[5] For a recent analysis of the data, see H. A. Bethe and F. de Hoffman, Phys. Rev. **95**, 1100 (1954).

[6] It is assumed that the $S_{\frac{1}{2}}$, $T=\frac{3}{2}$ phase shift is not proportional to momentum. J. Orear, Phys. Rev. **96**, 176 (1954) has shown, however, that the $S_{\frac{1}{2}}$ phase shifts may be proportional to momentum up to about 70 Mev, at which point there is a change in slope. This is somewhat high energy at which to have this change in slope, for the interpretation being considered here. This analysis of the data is not closely fitted in any of these calculations here.

[7] It must be noted that the predicted $P_{\frac{3}{2}}$ and D phase shifts are large enough to disturb many of the phase shift analyses on which their determination is based. A consistent treatment of all phase shifts would not qualitatively change the large S and $P_{\frac{3}{2}}$ effects but the quantitative results quoted above might be somewhat different. A more singular potential shape would reduce these $P_{\frac{3}{2}}$ and D wave predictions.

[8] F. Henley and M. Ruderman, Phys. Rev. **90**, 719 (1953); M. Nelkin (private communication).

Gyromagnetic Ratio of 10^{-8}-Second Ta^{181m}

S. Raboy and V. E. Krohn
Argonne National Laboratory, Lemont, Illinois
(Received July 26, 1954)

THE gyromagnetic ratio of the 480-kev isomeric state of Ta^{181} (1.1×10^{-8} sec) has been measured by the method used by the Swiss group[1] for a Cd^{111} isomeric state. The method involves a study of the angular correlation pattern for the 132-480 kev cascade (inset of Fig. 1) as a function of the magnetic field applied perpendicularly to the plane of the two gamma-ray detectors.

The source was prepared by irradiating hafnium metal in the new Argonne research reactor. The metal was dissolved in hydrofluoric acid and placed in Teflon holders covered with Scotch tape. The output of a fast coincidence circuit (10^{-7} sec) was fed into a slow triple-coincidence circuit, together with the outputs of two differential pulse-height analyzers. One of the analyzers had a 70-kev window straddling the 132-kev gamma ray, and the other analyzer had a window about 200 kev wide set with its lower edge at 450 kev. This eliminated detection of coincidences involving the 345-kev gamma ray. NaI(Tl) crystals with Lucite light pipes (six inches long) and 5819 photomultipliers were used as detectors. The Lucite light pipes, together with three layers of soft iron and one layer of mu-metal around the photomultiplier tubes, were sufficient to eliminate magnetic field effects on the photomultipliers.

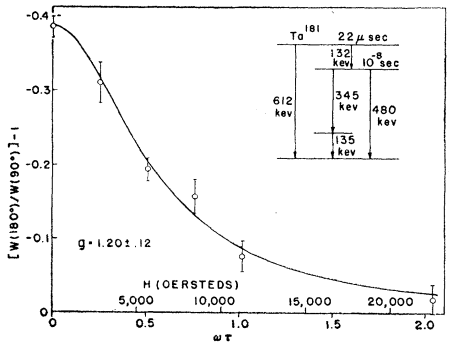

FIG. 1. Anisotropy calculated as a function of $\omega\tau$ (smooth curve) fitted to experimental points obtained as a function of magnetic field.

The magnitude of the gyromagnetic ratio for the 10^{-8}-sec state of Ta^{181} was obtained from a plot of the anisotropy of the 132–480 kev cascade *versus* the magnetic field (Fig. 1). The experimental points have been corrected for scattering from the magnet. This correction was based on a zero-field anisotropy $\{[W(180°)/W(90°)]-1\}$ determination in the presence of the magnet and the same measurement on a plywood table with scattering materials minimized. The latter determination gave an anisotropy in good agreement with the result of McGowan.[2] However, there was no decrease in the anisotropy during periods of up to twelve days following preparation of a source.

The anisotropy in a magnetic field was calculated by means of the following formula:

$$W(\theta,\omega\tau)=\int_0^\infty e^{-t/\tau}\{1+A_2P_2[\cos(\theta+\omega t)]+A_4P_4[\cos(\theta+\omega t)]\}dt,$$

where ω is the Larmor precession frequency, τ the lifetime of the 480-kev excited state, P_2 and P_4 are the second- and fourth-order Legendre polynomials, and A_2 and A_4 are their coefficients in the angular correlation function

$$W(\theta)=1+A_2P_2(\cos\theta)+A_4P_4(\cos\theta).$$

The magnetic field scale of Fig. 1 was then adjusted to fit the experimentally obtained points to the resultant smooth curve. The ratio of the magnetic field to $\omega\tau$ given by the scales of Fig. 1 was used to calculate the magnitude of the gyromagnetic ratio. The sign of the moment was determined by measuring coincidence rates at several angles for $H=5600$ oersteds (Fig. 2).

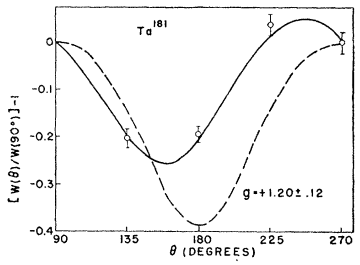

FIG. 2. Anisotropic part of the angular correlation pattern measured at a field of 5600 oersteds. The solid curve was calculated for $\omega\tau=0.51$ and the dashed curve for $\omega\tau=0$ (zero field).

