

TABLE I. Microwave spectrum of methyl alcohol.

Mc	Shape of Stark pattern	Minimum modulating voltage, v/cm	Series
20,898	unsym	300	I
20,989	unsym	300	I
21,551	unsym	300	I
22,095	unsym	300	I
23,033	unsym	300	I
25,385	unsym	300	I
24,040	unsym	300	II
24,081	unsym	300	II
24,317	unsym	300	II
25,050	unsym	300	II
24,928.8	unsym	30	III
24,954.6	sym	30	III
25,017.8	sym	30	III
25,132.0	sym	30	III
25,300.3	sym	30	III
25,546	sym	30	III
25,796	unsym	30	III
25,898	sym	30	III
26,310	sym	30	III
26,562	sym	30	III
23,121	unsym	300	—
23,415	unsym	300	—
23,450	unsym	300	—
23,861	sym	30	—

effect of the line at 25,126 Mc fitted the following formula

$$\Delta\nu = 0.084E,$$

where  $\Delta\nu$  is the frequency separation of the unsplit line and one of its two shifted Stark components (or groups of unresolved components). The separation  $\Delta\nu$  is in megacycles, and  $E$  is in volts/cm. The Stark patterns of the other lines were unsymmetric and for the line at 23,121.8 Mc  $\Delta\nu$  was 3.84 Mc for a field of 504 volts/cm.

The experimental data are summarized in Table I. Frequencies given to six figures were obtained using lines of the  $N^{14}H_3$  and  $N^{15}H_3$  spectrum as secondary standards; other frequencies were obtained using a calibrated wave-meter and are good to  $\pm 5$  Mc.

The rotational constants of methyl alcohol have been obtained from infra-red data by Borden and Barker.<sup>4</sup> They may be used with the appropriate selection rules to predict some of the features of the methanol spectrum in the microwave region. The transition  $\Delta J = +1$ ,  $\Delta K = 0$ , as pointed out by Hershberger and Turkevitch,<sup>1</sup> would give frequencies of 48,700 Mc and higher. For  $\Delta J = 0$ ,  $\Delta K = +1$  we should expect frequencies in the far infra-red. For  $\Delta J = \pm 1$ ,  $\Delta K = \pm 1$  it is possible to place only two or three lines in this region of frequency, and their separations should be irregular. This is also true for transitions between the degenerate  $K$  levels split by the slight asymmetry of the molecule.

Koehler and Dennison<sup>5</sup> have calculated the energy levels for methyl alcohol considered as two coupled symmetric rotors whose mutual rotation is hindered by a potential function having a triple minimum. One or perhaps two transitions between the levels for  $n = 0$  ( $n =$  torsional vibration quantum number) should fall in the  $K$ -band. It seems likely that each of these transitions should be split by centrifugal distortion into one or more series of lines characterized by different values of  $J$  and  $K$ .

It seems unlikely that a fine structure due to free rotation

is being observed, since the spacing of the levels is much too dense for the large values of the rotational constants of OH and  $CH_3$  found by Borden and Barker.

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<sup>1</sup> W. D. Hershberger and John Turkevitch, *Phys. Rev.* **71**, 554 (1947).  
<sup>2</sup> Richard H. Hughes and E. Bright Wilson, Jr., *Phys. Rev.* **71**, 562 (1947).

<sup>3</sup> W. E. Good and D. K. Coles, *Phys. Rev.* **71**, 383 (1947).

<sup>4</sup> A. Borden and E. F. Barker, *J. Chem. Phys.* **6**, 553 (1938).

<sup>5</sup> J. S. Koehler and D. M. Dennison, *Phys. Rev.* **57**, 1006 (1940).

### The 5.3 Day Isotope in Element 61

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A SAMPLE of element 61, formed by fission and shown by mass spectrographic analysis to be predominantly mass 147 (61 isotopes of other masses were present to less than one part in two thousand), was irradiated by slow neutrons in the Clinton Pile. After bombardment, a 5.3-day activity was found to be present in the element 61. The cross section for this reaction was approximately  $60 \times 10^{-24}$  cm<sup>2</sup>. The radiations from this sample, as determined by absorption curves, were a beta-ray of approximately 2.5 Mev, and a gamma-ray of approximately 0.8 Mev. This is probably the same activity observed by Law, Pool, Kurbatov, and Quill.<sup>1,2</sup> They observed it as formed by  $Nd(p, n)$ ,  $Nd(d, n)$ , and  $Nd(\alpha, p)$ . The second of these reactions is incompatible with our determination of the mass of this isotope.

To verify that the reaction involved was actually  $(n, \gamma)$  and hence that the mass of the 5.3-day active isotope in element 61 was 148, a portion of the sample was analyzed by means of a mass spectrograph.<sup>3</sup> After separation, active isotopes were found at masses 147 and 148. To verify that the activity at mass 148 had a half-life of 5.3 days, the following technique was used: The photographic plate upon which the separated isotopes were deposited was placed successively against various parts of a larger photographic plate for times calculated to give equal intensity in the 148 position if its half-life were 5.3 days. Five exposures were taken for successive times of 33.2 hours, 40.7 hours, 52.3 hours, 72.3 hours, and 122 hours. Upon development this large plate showed equal blackening at mass 148 and increasing blackening for successive transfers at mass 147. Thus the active isotope in element 61 with a half-life of 5.3 days is at mass 148.

<sup>1</sup> H. B. Law, M. L. Pool, J. D. Kurbatov, and L. L. Quill, *Phys. Rev.* **59**, 936 (1941).

<sup>2</sup> J. D. Kurbatov and M. L. Pool, *Phys. Rev.* **63**, 463 (1943).

<sup>3</sup> M. G. Inghram and R. J. Hayden, *Phys. Rev.* **71**, 130 (1947).