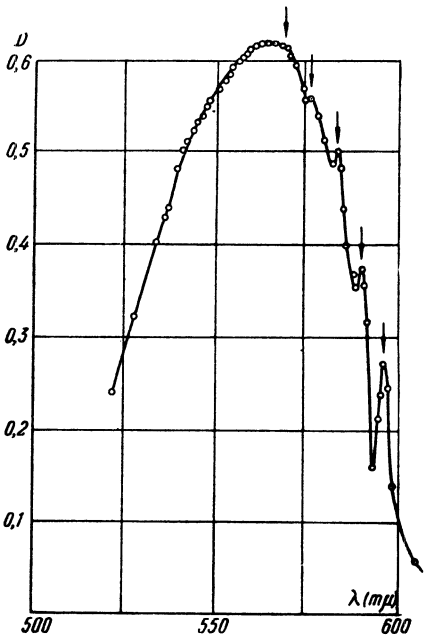
Fluctuating Structure in the Absorption Spectrum of Ruby

B. N. GRECHUSHNIKOV AND P. P. FEOFILOV
Institute of Crystallography
Academy of Sciences, USSR
(Submitted to JETP editor May 19, 1955)
J. Exper. Theoret. Phys. USSR **29**, 384
(September, 1955)

IT was theoretically demonstrated in the works of Pekar and Krivoglaz[1,2] that the form of the light absorption band by admixtures in the dielectrics can be expressed, within the limits of definite assumptions, as a product of two functions of frequency. The first factor, presented as a function of frequency, produces a smooth, bell-like curve and delineates the general contours of the absorption spectrum. The second factor, representing a rapidly oscillating function, shows the "structure" of the absorption band. In a case in which the dispersion of frequencies of normal fluctuations is small, the absorption band breaks into a series of fine lines. These are separated from one another by a distance ω_0, which is equal to the threshold frequency of longitudinal polarization fluctuations.

The absorption spectrum of ruby at the temperature of liquid nitrogen has been investigated in reference 3. Earlier, the influence of temperature upon the ruby spectrum had been studied by Gibson[4]. However, since the determinations obtained in these works pertained to separate wavelengths, the structure of the absorption spectrum did not become apparent. Photographs of the absorption spectrum at the temperature of liquid nitrogen have shown that the structure is clearly discernible at the long wave side of the broad absorption band. The graph shows the absorption spectrum of ruby obtained with a spectrograph ISP-51 at the temperature of liquid nitrogen and raised in optical density by means of blackening. At the long wave side of the absorption band we can see five subordinate maxima (indicated by arrows), separated by almost identical distances from one another. These are: 16,780, 16, 900, 17,200, 17,410 and 17,640 mc^{I}. Distances between the adjacent maxima are on the average 215 cm^{-1}.



Absorption spectrum of ruby (Al_2O_3 --- 0.1 % Cr_2O_3) for an ordinary wave, at the temperature of - 190° C.

The structure of the wide absorption band appears only in the spectrum of the ordinary wave. That is, polarization in the narrow absorption bands is the same as in the basic wide band. As the temperature increases, the subordinate maxima gradually fade and disappear completely at - 100° C. The structure does not appear at the short wave side of the wide absorption band. The distance between the subordinate maxima is comparable to the fluctuation frequency of 194 cm^{-1} discovered in the infrared absorption spectrum of ruby[5].

In this way, the observed structure of the wide absorption band of ruby can be construed to be the result of interaction between optical electrons at the "center of absorption" and the fluctuations of crystalline lattice.

---

[1] S. I. Pekar, J. Exper. Theoret. Phys. USSR **22**, 641 (1952)

[2] M. A. Krivoglaz and S. I. Pekar, Trudy Fiz. Inst. Akad. Nauk SSSR **4**, 37 (1954)

[3] B. N. Grechushnikov, Dokl. Akad. Nauk SSSR **99**, 707 (1955)

[4] K. S. Gibson, Phys. Rev. **8**, 38 (1916)

[5] Krishnan, Proc. Ind. Soc. **26A**, 6, 450 (1947)

Translated by R. G. Huzarski