good agreement with Latyshev's value of 5% and Johansson's value of 7% for the intensity of the 1.6-Mev gamma ray. The 5% intensity of the beta transition to the 2.2-Mev level is consistent with the combined intensities of the 2.2-Mev and the 1.5-Mev gamma rays (4.3% according to Latyshev). The 8.5%–9% beta excitation of the 1.8-Mev level is consistent with the sum of Latyshev's value for the 1.8-Mev gamma-ray intensity and Johansson's figure for the 1.03-Mev gamma (together 8.6%). Finally, Johansson's value of 18.5% for the 0.72-Mev gamma is in fair agreement with the combined intensities of Johansson's result for the 1.03 Mev gamma and Latyshev's value for the 1.5-Mev gamma and the beta excitation of the 0.72-Mev level (together 15.8%–17.3%).

As was indicated above, the 0.84-Mev gamma ray reported by Johansson was not found in alpha-gamma coincidence measurements[8] and is most probably the 0.859-Mev gamma transition in Pb^{208}.

ACKNOWLEDGMENT

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Gyromagnetic Ratio of the 10^{-8}-sec State of Ta^{181}†

V. E. Krohn and S. Raboy
Argonne National Laboratory, Lemont, Illinois

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The gyromagnetic ratio of the 482-kev state of Ta^{181}(10^{-8}-sec) has been measured by angular correlation techniques and found to be $+1.23\pm0.05$ nuclear units.

The present measurement of the gyromagnetic ratio of the 482-kev 10^{-8}-sec state[1] of Ta^{181} (Fig. 1) was undertaken to improve the accuracy of our previous result[2] and to obtain additional information about the effect of extranuclear fields on the results. Since our preliminary report, a group in Zurich[3] has made a similar measurement.

Hafnium metal, irradiated in the Reactor CP-5 at the Argonne National Laboratory, was dissolved in concentrated hydrofluoric acid. The sources were contained in Teflon holders with the active volume in a cylinder 3.2 mm in diameter and about 3.2 mm high.

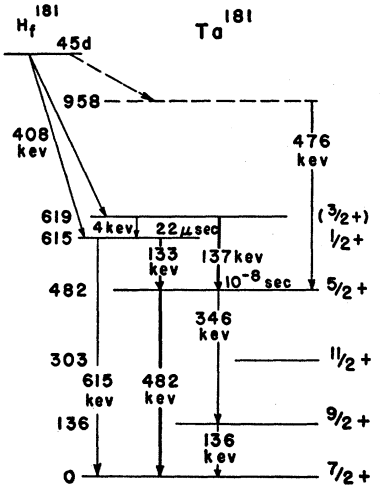

FIG. 1. Decay scheme of Hf^{181} as given by Boehm and Marmier.[1] The dark lines indicate the gamma rays involved in the present measurements.

The 482-kev and 133-kev or 137-kev gamma rays were detected by cylindrical NaI(Tl) crystals 3.8 cm in diameter and 2.54 cm long. These crystals were fastened to 28-cm Lucite light pipes which were optically bonded to fourteen-stage photomultipliers (6810). A fast-slow coincidence circuit was used for the measurements. The fast coincidence circuit was similar to the circuit described by Bell, Graham, and Petch,[4] and resolving times (2τ) from 20 to 70 mμsec were used during the course of the measurements. The pulses for the fast coincidence circuit were limited by EFP-60, secondary-emission pentodes, and fed to the fast-coincidence circuit without amplification. Pulses from the tenth dynodes of the 6810 multipliers were utilized for pulse height analysis. The system required a coincidence of the output pulses of each of the two single-channel analyzers, and the fast-coincidence circuit in order to register an event.

For a liquid source, with a magnetic field H applied perpendicularly to the plane of the detectors of the two gamma rays, the directional correlation is given by[5]

$$W(\theta,\omega)=\int_0^\infty \sum_n A_n e^{-\lambda_n t} P_n(\cos[\theta+\omega t]) e^{-t/\tau} F(t) dt, \quad (1)$$

where θ is the angle between the directions of emission of

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[3] Heer, Ruetschi, and Scherrer, Z. Naturforsch. **10a**, 834 (1955).

[4] Bell, Graham, and Petch, Can. J. Phys. **30**, 35 (1952).

