

The Half-Life of Tritium*

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WE are measuring the half-life of tritium by following with time the decrease in ion current from an ion chamber containing a mixture of hydrogen and tritium. The work is still in progress, but we feel that a preliminary report of our results is of interest, since we find that the tritium half-life is considerably lower than the previously reported value of 31 years.¹

The ion chamber contained two concentric gold electrodes, spaced about 1 cm apart. The outer electrode was connected to the positive side and the inner electrode to the negative side of the voltage supply. The ion current was determined by measuring the IR drop across a 10,000-ohm standard resistance. Readings were made over a period of eighteen days. The logarithm of the IR drop when plotted against time gave a straight line whose slope corresponded to a half-life of 10.7 years.

The precision of the points on the decay curve was very good, corresponding to an error of about 1 percent in the half-life. However, we can make no correction at present for two possible sources of error: the first caused by absorption of tritium in the ion chamber, the second caused by the slight increase in pressure as tritium molecules are replaced by He³ atoms. We do not feel justified in claiming an error less than about 20 percent; therefore our preliminary measurement of the tritium half-life gives a value of 10.7 ± 2.0 years.

* This document is based on work performed at Los Alamos Scientific Laboratory of the University of California under contract with the U. S. Atomic Energy Commission.

¹ R. D. O'Neal and M. Goldhaber, *Phys. Rev.* **58**, 576 (1940).

Microwave Absorption Spectra of N₂O

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THE rotational transition $J=0$ to $J=1$ has been observed for the isotopic molecules N¹⁴N¹⁴O¹⁶ and N¹⁵N¹⁴O¹⁶. It was expected that these lines would exhibit hyperfine structure, because of electric quadrupole interaction between the N¹⁴ nuclei and the electric fields in the neighborhood of these nuclei.

Rotational levels of the N¹⁵N¹⁴O molecule should possess a triplet structure, since the N¹⁴ nucleus has a spin of 1. Rotational levels of the N¹⁴N¹⁴O molecule should be nonets in general. For the particular case $J=0$ no hyperfine structure is to be expected. This makes transitions involving the lowest rotational level particularly simple to observe and interpret, since any structure appearing in the absorption line must be just that of the upper rotational level.

The method of Stark-effect modulation, described by Hughes and Wilson,¹ was used to locate the two absorption lines. The electric field applied to the gas varied sinu-

soidally with time at 200 kilocycles per second, and the output of the crystal was picked up on a communications receiver tuned to 400 Kc. A high electric field strength of 2000 r.m.s. volts per centimeter was used, since N₂O is known to have a rather small dipole moment. Absorption lines caused by N¹⁵N¹⁴O¹⁶ and N¹⁴N¹⁴O¹⁶ were found at 24,274.60 and 25,123.24 megacycles per second, respectively. The latter frequency is a remarkably good confirmation of the infra-red value.²

In order to make precision frequency measurements and study the hyperfine structure of these lines, the gas was held at a temperature of 195°K and a pressure of 10 microns. Under these conditions it was possible to observe the lines while sweeping the Klystron at 30 cycles per second and amplifying the crystal output with a wide-band amplifier.

The N¹⁵N¹⁴O line was found to be an extremely close triplet, as shown in Fig. 1a. The intensities and spacings are in agreement with a quadrupole coupling constant [$eQ(\partial^2 V/\partial z^2)$] of -0.27 mc. For the N¹⁴N¹⁴O line the structure observed is shown in Fig. 1b. Although it was not

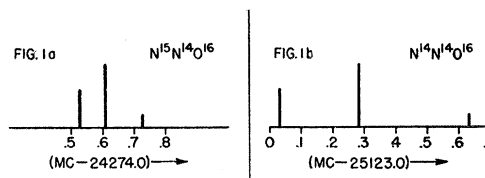


FIG. 1. Observed hyperfine structure for the $J=0$ to $J=1$ rotational transition of nitrous oxide.

possible to resolve the complete structure because of the two N¹⁴ nuclei, the comparatively wide triplet observed shows that the N¹⁴ nucleus in the end position of the molecule interacts much more strongly than the same nucleus in the central position. The observed triplet may be considered as essentially caused by the nucleus in the end position, except that the nucleus in the central position has the effect of slightly increasing the frequency for the two low frequency components. For the nucleus in the end position we estimate the coupling constant to be -0.84 mc. Both of these constants are much smaller than previous coupling constants obtained by microwave absorption.³

Molecular moments of inertia derived from the above line frequencies are

$$\begin{aligned} \text{N}^{15}\text{N}^{14}\text{O}^{16} \dots I_0 &= 69.12 \times 10^{-40} \text{ g cm}^2, \\ \text{N}^{14}\text{N}^{14}\text{O}^{16} \dots I_0 &= 66.79 \times 10^{-40} \text{ g cm}^2. \end{aligned}$$

If the effect of zero-point vibrations on the internuclear distances is ignored, one may calculate a distance of 1.126Å for N-N, and a distance of 1.191Å for N-O. These distances are in excellent agreement with those proposed by Pauling.⁴

¹ R. H. Hughes and E. Bright Wilson, Jr., *Phys. Rev.* **71**, 562 (1947).

² G. Herzberg, *Infrared and Raman Spectra of Polyatomic Molecules* (D. Van Nostrand Company, Inc., New York).

³ C. H. Townes, A. N. Holden, J. Bardeen, and F. R. Merritt, *Phys. Rev.* **71**, 644 (1947).

⁴ L. Pauling, *The Nature of the Chemical Bond* (Cornell University Press, Ithaca, New York, 1940).