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 twenty-eighth of the preceding month; for the second issue, the thirteenth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Raman Effect in Gases: CO and NO

With the high pressure apparatus described by the author in earlier communications,[1] the Raman spectra of gaseous carbon monoxide at a pressure of about 35 atmospheres and of gaseous nitric oxide at a pressure of about 20 atmospheres have been obtained. Besides unresolved rotational wings in the close proximity of the Rayleigh lines, Raman lines corresponding to vibrational transitions have been recorded in both cases. The frequency shifts are compared, in the table, with the respective vibration frequencies of these molecules in the ground state as deduced from absorption spectra (infrared for CO and ultraviolet for NO).[2] The agreement between the two sets of values is very satisfactory. It may be noted that the values 2155 and 2142 reported earlier by Rasetti[3] for carbon monoxide differ to some extent from that given in the table. The vibration frequency of nitric oxide from Raman spectra is reported here for the first time.

Gas	Raman frequency	Absorption frequency
CO	2139	2138
NO	1877	1878

The two gases used in the above investigation are generated under pressure by permitting the necessary chemicals to react with each other in closed and evacuated steel cylinders. In the case of CO, formic and concentrated sulphuric acids are used and the gas obtained appears to be very pure. Potassium ferrocyanide, potassium nitrite and acetic acid are used for generating NO, and it appears from the Raman spectrum of the resulting gas that it contains, besides nitric oxide, large proportions of nitrogen, nitrous oxide and carbon dioxide.

S. Bhagavantam

210, Bowbazar Street,
Calcutta, India,
September 14, 1932.

---

[1] Bhagavantum, Ind. Jour. Phys. **6**, 319 (1931).

[2] Int. Crit. Tab. **5**, 412 and 415.

[3] Rasetti, Nature **123**, 205 (1929) and Nuovo Cim. **6**, 356 (1929).

Note on the Electric Field in Paramagnetic Crystals

The work[1] of Kramers, Bethe, and especially of Van Vleck and his collaborators has created the possibility of drawing conclusions from magnetic data about the electric fields in paramagnetic crystals and hence about the spatial arrangement of atoms and molecules in the crystal.

In his recent paper Van Vleck[1] has shown that it is possible to account for the different magnetic behavior of crystals of hydrated Co and Ni compounds by assuming that to a first approximation the electric fields possess cubic symmetry around the magnetic ion, but that in the second approximation a rhombic term must be added. Quantitative calculations amplifying the theory are to be

---

[1] H. A. Kramers, Comm. Leiden **60**; Proc. Amsterdam Acad. **33**, 959 (1930); H. Bethe, Ann. d. Physik **3**, 133 (1929); Zeits. f. Physik **60**, 218 (1930); J. H. Van Vleck, *The Theory of Electric and Magnetic Susceptibilities*, Oxford University Press; Phys. Rev. **41**, 208 (1932); O. M. Jordahl, W. G. Penney and R. Schlapp, Phys. Rev. **40**, 637 (1932); W. G. Penney and R. Schlapp, Phys. Rev. **41**, 194 (1932); Schlapp and Penney, Phys. Rev. (in press).

published shortly by Schlapp and Penney in this journal.

If the potential energy of an electron in the lattice can be developed as a power series in the displacement from the center of the magnetic ion, the terms which give rise to a decomposition of the energy levels are

$$\Phi = \Sigma_i \{ A x_i^2 + B y_i^2 + c z_i^2 + D(x_i^4 + y_i^4 + z_i^4) \}.$$

Van Vleck concludes that D must be positive to account for the experimental data on hydrated salts of the iron group. The purpose of the present note is to consider what atomic groupings will lead to a positive D.

Since the contribution to D due to the different charges in the neighborhood of the central ion is proportional to R^{-5} (where R is the distance from the central ion), it is evident that only the immediate neighbors will give a noticeable contribution to the value of D.

If the metal ion is surrounded by 6 oxygen ions or water-dipoles[2] in an octahedral arrangement, D will be positive.[3] If on the contrary the ion is surrounded by 8 or 4 negative charges in a cubic or tetrahedral arrangement, D will be negative. This leads to the conclusion that in the hydrated salts of the iron group the metal ion is surrounded by six molecules of crystal water.

Dr. C. A. Beevers of the University of Liverpool kindly expressed to me his opinion that, from the result of x-ray researches, the arrangement indicated above may be regarded as probable, though not proved for the alums and the hepta- and hexa-hydrated sulphates. It seems probable to me that also in solutions the metal ions will be surrounded by six water molecules.

Penney and Schlapp have performed calculations on rare earth salts, and have shown that it is possible to explain the temperature variation of the susceptibilities of the octahydrates of Pr and Nd sulphates, assuming a cubic field again with a positive value of D. Consequently, here also, the octahedral grouping of the oxygen atoms is suggested. This demands six oxygen neighbors for the metal ion, but in the substances so far investigated there are only four water molecules to each such ion. Hence it is necessary to suppose either that oxygen atoms belonging to the SO_4-group figure among the immediate neighbors, or else that a water molecule may be shared by two metal ions. Both assumptions could give rise to deviations from cubic symmetry, which can perhaps account for any magnetic anisotropy which may be disclosed when measurements, on the principal susceptibilities of single crystals of rare earth salts become available.

A quantitative discussion of the arrangements proposed above will be able to decide whether the picture corresponds to reality.

C. J. GORTER

Natuurk. Laborat. v. Teylers Stichting,
Haarlem, Holland,
September 15, 1932.

---

[2] The dipoles will orient themselves in the field of the positive ion with the negative charge inside. With the octahedral arrangement the negative charges are at the face centers of a cube embracing the positive ion.

[3] Cf., for instance, H. Bethe, Ann. d. Physik **3**, 196 (1929).

Possibility of the Existence of the Chlorine Isotope Cl^{39}

Hardy and Sutherland[1] in a recent paper found no evidence for the existence of a third isotope of chlorine, Cl^{39}, in the absorption spectrum of HCl. They made a careful search for lines due to HCl^{39} in the 1.7μ absorption band, but failed to confirm the maxima reported by Hettner and Böhme,[2] even with much greater path lengths than used by the German investigators. A year ago, the writers[3] studied the ultraviolet absorption spectrum of AgCl vapor[4] at high vapor densities expressly to test the assertions of Becker[5] as to the existence of this isotope. Our results were entirely negative, a contradiction made more striking by the subsequent confirmation of Becker's conclusions by Hettner and Böhme. The latter authors refrained from commenting on our results, pending more complete publi-

---

[1] J. D. Hardy and G. B. B. M. Sutherland, Phys. Rev. **41**, 471 (1932).

[2] G. Hettner and J. Böhme, Zeits. f. Physik **72**, 95 (1931).

[3] M. Ashley and F. A. Jenkins, Phys. Rev. **37**, 1712 (1931).

[4] B. A. Brice, Phys. Rev. **35**, 960 (1930).

[5] H. Becker, Zeits. f. Physik **59**, 583 and 601 (1930).