The tables may be obtained directly from the Westinghouse Research Laboratories in East Pittsburgh, Pennsylvania.

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[1] *Internationale Tabellen zur Bestimmung von Kristallstructuren* (Gebruder Borntraeger, Berlin, 1935), Band II, pp. 585–608.

[2] J. H. Kittel, *Table of Interplanar Spacings*, Advisory Committee for Aeronautics (October, 1945).

Erratum: On the Fine Structure in the Inversion Spectrum of Ammonia

[Phys. Rev. **74**, 107 (1948)]

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In the above letter, numerical values quoted for the constants a and b were interchanged; they should have been given as

$$a=0.0011 \text{ Mc/sec.}, \quad b=0.0057 \text{ Mc/sec.}$$

Spin and Quadrupole Moment of S^{33}*

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July 12, 1948

Quadrupole effects caused by S^{33} in OCS have been found which show that the spin of S^{33} is $\frac{3}{2}$ and that its quadrupole moment is negative.

Previous evaluation[1] of the mass difference ratio $(S^{33}-S^{32}/S^{34}-S^{32})$ from frequencies of observed $J=1\rightarrow 2$ rotational lines of OCS^{32}, OCS^{33}, and OCS^{34} disagreed with other mass measurements. More recent[2] frequency measurements and measurements of the sulfur masses by Davison[3] have served only to increase the discrepancy. Since the most likely explanation of the discrepancy appeared to be a shift of the OCS^{33} line frequency by a quadrupole coupling between the S^{33} nucleus and the molecular field, the OCS^{33} absorption line $J=1\rightarrow 2$ was re-examined and a hyperfine structure caused by quadrupole effects found which had previously been overlooked.

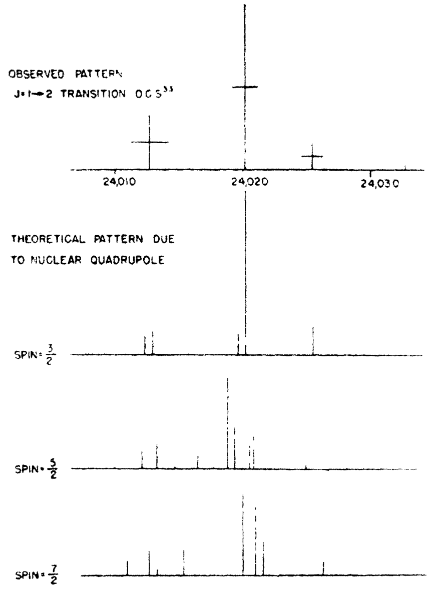

Fig. 1. Comparison of observed OCS^{33} spectrum with theoretical patterns for several assumed values of nuclear spin.

Table I. Observed frequencies and intensities compared with theoretical values for a spin of 3/2 and a quadrupole coupling constant of −28.5 mc.

Transition	Observed frequency	Theoretical frequency	Observed relative intensity	Theoretical relative intensity
$(J=1\rightarrow 2)$				
$F=1/2\rightarrow 3/2$ $5/2\rightarrow 5/2$	24,013.04	24,012.85	0.33	0.25
$1/2\rightarrow 1/2$ $3/2\rightarrow 5/2$ $5/2\rightarrow 7/2$	24,020.21	24,020.21	1.0	1.0
$3/2\rightarrow 3/2$	24,025.39	24,025.67	0.17	0.16
$3/2\rightarrow 1/2$	24,032.75	24,032.48	0.03	0.025

Table II. Results of measurements.

Molecule	Rotation-vibration constants in megacycles
OCS^{32}	$\alpha_1=18.12\pm 0.06$**
OCS^{34}	$\alpha_2=-10.37\pm 0.06$
OCS^{34}	q (l-type doubling constant) 6.07 ± 0.06

The frequencies and relative intensities of the lines found and the theoretically expected values are listed in Table I. That the lines allow a definite determination of the S^{33} spin as $\frac{3}{2}$ may be seen from Fig. 1, where theoretically expected patterns for various spins are compared with the observed spectrum. The horizontal bar through the midpoint of each observed line represents the half-width of the line under conditions of observation. It may be seen that although resolution was not sufficiently good to split the two low frequency components, their combined line is appreciably broadened.

Since the intensity of the OCS^{32} line is known[2] to be 5×10^{-5} cm^{-1}, absorption coefficients for the OCS^{33} lines may be calculated from the isotopic abundance of S^{33} (0.74 percent). It is found that the weakest observed line $(F=\frac{3}{2}\rightarrow\frac{1}{2})$ has a peak absorption coefficient of 5×10^{-9} cm^{-1} or 2.5×10^{-9} neper/cm at room temperature. This is apparently the weakest absorption line so far reported near 1 cm wave-length. The detection system used Stark modulation at 200 kc in a 3-meter wave guide and a phase-detecting or "lock-in" amplifier with a band width of about 20 cycles. The guide was cooled to −78° to enhance the line intensities threefold.

The quadrupole coupling constant $eQ(\partial^2 V/\partial z^2)$ is -28.5 ± 0.7 mc. Although the character of the molecular bonds is rather poorly known, the method of determining $\partial^2 V/\partial z^2$ previously described[4] appears to allow a definite determination of the sign of the S^{33} quadrupole moment as negative and a determination of the magnitude as -0.05×10^{-24} cm^2 with an accuracy of about a factor of two.

