LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twentieth of the preceding month; for the second issue, the fifth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

The Spin of the Sodium Nucleus

The $^1\Pi \leftarrow {}^1\Sigma$ absorption bands of molecular sodium have been studied by Frederickson and Watson[1] and by Loomis and Wood,[2] and Urey[3] has pointed out that a distinct alteration of intensities occurs in these bands. We have measured the relative intensities of the Q-branch lines $J''=48$ to $J''=73$ of the (0, 2) band and have found that the ratio of intensities of the odd to the even lines is 1.74.

A one meter long iron tube was used as an absorption cell, which was heated by resistance coils wound around it. The sodium vapor was confined to a 40 cm central portion where the temperature was uniform within two degrees by means of streams of nitrogen gas flowing in near the windows and out through more centrally located tubes. A 500 C.P. Point-O-Lite lamp served as a continuous source.

Sets of calibration marks were placed on each photographic plate below the absorption spectrum, and relative intensities were calculated from microphotometer curves. In view of the presence of considerable background irregularities in the absorption spectrum it was found necessary to refer all lines to an average background.

The intensity of the transmitted light is given by $I=I_0e^{-\alpha}$, where I has been taken as the intensity at the middle of the line and I_0 as the intensity of the background. α is proportional to the absorption coefficient since the intensities of all the lines are measured in the same column of vapor. For the values of α encountered in this work (0.02–0.08) we may take α as a measure of the relative intensities of the lines,[4] without introducing errors greater than one or two percent.

The α's of the Q-branch lines are theoretically given by the formula:

$$\alpha = Cg(2J+1)\exp(-BhcJ(J+1)/kT)$$

where C is a proportionality factor, and $g=(i+1)(2i+1)$ for the odd lines and $i(2i+1)$ for the even lines and the other symbols have their usual meaning. If the quantity $\ln(2J+1)/\alpha - BhcJ(J+1)/kT$ is calculated for all lines and averaged for the strong and weak ones separately, the difference between the two averages gives $\ln(i+1)/i$.

Since an important source of error in such measurements may be incomplete resolution of the lines, the effect of pressure, broadening in the observed value of $(i+1)/i$ was investigated. No systematic trend of $(i+1)/i$ was observed as the nitrogen pressure was varied from 2.5 mm to 185 mm of mercury. Also, the effect on the relative values of the α's of changes in shape of the absorption lines due to the optical system has been found to be negligible.

Table I gives the observed ratios under different experimental conditions.

TABLE I.

Plate	Temp. °C	Nitrogen pressure	$(i+1)/i$
B	347	2.5 mm	1.68
C	348	27.4	1.69
D	346	103	1.81
F	347	185	1.69
G	348	185	1.85
			Aver. 1.74

The probable error in $(i+1)/i$ calculated from the deviations of the individual lines from the mean is about 0.10 for each plate.

From the observed value of 1.74 for the ratio of $i+1$ to i, we conclude that the spin of the sodium nucleus is $\frac{3}{2}$. Rabi[5] using another method has secured this same value.

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[1] W. R. Frederickson and W. W. Watson, Phys. Rev. **30**, 429 (1927).

[2] F. W. Loomis and R. W. Wood, Phys. Rev. **32**, 223 (1928).

[3] H. C. Urey, Phys. Rev. **38**, 1074 (1931).

[4] See formulae given by Ladenburg and Levy, Zeits. f. Physik **65**, 189 (1930).

[5] I. I. Rabi, to appear in this journal.