NUCLEAR GROUND-STATE SPINS OF THALLIUM-198 AND -201†

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The atomic beam resonance method[1] has been used to measure the nuclear ground-state spins of Tl^{198} and Tl^{201} with the following values obtained: for the 5.3-hour Tl^{198}, $I=2$, and for the 3.0-day Tl^{201}, $I=\frac{1}{2}$.[2] The ground-state spin of Tl^{198} is particularly important because it confirms the decay schemes of Pb^{198},[3] and of the 1.8-hour isomeric state of Tl^{198}.[4] The isomeric state has been measured with the atomic beam method to have the spin $I = 7$.[5]

For the production of Tl^{198} thallium was bombarded with 85-Mev protons. This gives mainly Pb^{198}, which decays to the ground state of Tl^{198} with a half-life of 2.3 hours. The lead was separated from the thallium by ether extraction and then electroplated together with some milligrams of stable lead and thallium on a copper wire, which was put into the oven. The chemical separation was made a couple of hours after the bombardment in order to let the more short-lived lead isotopes decay away. A few hours after the separation the Tl^{198} activity was strong enough to give good signals. By this procedure an isotopically cleaner sample is obtained than by bombarding mercury and furthermore no isomeric state is produced. The Tl^{201} was produced by bombarding mercury with 25-Mev deuterons and chemically separated in a similar way.

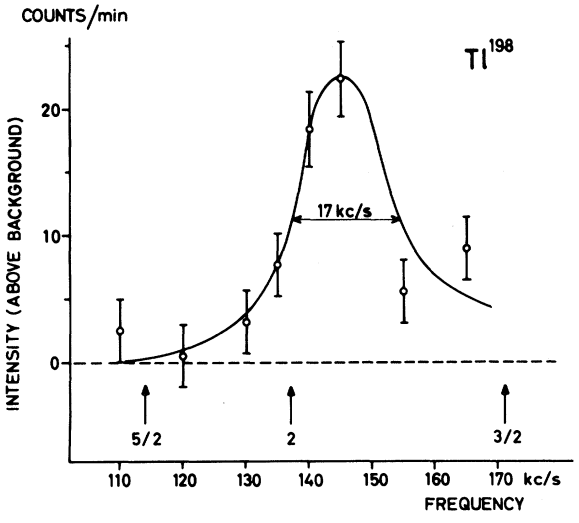

FIG. 1. Resonance curve of Tl^{198} at a field of 0.7 gauss. The arrows indicate the calculated resonance frequencies for different spin values without any quadratic effect.

Figure 1 shows a resonance curve of Tl^{198} at a C field of 0.7 gauss (corresponding to a potassium frequency of 0.5 Mc/sec) and Fig. 2 a curve of Tl^{201} at 2.8 gauss. The spin search of Tl^{198} was made at the lowest possible field to be sure that the quadratic effect should be small. Resonance curves have then been taken at several higher field strengths and they indicate an extremely small magnetic moment. The hfs separation seems to be only about 14 Mc/sec which means that the magnetic moment is smaller than 2×10^{-3} nuclear magnetons. This moment is as far as we know the smallest one for a state with a spin different from zero which has ever been measured. The only known magnetic moment of a radioactive thallium isotope is that of Tl^{204},[5] which is also very small, 0.089 nm.

The spin value of Tl^{198} has also been checked with an isotope-separated source. In the separator the isotope was collected on a copper strip. This was dissolved in acid and the thallium extracted by ether and then electroplated together with some milligrams of stable thallium.

The measurements are now being continued in order to get the hfs separation and magnetic moment of Tl^{198} more accurately and also possibly to find the spin of Tl^{196}.

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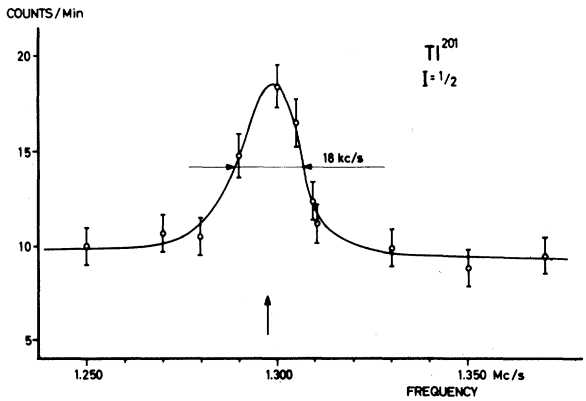

FIG. 2. Resonance curve of Tl^{201} at a field of 2.8 gauss. The arrow indicates the calculated frequency for $I = \frac{1}{2}$.

tions, and to Dr. G. Andersson et al. at the same institute for making the isotope separations.

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[1]I. Lindgren, Nuclear Instr. 3, 1 (1958).

[2]The spin value of Tl^{201} has independently been measured by the Berkeley group [L. L. Marino et al., Bull. Am. Phys. Soc. Ser. II, 3, 186 (1958)].

[3]B. Jung, Nuclear Phys. (to be published).

[4]G. Andersson and I. Bergström, Nuclear Phys. 3, 506 (1957).

[5]Brink, Hubbs, Nierenberg, and Worcester, Phys. Rev. 107, 189 (1957).

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