It is interesting to note in connection with the stability of V^{50} that on calculating the mass of Cr^{50}, V^{50}, and Ti^{50} using Wigner's[6] semi-empirical formula, one finds Cr^{50} and Ti^{50} to have practically identical mass with V^{50} about one-milli mass unit heavier. The presence of spin dependent forces not taken into account may, however, decrease the mass of V^{50}. It is possible that we are dealing with a situation wherein all three isobars, Cr^{50}, V^{50}, and Ti^{50}, have very nearly equal masses and, consequently, are stable or at least undetectably radioactive. A cloud chamber has been set up in which all three elements have been placed, and it is hoped that this will enable a critical examination as to their radioactivity.

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** A possible exception to this rule is La^{138} reported by Inghram, Hayden, and Hess, Jr., Phys. Rev. **72**, 967 (1947).

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Nuclear and Molecular Information from the Microwave Spectrum of FCl*

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The rotational transitions for $J=0\rightarrow1$ in FCl^{35} and FCl^{37} have been observed near 30,000 mc for both the ground vibrational state and the first excited vibrational state. A specially constructed Stark absorption cell resistant to fluorine corrosion was used. The hyperfine structure due to the electric quadrupole moment of the chlorine nuclei splits the $J=1$ levels so that the observed lines are triplets. The frequencies of the twelve resulting lines are given in Table I.

The hyperfine structure spacings do not agree with the theoretically predicted pattern for nuclear quadrupole splitting, even including second-order corrections. To explain this we assume an extra term in the Hamiltonian of the form $cI\cdot J$. Such a term has been found necessary to explain the spectrum of the alkali halides observed by Nierenberg and Ramsey,[1] and has also been introduced to explain small deviations from predicted frequencies in the NH$_3$ inversion spectrum.[2-4] The value of c for FCl^{35} is 0.036 ±0.009 mc and 0.019±0.009 mc for FCl^{37}. The magnetic field required at the Cl nucleus to produce interactions of this magnitude is unexpectedly large—about 70 gauss. It seems difficult to account for so large a field from molecular rotation alone, and the hypothesis of Van Vleck[1] that the field is due to coupling with higher electronic states is perhaps more plausible. The ratio $c^{35}/c^{37}=1.9\pm0.97$ is in agreement, within the rather large experimental error, with the ratio of the magnetic moments 1.2055 ±0.003 taken from Goldsmith and Inglis.[5] Assuming the effective magnetic field is the same in both isotopic species these two ratios should be the same.

TABLE I. Observed transitions and frequencies.

Molecule	v	$J=0\rightarrow1$ F	Frequency, mc
FCl^{35}	0	3/2→1/2	30,873.004±0.042
		3/2 5/2	30,843.948±0.042
		3/2 3/2	30,807.413±0.042
	1	3/2→1/2	30,611.761 0.069
		3/2 5/2	30,582.614 0.069
		3/2 3/2	30,545.994 0.069
FCl^{37}	0	3/2→1/2	30,280.107±0.042
		3/2 5/2	30,257.159 0.042
		3/2 3/2	30,228.359 0.042
	1	3/2→1/2	30,026.195 0.069
		3/2 5/2	30,003.218 0.069
		3/2 3/2	29,974.470 0.069

TABLE II. Molecular constants of FCl.

	FCl^{35}	FCl^{37}
B_e	15,483.688±0.026 mc	15,189.221±0.026 mc
I_e	54.1822×10^{-40} g cm^2	55.2326
D_e	0.0263 mc[a]	0.0253
α	130.666±0.029 mc	126.957±0.029
r_e	1.62811×10^{-8} cm	
μ	0.881±0.02 debye	
c	0.036±0.009 mc	0.019±0.009
eq$Q$	−145.94±0.26 mc	−114.92±0.26

[a] Calculated from the vibrational frequency given by A. L. Wahrhaftig, J. Chem. Phys. **10**, 248 (1942); also P. A. Griswold, thesis, State University of Iowa, 1949.

The values of the quadrupole coupling energy are eqQ^{35}= −145.99±0.26 mc and eqQ^{37}= −114.92±0.26 mc. The ratio eqQ^{35}/eqQ^{37}=1.2704±0.004 is only in fair agreement with the ratio of the quadrupole moments obtained by Davis and Zabel[6] from the spectrum of atomic chlorine, $Q^{35}/Q^{37}=1.2795\pm0.0026$. The existence of coupling with higher order electronic states also introduces a "pseudo-quadrupole" coupling[1,3] of unknown magnitude, indistinguishable from the nuclear coupling. Such a contribution to eq$Q$, being the same in both isotopic molecules, would tend to alter the observed ratios.

The ratio Be^{37}/Be^{35}=0.9809821±0.0000024 gives for the mass ratio Cl^{35}/Cl^{37}=0.9459775±0.000004. This agrees quite well with the value obtained by Townes *et al.*[7] from the microwave spectrum of ICl, 0.9459801±0.000005. Both microwave determinations disgree with the best value from mass spectroscopy,[8] 0.9459445 ±0.000007. We conclude that the latter is probably in error.

Stark effect measurements were made on the line $F=3/2\rightarrow3/2$, $M_F=3/2\rightarrow3/2$. The analysis of these data requires the solution of the secular equation for the case of intermediate field strength[9] $\mu^2E^2/B\sim$eq$Q$. The value of the molecular electric dipole moment appears in Table II along with other derived and measured molecular constants.

The bond in FCl is estimated at 80 percent covalent, 20 percent ionic, the latter figure being an average of the value obtained from electro-negativity difference and that obtained from the observed dipole moment. The large observed quadrupole coupling is in qualitative agreement with the value calculated on this basis, but somewhat larger than that obtained by assuming the covalent bond to be an s–p hybrid[10] and neglecting other contributions to q.

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