the odd PME in the interval 0.5 - 1.2 eV are shown in the figure for one of the samples and for different values of the magnetic field. Similar curves were obtained for the other samples. It is seen from the figure that at a specified value of the magnetic field the PME voltage reverses sign with increase in frequency and becomes negative, starting with $\hbar\nu = 0.7$ eV. This quantity agrees with the theoretical value obtained in [1]:

$$\hbar\nu \approx \left(\frac{kT\hbar\omega_0 \tau_e}{\tau_{im}}\right)^{1/2} + E_g \approx 0{,}9 \text{ eV},$$

where $T = 4.2°K$, $\hbar\omega_0 = 0.024$ eV, $\tau_e = 10^{-7}$ is the lifetime of the electron, $\tau_{im} = 3 \times 10^{-12}$ is the momentum relaxation time, and $E_g = 0.24$ eV is the width of the forbidden band. From this we can conclude that the observed effect of reversal of the PME sign is actually due to the hot electrons. Results of detailed investigations of the spectral characteristics of InSb and InAs will be published later.

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[1] V. F. Elesin and Yu. A. Bykovskii, ZhETF Pis. Red. 6, 497 (1967) [JETP Lett. 6, 29, (1967)].
[2] I. K. Kikoin and S. D. Lazarev, ibid. 5, 393 (1967) [5, 321 (1967)].
[3] R. V. Parfen'ev, I. I. Farbshtein, and S. S. Shalyt, ibid. 5, 253 (1967) [5, 203 (1967)]
[4] V. F. Elesin, Fiz. Tekh. Poluprov. 2 (1968), in press [Sov. Phys.-Semicond. 2, (1968), in press].

PULSED SUPERRADIANCE AT THE GREEN LINE OF THALLIUM IN TlI VAPOR

A. A. Isaev and G. G. Petrash
P. N. Lebedev Physics Institute, USSR Academy of Sciences
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In a recent note [1] we reported observation of superradiance at the green line of thallium in thallium vapor. This superradiance is of great interest, since the structure of the thallium levels is highly favorable for obtaining a high efficiency. However, to work with thallium it is necessary to heat it to a temperature of approximately 800°C. One of the methods of lowering the working temperature may be, in principle, the use of a discharge in thallium-salt vapor, similar to that used in gas-filled lamps with addition of metal salts, mostly iodides [2]. This is not the only reason for the interest in investigations of discharges in metal-salt vapor.

It was shown earlier that an excitation satisfying the Franck-Condon principle leads, under definite conditions, to the formation of inversion between the electronic states of molecules [3,4]. A natural extension of this reasoning to the case of excitation that leads to the dissociation of the molecule shows that when the potential curves are suitably disposed, the excitation of the molecule by electrons leads to predominant dissociation in one

of the excited states of the atom. An example of such an arrangement of the potential curves is shown schematically in Fig. 1. The mechanism in question can ensure in principle inversion both between the excited levels of the atom and for the transition to the ground level. Insofar as we know, this mechanism was neither considered nor realized in the past. A similar mechanism, using photodissociation to produce inversion, was first proposed in [5]. Excitation with electrons, while not having the selectivity of the photoexcitation, has nevertheless the advantage that it makes it possible to use high-lying levels and to obtain inversion in transitions in the visible and ultraviolet regions of the spectrum. In the case of photodissociation, it is difficult to advance into the short-wave region of the spectrum, owing to the lack of powerful far-ultraviolet excitation sources.

On the basis of the data on the potential curves of the molecule TlI [6] we can expect to obtain for it inversion by electronic excitation. The setup used in the experiments was that employed with thallium [1]. The discharge tube had an inside diameter 1.3 mm and an active length 20 cm. The buffer gases used were helium, neon, argon, and air. Superradiance was observed with all these gases in a temperature interval 370 - 410°C for the 5350 Å thallium line (transition $7^2S_{1/2}$-$6^2P_{3/2}$). The intensity of the superradiance increased in the indicated sequence of the buffer gases. The dependence of the superradiance power on the helium and argon pressure is shown in Fig. 2. Under all the experimental conditions, place-

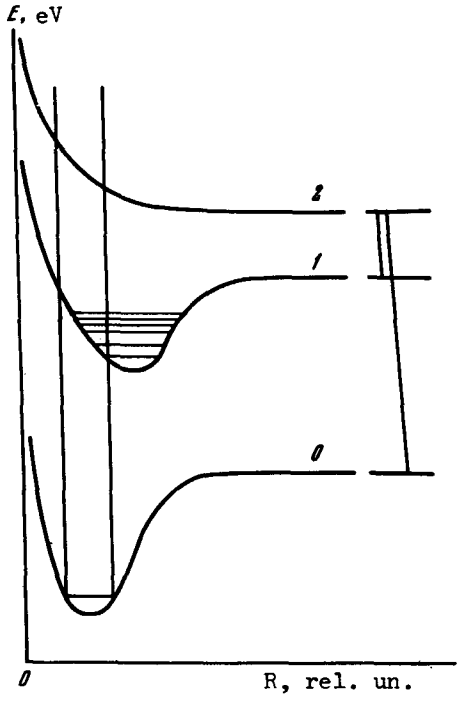

Fig. 1. Scheme of potential curves of a diatomic molecule, explaining the mechanism of inversion.