[5] A. Abragam and R. V. Pound, Phys. Rev. **92**, 943 (1953).

the gamma rays, the P_n are even Legendre polynomials, the A_n are coefficients which appear in the unperturbed correlation function, $F(t)$ is the acceptance function of the coincidence apparatus, the λ_n are attenuation coefficients determined by the average interaction between the time-varying extranuclear fields and the quadrupole moments of the intermediate state of the nucleus, and ω is the angular velocity associated with the Larmor precession of the magnetic moment of the intermediate state and is given by

$$\omega = g\mu_0 H/\hbar, \tag{2}$$

in which g is the gyromagnetic ratio of the state and μ_0 the nuclear magneton. In Eq. (1), τ is the mean life of the intermediate state and the summation is over even values of n and is limited by the spin of the intermediate state and/or the multipolarities of the gamma rays.

In the case of the Ta^{181} cascade we are concerned with terms up to $n=4$. In order to determine λ_2 and λ_4 for hafnium metal dissolved in hydrofluoric acid, measurements were made at two values of the delay with a resolving time of 20 mμsec. In the first case, the acceptance function of the coincidence circuit, $F(t)$ of Eq. (1), emphasized times from 0 to 15 mμsec, while the second set of measurements was made with emphasis on time from 10 to 30 mμsec. These measurements were made in the absence of the magnet; and, after correction for the solid angle of the detectors, the results of Table I were obtained for A_2' and A_4', where

$$A_2' = \int_0^\infty A_2 e^{-t(\lambda_2+1/\tau)} F(t)dt \bigg/ \int_0^\infty e^{-t/\tau} F(t)dt, \tag{3}$$

and a similar expression holds for A_4'. There is no evidence of attenuation; and the maximum attenuation consistent with the data would cause only a one percent error in the value we have obtained for the gyromagnetic ratio on the assumption that the attenuation is negligible.

TABLE I. Values of the angular-correlation coefficients obtained with two different delays and identical geometries. The quoted uncertainties were determined from the scatter of the data and are valid for comparing the two rows, but are believed to be somewhat smaller than the systematic errors.

$F(t) \geq \frac{1}{2}$ max	A_2'	A_4'
0 to 15 mμsec	-0.263 ± 0.002	-0.075 ± 0.003
10 to 30 mμsec	-0.266 ± 0.002	-0.073 ± 0.003

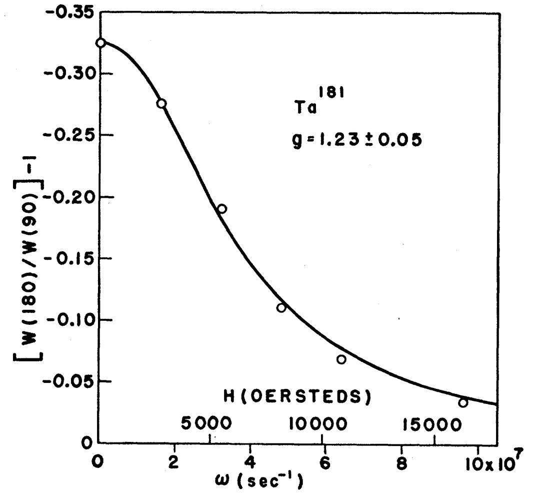

FIG. 2. Experimentally obtained anisotropy plotted as a function of magnetic field. The smooth curve is the anisotropy calculated as a function of ω and is fitted to the experimental points.

The anisotropy $[W(180°)/W(190°)-1]$ was measured (with 70-mμsec resolution) as a function of applied magnetic field and compared to the curve calculated from Eq. (1) with $\tau = (1.53 \pm 0.04) \times 10^{-8}$ sec,[6] $\lambda_2 = \lambda_4 = 0$, and values of A_2 and A_4 measured in the presence of the magnet without correction for the solid angle of the detectors. The results are shown in Fig. 2. The data were fitted to the calculated curve by adjusting the H scale relative to the ω scale, and the result, $g = +1.23 \pm 0.05$ nuclear units, was obtained by means of Eq. (2). The spin of the 480-kev state has been determined[2] to be $\frac{5}{2}$, so the magnetic moment is $\mu = +3.04 \pm 0.13$ nuclear magnetons.

The present result is in good agreement with our previous measurement and with the value ($g = +1.30 \pm 0.07$) obtained by the Swiss group.[2] At the present time the precision of the measurements is limited by a 2.5% uncertainty in the lifetime of the intermediate nuclear state. This contributes a 2.5% uncertainty to the measured values of g. Allowing for this uncertainty being common to both measurements, we obtain $g = +1.25 \pm 0.04$ as the weighted mean of our measurement and that of the Swiss group.

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[6] H. de Waard, dissertation, Universität Groningen, 1954, as quoted in reference 2.