

should be remembered that the value of h is obtained with the aid of a value of e .

As to the Rydberg constant R , agreement between the spectroscopic value and that calculated from other physical constants is a criterion not only of the value of e but also of the other physical constants involved ($h, e/m$).

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The Raman and Infra-Red Spectra of Carbon Dioxide.

MR. RASSETTI'S examination of the Raman spectrum of carbon dioxide as reported in his letter in NATURE of Feb. 9 is of extreme interest. He points out (1) a coincidence between (a) the infra-red frequencies deduced from the Raman spectrum, namely, 1284 and 1392 cm^{-1} , and (b) the wave number difference between the band centres of the double doublet at 2.7μ and the doublet maxima at 4.25μ as given by Schaefer and Philipps (*Zeit. f. Physik*, 36, 641; 1926), which are 1279 and 1381 cm^{-1} ; and (2) that there is no known band in the infra-red spectrum of carbon dioxide which would correspond with either of these.

A further examination of the absorption spectrum mentioned shows that the concordance is far from being a coincidence. There is perhaps no physical justification for calculating, as Mr. Rasetti does, the difference between the maxima in a simple Bjerrum doublet and the band centres in a double doublet. Adopting Schaefer and Philipps's nomenclature, we have four double doublets, *A, C, F*, and *K* (*D* and *E* being uncertain). The assumption of a triangular molecular model with two large and approximately equal moments of inertia, *A*, and one much smaller, *C*, gives as a general expression for the double doublet separation,

$$\Delta\nu = \left(\frac{1}{C} - \frac{1}{A} \right) h/2\pi^2$$

(assuming the absence of a zero branch). Now, the average value for this separation in the four bands quoted is 108 cm^{-1} , which is 1392-1284, and we should be justified in assuming that the frequencies in question represent such a double doublet.

However, the connexion between the deduced values and the observed spectrum is closer still. (i) If we determine the wave number differences between the band centres in the double doublets and those in the 'undoubled' bands, we have the values recorded in Table I.

TABLE I.

Bands	<i>C</i> → <i>I</i> .	<i>K</i> → <i>B</i> .	<i>B</i> → <i>A</i> .
$\Delta\nu$ in cm^{-1}	{ 1262 1375	{ 1293 1393	{ 1264 1368

These values are of the same order as the deduced frequencies. (ii) If we perform the same operation on the double doublets themselves the agreement is exact, within the experimental error, *F* → *A* giving 1388 and 1282 cm^{-1} . (iii) The frequency difference between the undoubled bands is a simple fraction of one of these frequencies; thus *B* → *H* is 687 cm^{-1} (approximately $\frac{1}{2} \times 1392$), and *E* → *D* is 637 cm^{-1} (approximately $\frac{1}{2} \times 1284$). There must consequently be some simple relationship between the double doublet separations and the band centre separations; and we actually find in the two frequencies deduced from the Raman spectrum, that if the former is

taken as 107 cm^{-1} , we have 1391 = 13 × 107, and 1284 = 12 × 107.

This fact is rendered more prominent by a re-consideration of the emission spectrum as determined by the writer in conjunction with Mr. K. H. Lih (Bailey and Lih, NATURE, 121, 941; 1928). To account for the regularities in this spectrum, we assumed that the bands could be represented as multiples of a fundamental frequency given by $\nu_0 = 16 \times 10^{11}$, or in wave numbers, 53.5 cm^{-1} , i.e. $\frac{1}{2} \times 107$, the half-value being adopted to provide for the just perceptible resolution of the band at 2.84μ . Now, if we accept the possible presence of a band at 1284 cm^{-1} (Eucken, *Zeit. f. Physik*, 37, 714 (1926)), it is interesting to note, postulated the existence of an optically inactive frequency at 7.86 μ , i.e. 1272 cm^{-1} , the emission spectrum can be represented in a very simple manner, as will be seen by a consideration of Table II.

TABLE II.

No.	1	2	3	4	5	6	7	8
λ in μ	1.46	1.70	1.99	2.40	2.84	3.12	4.46	(7.80)
ν in cm^{-1} obs.	6850	5890	5027	4167	3524	3206	2243	
ν in cm^{-1} calc.	6848	5885	5029	4173	3531	3210	2247	(1284)
<i>n</i>	64	55	47	39	33	30	21	12

The calculated wave numbers are obtained by multiplying $\nu_0 = 107 \text{ cm}^{-1}$ by *n*; in particular the bands 8, 7, 6, and 4 now become members of a series represented by $3\nu_0(1+3m)$. The above results were obtained with a rocksalt prism spectrometer; it is proposed to re-examine this spectrum with greater resolution and at higher sensitivity, when possibly other members of the series may be identified. It is difficult at the present to see the underlying physical significance of the above results.

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The Fulcher Bands of Hydrogen.

IN a communication just published (in the *Proceedings of the Royal Society of Edinburgh*) I have shown that the Fulcher bands of hydrogen can be arranged in three branches (*P'*, *Q*, and *R'*), the *Q* branches being identical with those of Richardson. The *P'* and *R'* branches have an initial level differing from that of the *Q* branch, while all three have a common final level, a fact proved conclusively by the intercombinations found to hold between them. This shows the final state to be an *S* state, as Birge has predicted.

It is of interest to inquire how these hydrogen bands fit in with the new mechanics, and in particular to determine the constant σ in the term form

$$B\{j(j+1) - \sigma^2\}.$$

An analysis of the bands shows that the terms fit this form provided *j* is given integral values. This is as it should be according to Mulliken's theory, if the emitting molecule is that of neutral H_2 (odd multiplicity). The lowest lines are *R'* (0), *Q* (1), and *P'* (2), which shows that σ'' is zero in the final terms, as we should expect for an *S* state.

While the major part of the term is clearly of the form just given, a preliminary examination of the term-differences showed that an appreciable 'correction term' in the fourth power of *j* (or *j_k*) is present. Such a term is to be expected on the old theory. Unfortunately, no general expansion for the band terms on the new theory is available. At the sug-