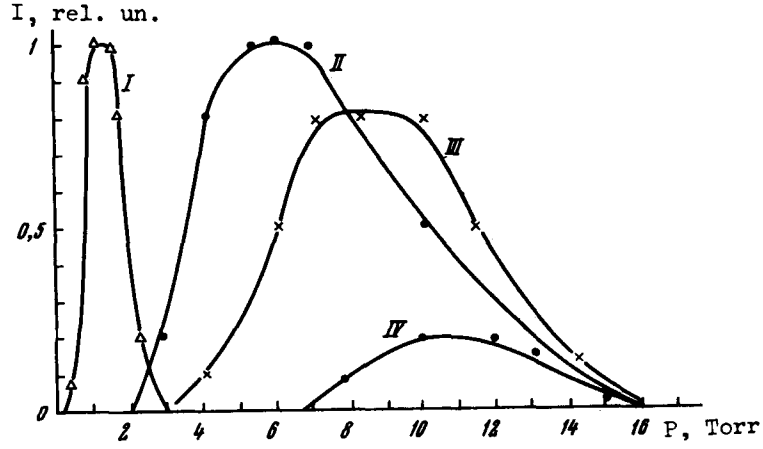

Fig. 2. Dependence of the superradiance in TlI vapor on the pressure of the beffer gas. I - argon, II - mixture of helium and argon (2.5 : 1), III-mixture of helium and argon (8:1), IV - helium.

ment of a mirror behind the tube did not increase the superradiance intensity. The superradiance pulse duration did not exceed 20 nsec, and its power was somewhat lower than that for thallium [1]. The pulse repetition frequency was usually 10 - 15 Hz. When the repetition frequency was increased to 300 Hz, the superradiance power decreased noticeably. The spectrum of the discharge in TlI vapor was investigated with the STE-1 instrument in the 2500 - 6000 Å region. When the superradiance was present, the main lines represented in it were I II, Tl II, and Tl III. The spectrum of the discharge depends little on the type of buffer gas. When the temperature was increased above 410°C, the superradiance disappeared and strong Tl I lines appeared in the discharge spectrum.

The results, particularly the character of the discharge spectrum, indicate that under our conditions the superradiance was not due to direct excitation of the thallium atoms, but more likely the result of excitation of the TlI molecule. Consideration must be given to photodissociation by the radiation produced in the discharge itself as the possible inversion mechanism. The spectra of helium, neon, and argon have no strong lines in the region necessary for photodissociation (close to 2000 Å). A strong line in this region is present in the spectrum of I I, but under superradiance conditions the I I lines are very weak. It is not excluded that the photodissociation played a definite role when air was used as the buffer gas, since rather intense bands of the nitrogen-molecule emission are present in the required region of the spectrum.

Thus, the available experimental data, at least for inert buffer gases, agree best with the mechanism of dissociation of the TlI molecule by electrons with preferred population of the upper level of the 5350 Å line. For a detailed clarification of the mechanism of the observed superradiance, further experiments are necessary.

[1] A. A. Isaev, P. I. Ishchenko, and G. G. Petrash, ZhETF Pis. Red. 6, 619 (1967) [JETP Lett. 6, 118 (1967)].

[2] G. N. Rokhlin, Gazorazryadnye istochniki sveta (Gas-discharge Light Sources), Energiya, 1966.

[3] P. A. Bazhulin, I. N. Knyazev, and G. G. Petrash, Zh. Eksp. Teor. Fiz. 47, 1590 (1964) and 49, 16 (1965) [Sov. Phys.-JETP 20, 1068 (1965) and 22, 11 (1966)].

[4] G. G. Petrash, Zhurnal Prikladnoi optiki i spektroskopii (J. Appl. Optics and Spectroscopy) 4, 395 (1966).

[5] S. G. Rautin and I. I. Sobel'man, Zh. Eksp. Teor. Fiz. 41, 2018 (1961) [Sov. Phys.-JETP 14, 1433 (1962)].

[6] A. Terenin, Phys. Zs. Sowjet. 2, 377 (1932).

HELICOIDAL ANTIPHASE SPIN ORDERING IN HEXAGONAL FERRITES WITH MAGNETOPLUMBITE STRUCTURE

O. P. Aleshko-Ozhevskii, R. A. Sizov, V. P. Cheparin, and I. I. Yamzin
Crystallography Institute, USSR Academy of Sciences

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We performed a neutron diffraction investigation of the ferrite $BaSc^{3+}_{1.8}Fe^{3+}_{10.2}O_{19}$(M) at 77°K and in magnetic fields up to 5000 Oe applied perpendicular to the scattering vector $\vec{\epsilon}$.

An earlier study of the magnetic properties of this compound has shown that, depending on the temperature, different orientations of the easy-magnetization axis are observed here [1]. Thus, in the temperature interval 125 - 355°K the easy-magnetization directions lie in