On Molecular Coupling Effects

J. G. VALATIN
Institute of Experimental Physics, University for Technical and Economic Sciences, Budapest, Hungary
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A CLEARER insight into the mechanism of the rotational coupling effects in a diatomic molecule can be attained by a direct investigation of the wave-mechanical expressions of the corresponding angular momentum operators. In a paper appearing in the *Hungarica Acta Physica* this is described as being performed by using a reference system, the z axis of which is chosen in the direction of the line joining the nuclei, its x, y, and z axes being given with respect to an inertia system by the Eulerian angles ϑ, ψ, φ. Accordingly, the wave functions of molecular states have to obey the additional restriction $-i(\partial\Psi/\partial\varphi)=L_z\Psi$. In such a system we can define operators L_x, L_y, L_z of the components of the resultant electronic angular momentum with the well-known commutation rules, and operators M_x, M_y, M_z of the components of total angular momentum obeying the commutation rules with an opposite sign. The term in the energy operator representing the coupling between rotation and electronic motion can be written in the form

$$-\frac{h^2}{4\pi^2\mu r^2}(M_xL_x+M_yL_y).$$

In a reference system as used by Van Vleck[1] and in Kronig's book[2] where one of the axes is bound to the nuclei and another axis is defined by an arbitrarily chosen plane $x'y'$, one cannot find operators M_x, M_y, M_z with a corresponding physical meaning. On the other hand, in a system as used by Kronig[3] and by Born and Flügge[4] where the xz plane is identified with a plane containing one of the electrons, one cannot define operators L_x, L_y, L_z with a simple commutation rule. To a full description of the interaction between the total and electronic angular momenta the additional variable φ is to be introduced in the diatomic case, in order to characterize a reference system bound to the nuclei.

The observed heterogeneous perturbations in molecular spectra are due to the "accidental" effects of the rotational coupling terms which presents itself besides the regular coupling effects in the case of the closeness of perturbing energy levels. Homogeneous perturbations result by the accidental effect of the other energy terms coupling the wave functions of levels of different electronic states. Owing to the fact that also in the case of the approximate factorization of the molecular wave functions corresponding to an unperturbed electronic state the motion of the nuclei is to be taken into account, and the wave function factor containing the electronic coordinates cannot be identified with an eigenfunction of the two-center problem in general,[5] the non-diagonal matrix elements of the electronic energy terms in the energy operator become important, and these "electronic perturbations" explain the magnitudes of some very strong observed perturbations.

The possibility of a direct experimental verification of this kind of homogeneous perturbation offers itself through constructing the potential curves and radial wave functions belonging to the "unperturbed" electronic states, since the matrix elements of perturbation due to the electronic terms are connected with the product of the radial wave functions of both states, as in the case of the Franck-Condon principle, whereas in neglecting this effect the matrix elements are connected according to Van Vleck with the product of one wave function with the derivative of the other.[6]

[1] J. H. Van Vleck, Phys. Rev. **33**, 467 (1929).
[2] R. de L. Kronig, *Band Spectra and Molecular Structure* (Cambridge University Press, 1930).
[3] R. de L. Kronig, Zeits. f. Physik **50**, 347 (1928).
[4] M. Born and S. Flügge, Ann. d. Physik, No. 5, **16**, 768 (1933).
[5] J. G. Valatin, Proc. Phys. Soc. **58**, 695 (1946).
[6] J. H. Van Vleck, J. Chem. Phys. **4**, 327 (1936).

On the Number of Elements

MIGUEL MASRIERA
Provenza 293, Barcelona, Spain
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IN 1943 I advanced the hypothesis that the total number of elements should be 96. Considering nuclear charges as elemental particles, the number of possible charges, which is equal to the number of elements, should also be equal to Eddington's number $N_1(96)$ of possible single wave equations. This hypothesis was published in my Spanish translation of Eddington's "New Pathways in Science" and in two notes.[1]

I wish to state that both the theoretical development on which I am still working and the experimental data on new elements published to date, support this point of view.

[1] M. Masriera, Memorias de la Real Academia de Ciencias y Artes de Barcelona (1946), p. 579; Iberica (1946), p. 84.

Magnetic Ions and Magnetic Currents

BROTHER GABRIEL KANE
Department of Physics, Manhattan College, New York, New York
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THE reported dissociation of water by a magnetic field,[1] with an accompanying loss of pole strength of a permanent magnet,[2] as well as the rotation of colloidal particles in a magnetic field,[3] have been offered as evidence of the existence of a magnetic current. The experimental evidence has been thoroughly investigated by the author and by others.[4] The conclusions reached are that no dissociation of water nor loss of pole strength occurs when proper experimental procedures are observed and that there is a satisfactory electrochemical explanation for the rotation of the colloidal particles.[5]

The polar movement of metallic particles has also been presented as evidence of single magnetic poles. Microscopic metallic particles may move against the force of gravity under the *combined* action of a strong beam of light and a magnetic field; this phenomenon is known as magneto-photophoresis.[6] That this effect does not indicate the presence of a true magnetic charge is shown by the fact that the motion ceases as soon as the light is turned off.[7] Under certain conditions, the particles will move against the gravitational field even without the action of light.[8]