Temperature Dependence of the Relaxation Time of Luminescence of Platino Cyanides of Barium and of Potassium, and of Fluorite Activated with Europium

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BY employing the method of the ultra-taumeter[1], we have succeeded in investigating for the first time the kinetics of the photoluminescence of several substances with relaxation time lying in the time interval of 10^{-7} - 10^{-5} sec. It was the absence of data pertaining to the relaxation of photoluminescence that had at one time caused Vavilov to call this interval the "white spot" in the luminescence[2].

1. Platino Cyanide of Barium (yellow-green variety, commercial product). The relaxing and lighting of luminescence are exponential [$I_{rel} \sim I_0 e^{-t/\tau}$, $I_{light} \sim I_0(1 - e^{-t/\tau})$]. Within the range of temperatures from - 183° C to - 80° C, $\tau = 8 \times 10^{-7}$ sec = const. Brightness of the luminescence is also constant. As the temperature continues to increase, the substance loses two molecules of its water of crystallization and ceases (irreversibly) to luminesce.

2. Platino Cyanide of Potassium (commercial product). Relation of τ and I_0 to the temperature is shown in Fig. 1. It can be seen here that τ and I_0 do not follow the simple law of relaxation $I_0 \sim \tau \sim 1/(1 + Ce^{-U/kT})$.

Light spectra of both platino cyanides are shown in Fig. 2. As the temperature decreases, the light band of each substance narrows and moves toward the long wave side.

Khvostikov[3], working on the basis of his measurements of light depolarization in solutions, arrived indirectly at the value of τ for platino cyanide of potassium. According to him, when the relaxation does not occur, $\tau = 5.6 \times 10^{-9}$ sec. It can be seen from Fig. 1 that direct measurements differ greatly from his value.

3. Calcium Fluoride activated with bivalent europium[4], $CaF_2(Eu^{++})$, produces a purely exponential luminescence. Relation of τ and I_0 to the temperature is shown in Fig. 3. Ratio of I_0/τ shows no dependence on the temperature. Both I_0 and τ follow the simple law of relaxation. Activation energy of relaxation is $U = 0.75$ ev.

For all three substances the brightness of luminescence is proportional to the intensity of

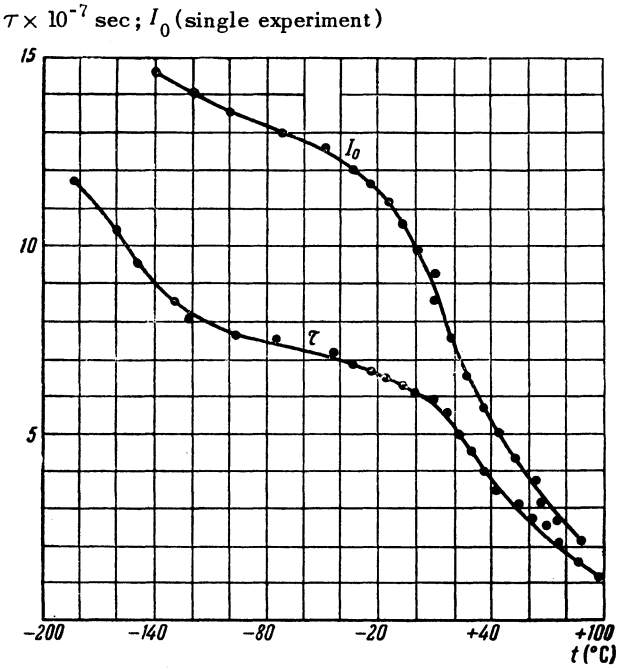

FIG. 1. $K_2[Pt(CN)_4] \cdot 3H_2O$

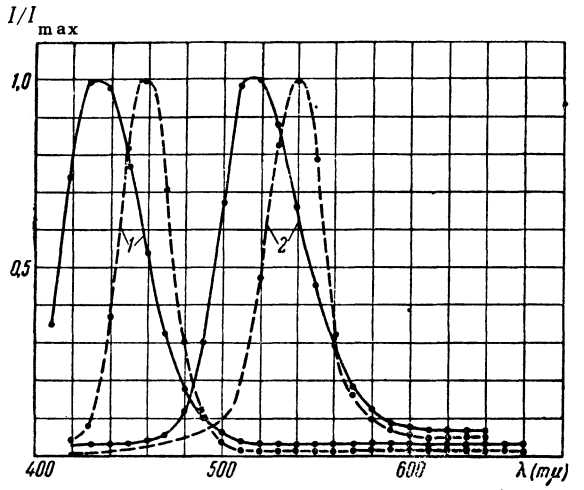

FIG. 2. *1.* Potassium; *2.* Barium. Continuous curves were obtained at $t = 20°$ C, curves shown in dashes were obtained at $t = -183°$ C.

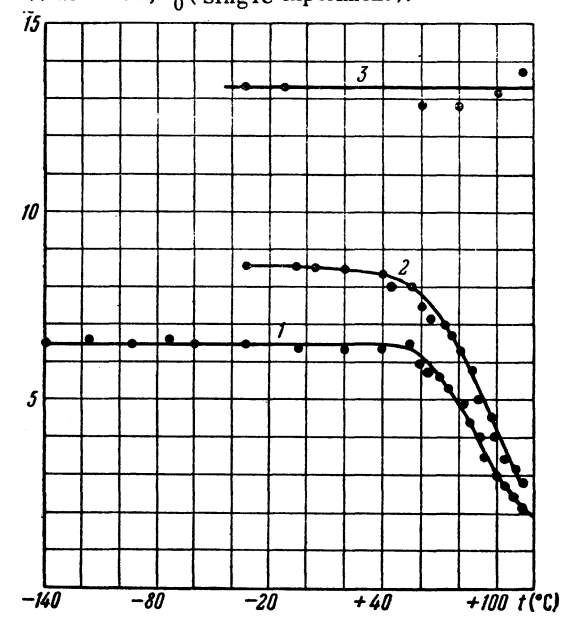

FIG. 3. $CaF_2(Eu^{++})$. *1.* τ; *2.* I_0; *3.* I_0/τ.

excitation, E, while the time necessary for relaxing and lighting does not depend on E. It can be seen from the above that in the case of all three substances we are dealing with a monomolecular process representing a relatively slow fluorescence.

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The Measurement of the Specific Charge of Conduction Electrons

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IN the development of the theory of metals and semiconductors there arises the problem of the experimental determination of the ratio e/m and the effective mass of conduction electrons.

As is well-known, Mandel'shtam and Papaleski [1] were the first to show the inertia for transport of charges in metals experimentally, but, because of the beginning of the war in 1914, they were not able to complete their work. In 1916-1926, Tolman and his co-workers proved conclusively, in a series of papers, that the transport of charges in metals was due to electrons. The value of e/m obtained in this work and the corresponding value for free electrons in a vacuum were, however, different from each other. This difference could be explained by inaccuracies in the theory.[2] Thus, assuming that the acceleration of the electron with respect to the conductor is equal to the acceleration of the conductor, with opposite sign, the value of e/m found in the later papers of this series can be interpreted as an overestimate of the electrons' acceleration. The sign of e/m obtained, in the first paper, by braking a rotating coil can be explained in terms of the disregard of capacitative currents and self-induction. Heat due entirely to electronic motion was also not taken into account. In what degree the various simplifications of the theory affected the result has not been established[3]. Planned extensions of the research have not occurred.

In future measurements of the ratio e/m of conduction electrons, we require both improvement in experimental techniques and the use of new methods, and also simpler and more accurate interpretation of the experiments. If the Coriolis effect