siderations have led to the constants (the c's are in Mev)

$$c_1=26.00,\quad c_2=9.560,\quad c_3=0.00780,\quad c_4=22.5,$$
$$c_5=33.5,\quad \gamma=0.400\quad \text{and}\quad B=200.$$

Together with Eq. (1) these simple key functions characterize an empirical energy surface which does not deviate significantly from the Weizsäcker surface for the great range of mass numbers and which lies significantly closer to the true nuclear surface for very heavy nuclei. Furthermore, Eq. (4) is now exact.

Apart from systematizing nuclear data, it is thought that this empirical surface will be very useful as a base surface for investigating the irregularities of the actual surface. Thus if $E_{sh}(A, D)$ is the deviation of the true surface from the empirical surface at the A, D point then any discrepancy between an experimental Q value and the calculated Q value is given by

$$Q_{\text{exp}}-Q_{\text{calc}}=E_{sh}(A, D)-E_{sh}(A', D'). \tag{15}$$

I would like to thank the many students who have assisted in this study, in particular Mr. Robert Minogue who determined the values of c_1, c_2, and c_3 quoted above. Mr. Minogue has also carried out a survey of experimental and calculated neutron binding energies and alpha-decay energies as well as a study of the shell correction in the neighborhood of mass number 208. These results will be reported in a detailed communication.

[1] L. Rosenfeld, *Nuclear Forces* (Interscience Publishing Company, Inc., New York, 1949).

On the Spin and Quadrupole Moment of Cl^{36}

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FROM observation of the hyperfine structure of the $J=0\rightarrow1$ transition of CH_3Cl^{36} we have confirmed the assignment of 2 for the nuclear spin of Cl^{36} by Townes and Aamodt.[1] This is the only known nuclear spin value of 2.

The hyperfine structure of a $0\rightarrow1$ transition is particularly simple, consisting of only three lines for any spin value. The ratios of the frequency intervals differ widely for different spin value, so that an unquestionable assignment of a spin can be made by a precise measurement of these ratios. Table I lists the frequency ratios for spin values 1 to 4, together with the measured value for CH_3Cl^{36}. It is seen that all theoretical values except those for $I=2$ are considerably outside the range of limits of error.

TABLE I. Frequency ratios of hyperfine components for different spin values.

Spin	Theoretical ratio	Observed ratio
1	1.500	
2	0.556	0.547 ±0.017
3	0.350	
4	0.257	

Tables II and III list the various constants which were evaluated. The quadrupole moment is determined from the coupling ratio, using the Cl^{35} moment -0.07894×10^{-24} cm^2, as revised by Jaccarino and King.[2] The value agrees with that of Townes and Aamodt,[1] $-0.0172\pm0.0004\times10^{-24}$ cm^2,[3] within the limits of error of the two observations.

TABLE II. Measured frequencies of CH_3Cl^{36}.

Transition	Observed frequency Mc/sec	B_0 Mc/sec
$J=0\rightarrow1$, $F=2\rightarrow2$	26,372.42 ±0.05	
$2\rightarrow3$	26,376.01	13,187.66[a]
$2\rightarrow1$	26,377.97	

[a] D_J is assumed to be 26.5 kc/sec.

TABLE III. Cl^{36} constants.

Spin	Coupling Mc/sec	Quadrupole moment cm²
2	−15.87 ±0.09[a]	$-0.0168\pm0.0001\times10^{-24}$

[a] The accuracy of relative frequency measurements is ±0.03 Mc/sec.

Figure 1 shows a cathode-ray presentation of the spectrum, with bars to indicate the theoretical spectrum for $I=2$. One of the lines of CH_3Cl^{35} in an excited vibrational state falls among the Cl^{36} group. Although this could not be completely "frozen out," it was easily identified and resolved from the Cl^{36} lines. The observations were made at dry ice temperature with a 20-foot Stark cell. A 100-kc square wave Stark modulating voltage was employed, with the field adjusted so as to remove the Stark components completely from the undisplaced group (zero field components). The methyl chloride was synthesized by reacting NaCl with H_2SO_4 and CH_3OH. The Cl^{36} was made by neutron capture in Cl^{35} in a reactor. Its concentration was less than 1 percent.

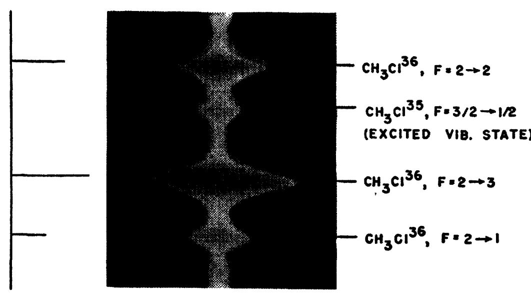

FIG. 1. Oscilloscope picture of $J=0\rightarrow1$ hyperfine pattern for CH_3Cl^{36}, with the calculated pattern below.

Since the hyperfine structure lines of an excited vibrational state of CH_3Cl^{35} occur so near the Cl^{36} group, the frequencies of these lines were also measured during this experiment in order to determine whether or not the quadrupole coupling remained the same as in the ground state. The coupling was found to be −74.70 Mc/sec, which is not significantly different from the latest value,[4] −74.77 Mc/sec, given for the ground state.

We wish to thank Ralph Trambarulo, J. Q. Williams and C. F. Luck for assisting with the measurements.

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† The research at this institution was performed for the AEC.
[1] C. H. Townes and L. C. Aamodt, Phys. Rev. **76**, 691 (1949).
[2] V. Jaccarino and J. G. King, private communication.
[3] This value has not been corrected for the revised moment of Cl^{35}.
[4] Geschwind, Gunther-Mohr and Townes, Phys. Rev. **81**, 288 (1951).

The Specific Alpha-Radioactivity of Pu^{240}

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THE small concentrations of Pu^{240} produced by the reaction $Pu^{239}(n,\gamma)Pu^{240}$ during irradiation of uranium or plutonium samples in thermal neutron reactors make possible the calculation of the half-life of Pu^{240} from a determination of the relative specific

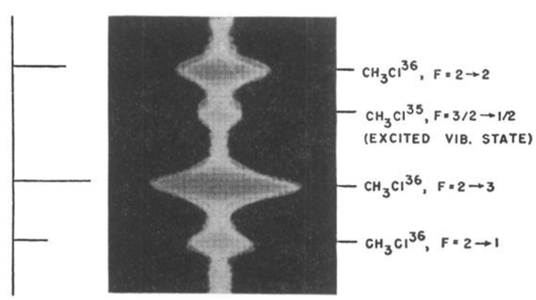

FIG. 1. Oscilloscope picture of $J=0\rightarrow1$ hyperfine pattern for CH_3Cl^{36}, with the calculated pattern below.