

electrons have $n=2$ their interaction with the nucleus will be far smaller than that of the $1s$ electron, and will be neglected here.

To obtain finally the hyperfine structure for the $1s\ 2s\ ^3S$ and $1s\ 2p\ ^3P$ states of Li^+ , use is made of the expressions derived by Goudsmit and Bacher (*Phys. Rev.*, **34**, 12; 1929). Assuming for simplicity $i=1/2$, which does not affect the order of magnitude of our results, we expect to a first approximation:

	Calc.	Obs.
3S_1	$\Delta\nu = 0.17\ g(i)$	0.6 cm. ⁻¹
3P_2	$= 0.14\ g(i)$	0.3
3P_1	$= 0.085\ g(i)$	0.3

The result is that the expected separations are not of an order of magnitude 1840 times smaller than the multiplet separation of 3P , which is approximately 5 cm.⁻¹.

Recently Schüler and Brück (*Zeit. f. Phys.*, **58**, 735; 1929) have given a tentative analysis of the Li^+ hyperfine structure leading to $i=1/2$, and giving the separations mentioned as observed in the above table. With respect to the uncertainty in the screening effect and interpretation, their results indicate a $g(i)$ -value of about 3 to 6. (It was hoped that this value would be approximately 2.) The application of these formulæ to hyperfine structure in other atoms, which can be done to a first approximation by replacing $(Z/n)^3$ by Zz^2/n_0^3 , also seems to lead to rather large values for $g(i)$.

If the tentative interpretation of this hyperfine structure given by Schüler and Brück is correct, the hyperfine splitting is inverted. Another example where this is the case is the cadmium isotope with $i=1/2$ (Schüler and Brück, *Zeit. f. Phys.*, **58**, 737; 1929). This means that the magnetic moment of the nucleus is related to its mechanical moment as if it were due to negatively charged particles. However, it is possible, though improbable, to have a complicated configuration of positive particles for which the resultant magnetic moment is oppositely directed to the mechanical moment. Something similar occurs for the extra-nuclear electrons in certain complicated configurations which show a negative Landé g -value (for example, $^6F_{1/2}$, with $g = -2/3$).

S. GOUDSMIT.
L. A. YOUNG.

Department of Physics,
University of Michigan,
Jan. 30.

Moment of Inertia of Hydrogen from Band Spectra.

THE commonly accepted value of the moment of inertia of the hydrogen molecule, in the normal state, is due to Hori (*Zeit. f. Phys.*, **44**, 834; 1927). In deriving this value, Hori expressed the rotational energy as $E_m = B_v m^2 + D_v m^4$, and calculated empirical values of D_v directly from the data. The term $D_v m^4$ is due to the swelling of the molecule with rotation, and it is now well established that the theoretical values of D_v hold accurately in the case of electronic levels for which there is no resultant electron momentum to complicate matters. This is the situation in the normal level of hydrogen ($^1\Sigma$). Hori's values of D_v are several times as small as those given by theory and, what is more important, are positive, whereas a swelling of the molecule with rotation requires that they be negative. Hori made note of this discrepancy in sign, but was unable to explain it. We find, however, in agreement with Schaafsma and Dieke (*Zeit. f. Phys.*, **55**, 164; 1929) that Hori's data, although relatively inaccurate and meagre, do indicate negative values of D_v , and we are unable to locate the origin of

his published values. It should be pointed out, in addition, that Hori's data give probable errors for B_v (his A_v) and D_v (his β) ten to one hundred times as large as his published errors for these quantities.

There are now available much more extensive and accurate data for the normal state of hydrogen. Schaafsma and Dieke (*loc. cit.*) have published rotational energy data, based on H_2 plates obtained by Dieke and Hopfield (*Phys. Rev.*, **30**, 400; 1927) on the 50 cm. vacuum spectrograph at the University of California. One of us (see H. H. Hyman and R. T. Birge, *NATURE*, **123**, 277; 1929) has recently obtained similar data from spectrograms taken with Prof. Hopfield's new 10-ft. vacuum spectrograph. Using all available data from these sources, and employing the various known theoretical relations, we have calculated values of B as a function of v , and find

$$B_v = 60.587 - 2.7938(v + 1/2) + 1.0500 \times 10^{-2}(v + 1/2)^2 - 24.058 \times 10^{-4}(v + 1/2)^3.$$

In this equation, the actual vibrational energy levels are given by $v=0, 1, 2$, etc., and the available data run from $v=1$ to 12 inclusive. The equation is entirely satisfactory from $v=1$ to 9. The higher values of v lie close to dissociation and the observed values of B_v are smaller than those given by the equation.

The most important constant is of course B_0 , corresponding to the lowest actual vibrational level ($v=0$). The absorption bands of the $B-A$ system, observed and measured by Dieke and Hopfield (*loc. cit.*) lead directly to a value of B_0 , but the probable error is quite large. On the other hand, only one emission band (observed by Witmer, *Phys. Rev.*, **28**, 1223; 1926) is available for this purpose, and the data in this case are very fragmentary. It is therefore necessary to evaluate B_0 by extrapolation, using the equation just given, with $v=0$. The extrapolation in this case is quite trustworthy provided the B_v curve is really smooth. The result is $B_0 = 59.192$ cm.⁻¹. Using the new conversion factor $(27.66 \pm 0.04) \times 10^{-40}$, given by Birge (*Phys. Rev.*, Supplement **1**, 1; 1929), one then obtains $I_0 = 0.4673 \times 10^{-40}$ gm.cm.², and $r_0 = 0.7500 \times 10^{-8}$ cm. Hori found $B_0 = 57.77$, giving $I_0 = 0.479 \times 10^{-40}$. This differs from our value by 2.2 per cent.

In this connexion we should like to emphasise that Hori's published $I = 0.467 \times 10^{-40}$ refers to the true state of zero vibration ($v = -1/2$) and would now be denoted I_e . Nearly everyone has quoted and used Hori's I_e value as though it were I_0 . Our own value of B_e is given by the constant term in our equation (60.587), and this leads to $I_e = 0.4565 \times 10^{-40}$, $r_e = 0.7412 \times 10^{-8}$. It is interesting to note that Wang (*Phys. Rev.*, **31**, 579; 1928) obtained $I_e = 0.459 \times 10^{-40}$, from a theoretical wave mechanics calculation. We believe that the probable error in the values of B_1 to B_9 , as given by the above equation, is 0.1 per cent, or less. So far as the uncertainty of the extrapolation is concerned, the probable error in B_0 and B_e is not more than 0.2 per cent. It is, however, shown in the following letter by Birge and Jeppesen that B_0 is definitely perturbed, so that our value is not correct. Whether B_e is correct cannot be tested, since this constant refers to a molecular state which does not exist.

This work has been carried out with the advice and assistance of Prof. R. T. Birge, to whom we wish to express our sincere thanks.

HUGH H. HYMAN.
C. RULON JEPPESEN.

Union College, Schenectady, N. Y.,
and
University of California,
Berkeley, California,
Jan. 10.