

### Letters to the Editor.

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#### Infra-red Spectrum of Diamond by Infra-red Spectrometer and Raman Methods.

FROM the data given by specific heat, melting-point, and photoelectric effect, Einstein, Nernst, and Lindemann have deduced that diamond should have a frequency varying according to the method of calculation from 7.7 to 11 $\mu$ .

##### *Spectrum obtained by Infra-red Spectrometer.*

The infra-red spectrum of diamond has been examined by the spectrometer by Ångström, Julius, and Reinkober, but without obtaining a complete statement of the bands and without any attempt to determine their relationships. Reinkober reported transparency where Julius found absorption. We have also found and are investigating such an abnormal diamond as that of Reinkober. For seven normal diamonds, however, we find a band system in which there are apparently three fundamental frequencies and one combination band. The wave-numbers (cm.<sup>-1</sup>) for these bands have the following approximate values:  $\nu_1 = 1246$  cm.<sup>-1</sup> = 8.02 $\mu$ ;  $\nu_2 = 2086$  cm.<sup>-1</sup> = 4.8 $\mu$ ;  $\nu_3 = 2438$  cm.<sup>-1</sup> = 4.10 $\mu$ ; and  $\nu_1 + \nu_2 = 3353$  cm.<sup>-1</sup> = 2.98 $\mu$ . On inspecting these frequencies, it appeared at first that  $\nu_3$  might be a first harmonic of  $\nu_1$ , but further consideration makes it much more likely to be one of the fundamentals required for the structure of diamond, which as Bragg has shown contains a six-sided ring analogous to the benzene ring. Three directions in this ring starting from a given carbon atom correspond to the ortho, the meta, and the para linkings of the organic chemist.

From the geometry of the puckered hexagonal ring of Bragg the ratios of lengths of these linkings are as follows:

$$1 : 1.63 : 1.91.$$

It is to be remarked that the ratios of the frequencies given above come out as follows:

$$1 : 1.67 : 1.96.$$

##### *Spectrum obtained by Raman's method.*

We have also subjected diamonds to radiation by the Raman method in which the line  $\lambda 4358$  is selected in the manner suggested by Wood and have examined the spectrum. Here we find a sharp line at  $\lambda 4629$  nearly. The difference in wave-numbers between this and the originating line is 1342 cm.<sup>-1</sup>, which is just inside the farthest out band at 8 $\mu$  but not in the centre of this wide band. We have also observed two diffuse bands, but these require further investigation.

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May 1.

#### Raman Effect in Diamond.

FROM many points of view diamond is a crystal of supreme interest, and it is remarkable that, though more than two years have elapsed since the discovery of the Raman effect, no attempt appears to have been made so far to study the scattering of light in this substance. I have found that quite a small diamond

(half carat size) suffices to photograph the Raman spectrum of crystalline carbon. Each of the mercury lines 4046.6 Å. and 4358.3 Å. excites a single Raman line of remarkable sharpness and intensity (Fig. 1, marked with arrows); the wave-number shifts are 1331 cm.<sup>-1</sup> and 1333 cm.<sup>-1</sup> respectively, in pleasing agreement with the wave-number 1333 cm.<sup>-1</sup> of the *Rest-strahlen* frequency of diamond (Nernst and Lindemann; *Z. Electro-Chemie*, 17, 822; 1911). The sharpness of the line is to be expected in view of the known perfection of the crystal, according to the ideas of Sir C. V. Raman (Faraday Society's Discussion, Bristol meeting). The brightness of the line is also not surprising in view of the ease with which organic substances generally give the Raman effect. Experiment shows that the line is strongly polarised.

The appearance of the Raman effect in diamond is specially significant in view of the fact that its crystal structure is not a molecular lattice but a continuously linked assemblage of similar atoms. Other cubic crystals with a relatively simple structure, as, for

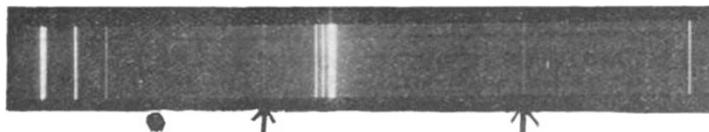


FIG. 1.

example, sodium chloride, and sodium and lithium fluorides, which have been previously examined, have failed to exhibit any Raman lines. Whether the difference between diamond and rock-salt is due to the difference in their crystal structure, or due to the essential dissimilarity in the nature of the forces holding the atoms together in the lattice (homopolar in one case and electrostatic in the other) is a point which can only be settled by further research. Reference should be made here to a recent interesting note by Clemens Schaefer (*Zeit. für Physik*, 54, 153; 1929).

Besides the two Raman lines, the spectrum shows also a diffuse band at 4155 Å. (marked with a dot), the origin of which is under investigation. [The band is too faint to be visible in the reproduction of the photograph in Fig. 1.—ED. NATURE.]

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#### Photoelectric Recording of Daylight.

IN a letter in NATURE of Mar. 1, 1930, Dr. W. R. G. Atkins and Dr. H. H. Poole describe an apparatus for the photoelectric recording of daylight. A photoelectric daylight recorder has been in existence at the National Physical Laboratory, Teddington, for two years and has been utilised there since April 1929 for almost continuous recording, and a few further remarks upon this subject may therefore be of interest.

In the first place, photoelectric recording of daylight was first described by James E. Ives<sup>1</sup> in 1925 and continuous recording has, it is believed, been taking place under his supervision at the Office of Industrial Hygiene and Sanitation, United States Public Health Service, Washington, since that time. Ives used a thin film barium photoelectric cell—made by T. W. Case—in which a complex surface of barium, oxygen, and an oxide of barium is formed on aluminium. Notwithstanding the fact that the thinness of the film and its complex nature makes these cells