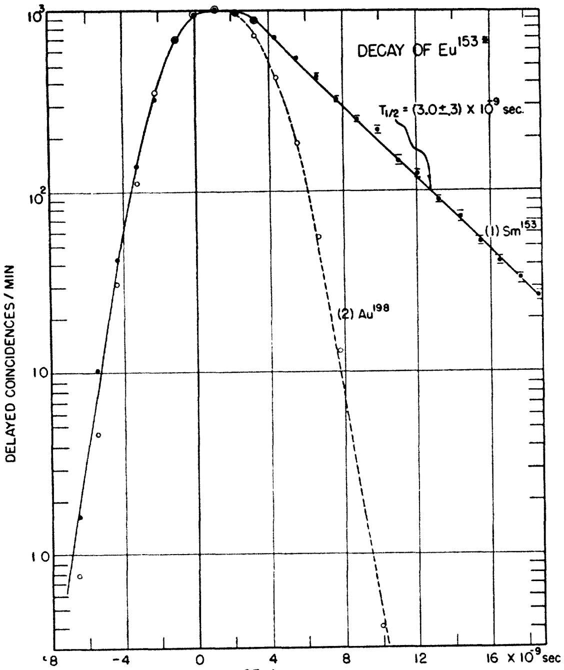

FIG. 1. Delayed coincidences as a function of delay time.

which are strongly converted.[4] In Fig. 1, curve (1), the number of coincidences are plotted as a function of delay time obtained with a source of Sm^{153}. This delayed coincidence resolution curve was recorded by exciting one channel of the delayed coincidence apparatus by the nuclear beta-rays and the other channel by the L, M, or N internal conversion electrons of the 103-kev γ-rays. Without a change in the apparatus, a resolution curve for prompt coincidences was obtained between the 411-kev γ-rays or internal conversion electrons and 85- to 110-kev nuclear beta-rays with a source of Au^{198}. Curve (2) shows the result of such a measurement. Thus, for delay $T \geqslant 8\times 10^{-9}$ sec. the half-life of Eu^{153*} may be determined from the slope of curve (1).

The spectrum of the radiation announcing the formation of the metastable state appears to be a simple beta-ray distribution unaccompanied by γ-rays. This information plus the fact that the decay curve for Eu^{153*} was obtained selecting coincidences between the nuclear beta-rays and the L, M, or N internal conversion electrons of the 103-kev γ-ray fixes the position of the metastable state at 172 kev above the ground state of Eu.

Measurements of the internal conversion electron spectrum of the delayed radiation indicate the presence of the 69- and 103-kev γ-rays. The relative heights of the K conversion peak of the 103-kev γ-ray (superimposed on the L, M, and N conversion lines of the 69-kev γ-ray) and the $L+M+N$ conversion peak of the 103-kev γ-ray indicates that the amount of internal conversion in the L shell is comparable to that in the K shell. Also, the spectrum of the unconverted and delayed electromagnetic radiation shows the presence of two peaks which are attributed to the K x-ray of Eu and the 69-kev γ-ray. These observations favor the idea that the isomeric transition is the 103-kev transition.

From the energy and half-life of this isomeric state the transition is probably electric quadrupole or a combination of electric quadrupole and magnetic dipole radiation.

* This document is based on work performed for the Atomic Energy Project at Oak Ridge National Laboratory.
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Radiofrequency Spectrum of D_2 in a Magnetic Field*

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THE radiofrequency spectrum of D_2 in a magnetic field of about 1616 gauss has been investigated by means of a molecular beam apparatus[1] of improved resolution. The molecules of the beam are cooled to the temperature of liquid N_2, so that most of them are in the zeroth and first rotational states. They traverse a path of total length 269 cm. Experimental evaluation of the frequency separations of the six first rotational state resonances permits more accurate determination of D_2 molecular and nuclear constants. In the customary notation,[2] the results are

$$H'=13.43\pm0.06 \text{ gauss},$$
$$S_D=\tfrac{1}{5}(H''+H''')=19.301\pm0.015 \text{ gauss},$$
$$H'''=-5e^2qQ/4\mu_D=86.11\pm0.08 \text{ gauss},$$
$$-qQ=(1.2931\pm0.0012)\times10^3 \text{ cm}^{-1},$$
$$Q=(2.739\pm0.016)\times10^{-27} \text{ cm}^2.$$

The error in the above value of the quadrupole moment of the deuteron is largely the consequence of error in the newly calculated value[3] of q.

Improved accuracy of the present results is to be attributed chiefly to three factors: (a) increased length of the apparatus, (b) variation of frequency instead of magnetic field, (c) use of a recently developed technique[4] of applying the radiofrequency current in two separated sections near the ends of the homogeneous magnetic field. The latter method, involving only the average effect of the field along the molecular path, minimizes the results of field inhomogeneities, which otherwise are found in the present apparatus to be rather serious. Line widths in the new method are very close to theoretical. Instead of turning the oscillator on and off, as in customary operation, we found it advantageous to change the phase of one r-f end section 180° relative to the other. By recording the sense as well as the magnitude of the resulting signal, one can obtain a resonance curve of the same shape (near resonance) as the customary one[1,4] but having double the effective amplitude. Experimental curves of this type are shown in Fig. 1. Moreover, the phase-shifting method greatly reduces r-f pick-up changes in the detector circuit by eliminating r-f current amplitude changes.

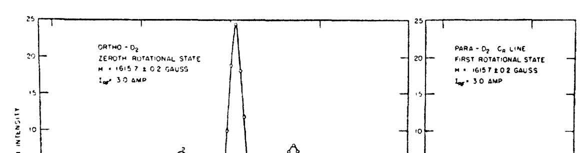

FIG. 1. Experimental resonance curves for D_2 in zeroth and first rotational states, obtained by reversing relative phases of separated r-f sections. Relative intensities are in approximate agreement with theory.

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