This quadrupole coupling increases the frequency of the strongest line (previously measured) by 0.54 mc. Allowing for this effect and using the latest frequency measurements, the mass ratio $(S^{33}-S^{32}/S^{34}-S^{32})$ can be determined as 0.50066 ± 0.00015. This is in good agreement with the value 0.50060 ± 0.0005 obtained from recent measurements of nuclear reaction energies.

Some additional rotational lines of OCS molecules in excited vibrational states were measured incidentally to this work. They give the results shown in Table II.

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* Work supported by the Signal Corps.

** Also recently measured by A. Roberts (private communication).

[1] C. H. Townes, A. N. Holden, and F. R. Merritt, Phys. Rev. **72**, 513 (1947).

[2] C. H. Townes, A. N. Holden, and F. R. Merritt (to be published).

[3] P. Davison, Paper (P5) of Am. Phys. Soc. meeting in Washington (1948).

[4] C. H. Townes, Phys. Rev. **71**, 909 (1947).

The Radioactive Lanthanum and Cerium Isotopes of Mass 137

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July 9, 1948

A SAMPLE of CeO_2 (Hilger Lab. No. 13386) was submitted to long neutron bombardment in a graphite-moderated pile. The activities were studied by the mass spectrographic transfer technique[1] and shown to consist principally of 30.6-day Ce^{141}, 1.4-day Ce^{143}, and 13.5-day Pr^{143}. After the sample had "cooled" for ten months, its isotopic constitution was compared with that of normal cerium using the surface ionization type of mass spectrometer previously described.[2]

Normal cerium showed ion currents at masses 152, 154, 156, and 158, due to the oxide ions $Ce^{136}O^{16}$, $Ce^{138}O^{16}$, $Ce^{140}O^{16}$, and $Ce^{142}O^{16}$. In addition, weak peaks were observed due to the two weaker oxygen isotopes. Pertinent impurities present were Ba, La, and Pr. The lanthanum and praseodymium were detected as $La^{139}O^{16}$ and $Pr^{141}O^{16}$, appearing at masses 155 and 157; the barium, as metallic ions at masses 130 to 138. The bombarded sample showed in addition to the above peaks a new peak at mass 153. That this peak is due to a new isotope of lanthanum was proved by eliminating in turn all the other elements which might give rise to this peak. That it was not cerium was proved by the fact that the ratio of the 152 to 153 peaks varied by a factor of 100 as the temperature of the filament varied. Barium was eliminated because barium ions are emitted as oxides. It is thus concluded that the isotope observed at mass 137 is lanthanum which has been formed by radioactive decay of Ce^{137}. In the particular sample under investigation the ratio of La^{137} to La^{139} was 0.15.

From the fact that at the time of isotopic analysis no Ce^{137} could be detected, it is concluded that the half-life of Ce^{137} is less than two months. By further consideration of the fact that the amount of radioactivity at mass 137 was too small to show by the transfer technique and that all of the La^{137} was the daughter of the Ce^{137} it may be concluded that the half-life of Ce^{137} is less than two weeks. Since the isotopic composition of the barium impurity was not detectably changed as the result of decay of La^{137}, the half-life of La^{137} must be greater than thirty years.

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[1] R. J. Hayden and M. G. Inghram, Phys. Rev. **70**, 89 (1946).

[2] M. G. Inghram, R. J. Hayden, and D. C. Hess, Jr., Phys. Rev. **72**, 967 (1947).

The Velocity of Discharge Propagation in Geiger Counters

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June 2, 1948

THE importance of the finite speed of propagation of the Geiger counter discharge was indicated some years ago by Dunworth,[1] and its existence was indicated by various workers.[1-3]

It was only recently that various and widely different experimental methods have been used by Hill and Dunworth,[4] Huber *et al.*,[5] and Wantuch[6] to measure the velocity of discharge spread along counters filled with self-quenching gas mixtures, such as argon/ethyl alcohol vapor. The results of the above authors disagree to an appreciable extent, as discussed by Wantuch.[6] The purpose of this note is not to comment further on the measurements with self-quenching ("fast") counters, but to submit measurements taken with externally quenched counters containing hydrogen. The use of elementary gases should enable simpler analyses of the results to be made and, it is hoped, might ultimately provide data on photo-ionization in such gases.

The method used in the present experiments was different from any of those used by the above authors and is shown schematically in Fig. 1. A pulse resulting from discharge build-up in one of the short end cylinders ("start cylinder") in the long counter shown (we have used them up to 2 m in length) connects a 4-mc/sec. quartz-controlled oscillator through a gate circuit to a fast scaler and recorder; the discharge then spreads along the counter.

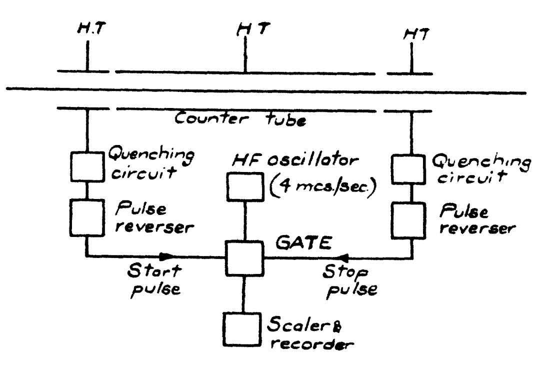

FIG. 1. Method used in experiments shown schematically.