Assuming a value[2] of 0.32080 for the ratio $\nu(B^{11})/\nu(H^1)$, one obtains

$$\nu(Nb^{93})/\nu(H^1)=0.24441\pm 0.00013.$$

This value should be increased by a Lamb[3] correction of 0.38 percent because of the diamagnetic effects of the atomic electrons. Use of this correction and of the value 5.58504 for the $g$-factor of the proton[4] leads to the following value for the nuclear $g$-factor of $Nb^{93}$:

$$g(Nb^{93})=1.3702\pm 0.0007.$$

Since the spin of $Nb^{93}$ is known from hyperfine structure data[5] to be 9/2, the nuclear magnetic moment of $Nb^{93}$ is

$$\mu(Nb^{93})=6.1659\pm 0.0032 \text{ nuclear magnetons.}$$

These values are to be compared with the earlier values $g=1.18$ and $\mu=5.31$ obtained by Meeks and Fisher[6] from hyperfine structure studies. The value obtained in the present work lies close to the upper Schmidt limit value of $+6.79$ for a $g_{9/2}$ odd proton, which $Nb^{93}$ has according to Mayer's[7] theory.

We wish to express our appreciation to the Ohio State University Development Fund and Research Foundation for grants that made this work possible.

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* AEC Research Fellow.

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## Isotope Effect in the Superconductivity of Mercury*

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March 24, 1950

The existence of a small quantity of $Hg^{198}$ at the National Bureau of Standards[1] prompted us to investigate its properties as a superconductor.[2] The sample available to us had a high degree of isotopic separation and was approximately 98 percent pure $Hg^{198}$. The average atomic weight[3] of natural mercury is 200.6. The mercury had been produced by the transmutation of gold and had been prepared by distilling it off the bombarded gold foil.

Preliminary results are now available on the critical field behavior and transition temperature. The destruction of superconductivity was detected magnetically by a ballistic galvanometer method and the zero-field transition temperature determined by extrapolation of the critical field curve to zero field. (Further details of the experimental method will appear elsewhere.) Tests were made with natural mercury and with two specimens of $Hg^{198}$ about 400 mg each (both derived from the original sample). The natural mercury was prepared by our Chemistry Division and is presumed to contain less than 0.001 percent impurity. The specimens of $Hg^{198}$ were separately redistilled in vacuum (following the original distillation from the gold foil) and were enclosed in Pyrex capillaries which were evacuated and sealed off. Temperatures were measured with a helium vapor pressure thermometer using the tables prepared at the Royal Society Mond Laboratory (June 4, 1949) for reducing the pressures to degrees Kelvin.

The results are indicated in Fig. 1 which is a plot of current in the Helmholtz coils (at critical field) *vs.* the absolute temperature for both the natural mercury and $Hg^{198}$. Any small difference in slope is not significant since the demagnetization factors of the samples and the exact disposition in the field may have been different. The intercepts are significant and give the transition temperatures as 4.156°K for natural mercury and 4.177°K for $Hg^{198}$.

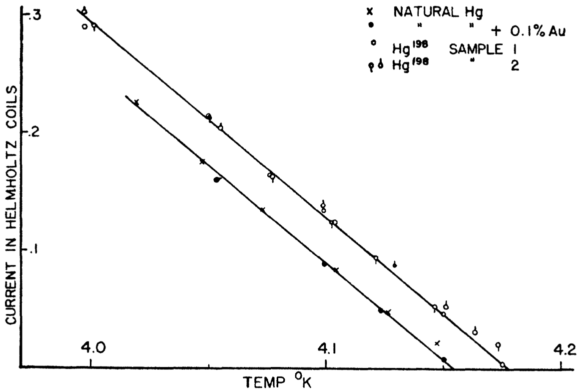

FIG. 1. Current in the Helmholtz coils at the critical field *vs.* the absolute temperature.

Many pains were taken to exclude the possibility of secondary effects. The earth's field was compensated to within $10^{-4}$ gauss. The distillation apparatus and capillaries were carefully cleaned. The clean appearance of the mercury was good evidence of the absence of base metal impurities in excess of 0.001 percent but there was some possibility that the $Hg^{198}$ might have contained a gold impurity, derived from the original foil which would not have shown up in the form of surface sum. Spectrochemical analysis of the $Hg^{198}$ was not feasible, so a sample of natural mercury with 0.1 percent gold was prepared and tested. (A saturated solution of gold in mercury will contain about 0.15 percent.) The results are given by the black dots and show that even this large amount of gold impurity is unimportant.

From these results one may infer that the transition temperature of a superconductor is a function of the nuclear mass, the lighter the mass the higher the transition temperature. At the ONR conference in Atlanta, March 20–21, it was reported that Serin and Reynolds[4] at Rutgers University had undertaken a similar investigation independently and simultaneously with our own. They found that the transition temperatures of $Hg^{199}$, $Hg^{202}$, and $Hg^{204}$ were also a function of the atomic mass, with the lighter isotopes having higher transition temperatures. It is gratifying to find that our results are mutually consistent and complementary. Taken together they definitely establish a dependence of transition temperature on mass number.

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* Supported by the ONR Contract NA-onr 12-48.

[1] We are indebted to Dr. W. F. Meggers for making this sample available to us.

[2] The suggestion of examining a pure isotope was also made to us independently by Professor K. F. Herzfeld.

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## Magic Numbers and Elements with No Stable Isotopes

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March 20, 1950

That the abnormal instability of *all* isotopes of $_{43}Tc$ and $_{61}Pm$ may have something to do with the occurrence, close by, of magic neutron numbers 50 and 82, is an obvious enough suggestion. It becomes even more plausible if we consider that only the absence of odd-mass isotopes requires a special explanation (even-mass isotopes are, for $Z=43$ and 61, excluded by parity rules). Two other elements, A and Ce, then appear to share the same anomaly and in both the latter cases the connection with the magic neutron numbers (20 and 82, respectively) is even more evident.[1,2]