotope shift, and little Doppler broadening because of the high mass.

We have bombarded gold with slow neutrons from the 60″ cyclotron, and have collected enough of the transmutation product, mercury, to observe its spectrum. Since gold has only one isotope, 197, slow neutron capture gives rise to a single radioactive isotope, Au^{198}. This artificially radioactive product emits negative beta-rays with a half-life of 2.7 days and therefore turns into Hg^{198}, one of the stable isotopes of Hg. The experimental procedure is as follows:

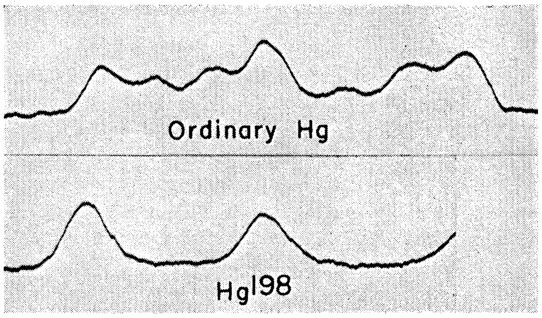

FIG. 1. Microphotometer traces for λ4047 from ordinary Hg and from Hg^{198}.

A cylinder of gold 15 cm long, 2.5 cm in diameter, and with a wall thickness of 0.2 mm is placed in a quartz tube of slightly larger diameter. To one end of this tube is fused a quartz capillary with an inside diameter of 2 mm. The whole system is evacuated and heated for 36 hours in a furnace almost to the melting point of gold. The gold is thus freed of any ordinary mercury contamination. Spectroscopically pure argon is then admitted to a pressure of 6 mm of Hg, and the quartz system is sealed off from the pumps. The gold cylinder in its quartz container is now placed in a paraffin-lined box near the target of the cyclotron, where it is bombarded with "stray" neutrons for about a month. At the end of this time the gold is again heated, while the end of the capillary tube is cooled in liquid air. After an hour of this treatment, a 3-cm length of the cooled capillary is sealed off. When the spectrum of the gas in this tube is excited by a 3-meter oscillator, the mercury lines are quite brilliant, but the argon spectrum is quenched. The mercury lines are visible after a neutron bombardment of a few hours, but they last for only a few seconds; under these conditions the Hg vapor is driven into the walls by the discharge. With a bombardment of a month, however, equilibrium between gas space and walls is apparently attained, so the spectrum is visible for some time. A microphotometer trace of a Fabry-Perot etalon spectrogram of the line λ4047 is shown in Fig. 1. The absence of the hyperfine components shows that the mercury is actually a transmutation product.

Since the Hg^{198} is a by-product of bombardments for biological purposes, no expenditure of "cyclotron time" is involved in its preparation. We will therefore be able to satisfy a reasonable demand for tubes filled with pure Hg^{198}, and we invite requests for such tubes. We gratefully acknowledge the support given to this work by the Research Corporation.

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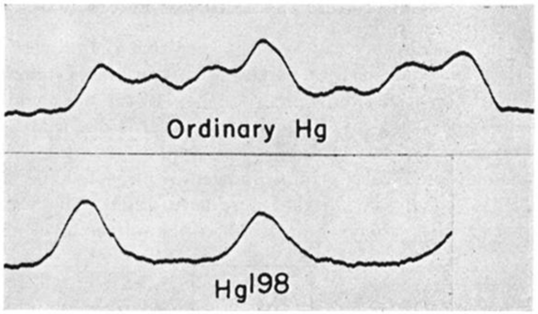

FIG. 1. Microphotometer traces for λ4047 from ordinary Hg and from Hg^{198}.