structure of the $^2P_{\frac{1}{2}}$ ground state of Tl^{205} and Tl^{203} by the atomic beam magnetic resonance method.

Since the zero field h.f.s. separation of the two F levels is very large, observation of the lines $\Delta F=\pm 1$ presents large technical difficulties. The $\Delta\nu$ has, therefore, been determined from an observation of the lines $\Delta F=0$, $\Delta m_F=\pm 1$. The largest contribution to the frequencies of the lines occurs from the terms $g_F\mu_0 H/h$, but a small term, quadratic in H, permits $\Delta\nu$ to be determined.

The spin of both Tl^{205} and Tl^{203} is known to be $\frac{1}{2}$. Thus, only two lines $(1,1)\leftrightarrow(1,0)$ and $(1,0)\leftrightarrow(1,-1)$ of the specified type exist for each isotope. If it is assumed that $g_J(^2P_{\frac{1}{2}}, \mathrm{Tl})=g_J(^2P_{\frac{1}{2}}, \mathrm{In})$, then it is possible from the known values[1,2] of $g_I(\mathrm{Tl})/g_I(\mathrm{H})$ and $g_I(\mathrm{H})/g_J(^2P_{\frac{1}{2}}, \mathrm{In})$ [3] to find $g_I(\mathrm{Tl})/g_J(^2P_{\frac{1}{2}}, \mathrm{Tl})$. By application of the well-known relationships which describe the energies of the magnetic levels of an atom for which $J=\frac{1}{2}$, the two observed line frequencies then determine both $\Delta\nu$ and the parameter

$$x=(g_J-g_I)\mu_0 H/h\Delta\nu.$$

It is found that

$$\Delta\nu^{(205)}=(21312\leftrightarrow 3)\times 10^6 \text{ sec.}^{-1}$$

and

$$\Delta\nu^{(203)}=(21113\pm 3)\times 10^6 \text{ sec.}^{-1}.$$

Since the data of the experiment are reduced to the frequencies of four lines at a fixed magnetic field, the quantity $x\Delta\nu/(g_J-g_I)$ should be the same when calculated for each of the two isotopes of thallium. The agreement is excellent and justifies the precision for the $\Delta\nu$'s if both g_I values are assumed to be negative. The negative g_I's are in agreement with the positive magnetic moments deduced from observations of the nuclear magnetic resonance of thallium by the nuclear induction method. From these results, the ratio

$$\frac{\Delta\nu(205)}{\Delta\nu(203)}=1.00947\pm 0.00020$$

is in excellent agreement with the ratio

$$\frac{\Delta\nu'(205)}{\Delta\nu'(203)}=1.00966\pm 0.00046$$

of the h.f.s. splittings of the $\lambda 4946$ line in the spectrum of Tl II, measured by Schuler and Korshing.[4]

Poss has found that

$$\frac{g_I^{205}}{g_I^{203}}=1.00986\pm 0.00005.$$

The discrepancy between this value and the ratio of the $\Delta\nu$'s is well beyond experimental error.

This appears to be another example of an effect observed previously for other pairs of isotopic nuclei[5-7] which has been explained,[8] in the case of H and D in terms of effects arising from the finite structure of the nucleus.

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The Electric Quadrupole Moment of the Deuteron*

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As has been pointed out previously,[1-3] the determination of the quadrupole moment of the deuteron requires finding the ratio of the quadrupole interaction energy to the value of the electric field gradient at the D nucleus.

The interaction energy in HD and D_2 molecules has been determined experimentally,[1] but the field gradient must be calculated from a suitable electronic wave function for the molecule. This calculation was originally done by A. Nordsieck[2] and later by E. Ishiguro[3] with resulting values $Q=2.73\times 10^{-27}$ cm^2 and 2.79×10^{-27} cm^2, respectively. Both calculations were estimated to be within ± 2 percent, overshadowing the experimental error of 0.6 percent.

By means of the variation principle, a new six-parameter electronic wave function has been determined for the ground state of the molecule. The field gradient as calculated from this wave function leads to the value $Q=2.766\times 10^{-27}$ cm^2. In spite of considerable effort to reduce the over-all calculational error in the electric field gradient to a minimum, it was unfortunately not found possible to reduce the error below 0.6 percent. It is felt that any substantial improvement in the accuracy of the calculation would require high speed automatic computing means.

The total probable error in Q, due to both experiment and calculation is thus taken to be $\sqrt{2}$ (0.6) percent=0.9 percent:

$$Q=(2.766\pm 0.025)\times 10^{-27} \text{ cm}^2.$$

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Functions Used in Flügge's Method of Predicting Approximate Spatial Neutron Distributions*

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A method due to Flügge,[1] which permits prediction of the approximate spatial distributions of neutrons in an infinite hydrogenous medium due to a point source of monoenergetic neutrons of energy E_0, applies age theory to the distributed source of those neutrons that have made one slowing-down collision. The assumption is made that these neutrons have an average energy E_0/e. The resulting distribution equation can be put into the form

$$qr^2=\frac{Q}{4\pi\lambda_0}[xe^{-x^2}][F(a+x)-F(a-x)], \quad x=r/2L_s, \quad a=L_s/\lambda_0,$$

where the slowing-down distance, L_s, is measured from the energy E_0/e, λ_0 is an "effective" mean-free-path for a first collision with hydrogen, r is the space coordinate, and Q is the source strength. The functions $F(Z)$ and $[-F(-Z)]$ are tabulated by Flügge for values of Z from zero up to and including $Z=3.0$.

This method was applied to the analysis of various experimental distributions in collaboration with Professor C. W. Tittle of North Texas State College, the results of which will be the subject

Table I. Tabulation of $F(Z)$ and $-F(-Z)$.

Z	$F(Z)$	$-F(-Z)$	$\log[-F(-Z)]$
3.0	1.20	2.93×10^3	3.46687
3.5	1.28	6.49×10^4	4.81224
4.0	1.35	2.43×10^6	6.38561
4.5	1.41	1.54×10^8	8.18752
5.0	1.47	1.64×10^{10}	10.21484
5.5	1.52	2.94×10^{12}	12.46835
6.0	1.57	8.76×10^{14}	14.94250
6.5	1.61	3.80×10^{17}	17.57978
7.0	1.65	3.60×10^{20}	20.55630