The solid curve of the figure was calculated for a positive gyromagnetic ratio and $\omega\tau=0.51$ (as required by the fitting of the H and $\omega\tau$ scales of Fig. 1). Using $1.59\pm0.08\times10^{-8}$ sec for τ, we obtain

$$g=+1.20\pm0.12 \text{ nuclear units.}$$

We have used for A_2 and A_4 the values -0.280 and -0.058, respectively, as determined by McGowan.[2]

These values were corrected for the solid angle of our detectors. The calculation assumes that there is no attenuation of the angular correlation pattern caused by time dependent electric interactions in the liquid medium.[3,4] This assumption is inconsistent with McGowan's conclusions, but it can be justified by the following arguments: Consider two sets of operating conditions used by McGowan (Table II of reference 2); (a) resolving time, $2\tau_0=0.18\times10^{-6}$ sec, and zero delay; and (b) resolving time, $2\tau_0=1.32\times10^{-8}$ sec, and 6×10^{-9} sec delay. In an indirect manner McGowan arrived at attenuation factors $G_2=0.735$ and $G_4=0.497$. With these attenuation factors and formulas (72), (73), and (74) of Abragam and Pound[3] we calculate that the A_2 measured with operating conditions (b) should have been twenty percent higher than the A_2 measured with operating conditions (a). We also calculate that the A_4 for case (b) should be forty-five percent higher than the A_4 for case (a). These differences were not observed by McGowan.

We can obtain lower limits for G_2 and G_4 in the hydrofluoric acid medium by using McGowan's data. A difference of five percent in the A_2's or ten percent in the A_4's for the above pair of operating conditions would have been detected by McGowan. These differences correspond to $G_2=0.93$ and $G_4=0.86$, and we have taken these values as lower limits on the attenuation coefficients. If the attenuation factors actually fall at these lower limits, our result for g should be raised by about ten percent. The error quoted for g does not include the uncertainty arising from possible attenuation.

An additional argument in favor of values near unity for G_2 and G_4 in the hydrofluoric acid medium is that with such values the calculated "hard core" anisotropy does not fall significantly above the anisotropy measurements of McGowan for solid media.

At this time we are not prepared to make spin assignments to Ta^{181} but feel that this problem requires further study.

We wish to express our appreciation to Dr. F. Coester, with whom we have had many helpful discussions.

[1] Aeppli, Albers-Schönberg, Frauenfelder, and Scherrer, Helv. Phys. Acta **25**, 340 (1952).
[2] F. K. McGowan, Phys. Rev. **93**, 471 (1954).
[3] A. Abragam and R. V. Pound, Phys. Rev. **92**, 943 (1953).
[4] F. Coester, Phys. Rev. **93**, 1304 (1954).

Radiogenic Osmium fromRhenium-Containing Molybdenite

H. Hintenberger, W. Herr, and H. Voshage
Max-Planck-Institut für Chemie, Mainz, Germany
(Received July 26, 1954)

ACCORDING to Mattauch's[1] isobar rule either osmium or rhenium should have a naturally radioactive isotope of mass number 187, and in 1948 Naldrett and Libby[2] were able to establish a natural beta activity of rhenium to which they ascribed a half-life of 4×10^{12} years, and which was attributed to the isotope 187. If follows that rhenium-containing minerals must also contain radiogenic osmium. Professor Geilmann,[3] who from earlier investigations on the occurrence of rhenium[4] was in possession of minerals with high rhenium content, very kindly provided us with molybdenite with a rhenium content of 0.32 percent. To 139 g of this mineral we added 0.147 mg of ordinary osmium (made radioactive by cyclotron irradiation for control of the completeness of the osmium separation) and were able to recover altogether 2.26 mg osmium; 0.28 mg of this osmium was investigated in a 60-degree mass spectrometer. We identified the mass spectrogram of osmium in 5 different places with the

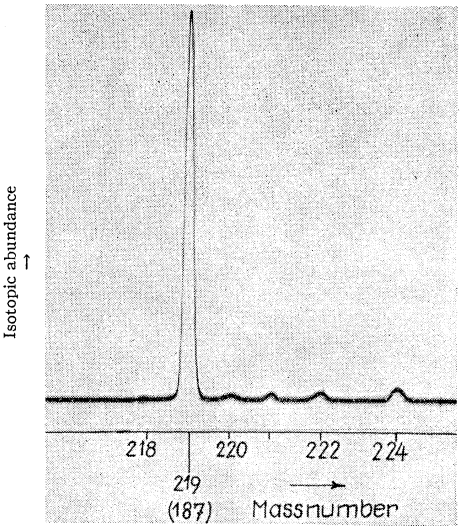

FIG. 1. Mass spectrum of radiogenic osmium in the mass range of OsO_2^+ ions.

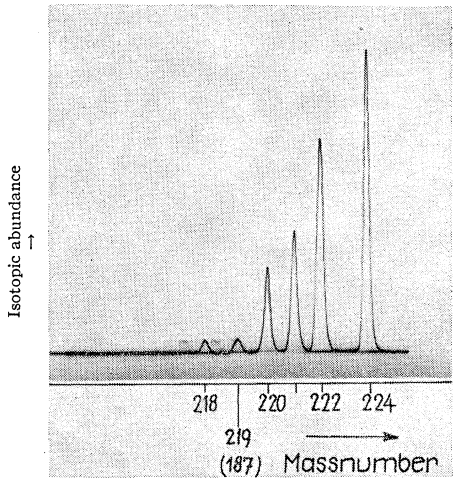

FIG. 2. Mass spectrum of normal osmium in the mass range of OsO_2^+ ions.