RASHBA, E. I.

23(4) PHASE I BOOK EXPLOITATION SOV/3140

Akademiya nauk Ukrainskoy SSR. Institut fiziki

Fotoelektricheskiye i opticheskiye yavleniya v poluprovodnikakh; trudy pervogo vsesoyuznogo soveshchaniya po fotoelektricheskim i opticheskim yavleniyam v poluprovodnikakh, g. Kiyev, 20-26 noyabrya 1957 g. (Photoelectric and Optical Phenomena in Semiconductors; Transactions of the First Conference on Photoelectric and Optical Phenomena in Semiconductors...) Kiyev, 1959. 403 p. 4,000 copies printed.

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Ed. of Publishing House: I. V. Klimz; Tech. Ed.: A. A. Matveychuk; Resp. Ed.: V. Ye. Lashkarev, Academician, Ukrainian SSR, Academy of Sciences.

PURPOSE: This book is intended for scientists in the field of semiconductor physics, solid state spectroscopy, and semiconductor devices. The collection will be useful to advanced students in universities and institutes of higher technical training specializing in the physics and technical application of semiconductors.

COVERAGE: The collection contains reports and information bulletins (the latter are indicated by asterisks) read at the First All-Union Conference on Optical and Photoelectric Phenomena in Semiconductors. A wide scope of problems in semiconductor physics and technology are considered: photoconductivity, photoelectromotive forces, optical properties of hard and corpuscular radiations, photoresistors, the action of complex semiconductor systems, etc. The materials were prepared for publication by E. I. Rashba, O. V. Snitko, K. M. Tolpygo, A. F. Lubchenko, and M. K. Sheynkman. References and discussion follow each article.

26.2320

S/058/62/000/005/046/119
A001/A101

AUTHORS: Broude, V. L., Yeremenko, V. V., Rashba, E. I.

TITLE: Impurity absorption and luminescence in CdS single crystals

PERIODICAL: Referativnyy zhurnal, Fizika, no. 5, 1962, 33, abstract 5V225 (V sb."Fotoelektr. i optich. yavleniya v poluprovodnikakh", Kiyev, AN USSR, 1959, 43-52)

TEXT: On the basis of studying absorption spectra of CdS crystals, the impurity origin of absorption in the region of narrow lines (20,400 - 206,000 cm^{-1}) was shown; these lines are due to electron transitions in the CdS lattice near its dislocations. Blue luminescence of CdS is caused by light emission from the same absorption centers to which pertain absorption lines 20,440; 20,525; 20,575 and ~20,600 cm^{-1}. A hypothesis is put forth on the existence of six types of defects.

[Abstracter's note: Complete translation]

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RASHBA, E.I.

Symmetry of the energy zones in crystals of the wurtzite type. Part 1: Symmetry of zones without taking spinorbital interactions into account. Fiz. tver. tela 1 no.3:407-421 Mr '59. (MIRA 12:5)

1. Institut fiziki AN USSR, Kiyev.
(Crystal lattices) (Semiconductors)

SOV/56-36-6-12/66

24(5)
AUTHOR: Rashba, E. I.

TITLE: The Effect of Resonance Excitation Transfer in the Theory of the Large Radius Exciton (Effekt rezonansnoy peredachi vozbuzhdeniya v teorii eksitona bol'shogo radiusa)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 6, pp 1703 - 1708 (USSR)

ABSTRACT: There are two possible mechanisms for describing exciton displacement in a crystal. The first is by Frenkel' (Ref 1), assumes resonance interaction, and consists in principle in the fact that when excitation vanishes at one point of the crystal, it occurs at another point, the width of the exciton zone and, consequently, also the group velocity of the exciton remaining finite if the overlapping integrals tend towards zero. The second mechanism (according to the large radius exciton theory developed by Wannier and Mott (Refs 2,3)) consists in an electron + hole displacement; electron and hole are considered to be quasiparticles obeying a given dispersion law which describes the structure of certain electron- and hole-zones (or groups). The electron zone tends towards zero if the exchange integrals determining the width of the electron- and

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The Effect of Resonance Excitation Transfer in the Theory of the Large Radius Exciton SOV/56-36-6-12/66

hole-zone disappear. The first of these mechanisms is in the following described as resonance mechanism, the second as exchange mechanism. Wannier and Mott did not take generation- and annihilation effects into account in their theory. In the present paper annihilation terms are introduced into the theory of the large radius exciton, and the conclusions resulting herefrom are investigated. The author investigates a dielectric and constructs its electron wave function by means of the orthogonal system of Wannier's quasiparticle functions; notation system by Wannier is employed. Under certain simplifying assumptions, the author goes over to a continuum and obtains an integro-differential equation containing a non-relativistic contact term. Its solution is briefly discussed and the contact term for plane waves with the quasimomentum $\vec{k}$ is explicitly written down. The author thanks S. I. Pekar for discussing this work. There are 13 references, 5 of which are Soviet.

ASSOCIATION: Institut fiziki Akademii nauk Ukrainskoy SSR (Physics Institute of the Academy of Sciences, Ukrainskaya SSR)

SUBMITTED: September 8, 1958

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24(2)
AUTHORS: Brcude, V. L., Prikhot'ko, A. F., Rashba, E. I. SOV/53-67-1-5/12

TITLE: Some Problems of the Luminescence of Crystals (Nekotoryye voprosy lyuminestsentsii kristallov)

PERIODICAL: Uspekhi fizicheskikh nauk, 1959, Vol 67, Nr 1, pp 99-117 (USSR)

ABSTRACT: The authors make a contribution to the research of non-equilibrium states of nonmetallic crystals by the publication of a carefully compiled survey of the research results concerning crystal luminescence, devoting special attention to the exciton mechanism (Ya. I. Frenkel')(Ref 1). The latter was found to be very suited for describing excited states of crystals, in which there is no photoconductivity. Problems like the excitation and exctinction of luminescence are not dealt with because they and others have been discussed by L. V. Levshin (Ref 6) in a survey. The entire experimental material confirms that in the case of excitation within the range of eigenabsorption the luminescence spectrum does not depend on the wavelength of the exciting light. The article first gives a short survey of the luminescence of pure crystals, i.e. of such without structural defects and

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impurities. Table 1 gives data (ν, λ) for benzene, naphthalene, anthracene, naphthacene, hexamethyl benzene, hexaethyl benzene, and ψ-iso-cyanine for the longest-wave intensive bands of eigenabsorption (Refs 11-17). A more detailed account is given of the luminescence phenomena on crystals containing impurities. Among others, the investigations carried out by V. Ye. Lashkarev and Yu. M. Karkhanin (Refs 33,42) on semiconductor crystals (Cu_2O) concerning excitation as a result of energy transfer by electron-hole pairs are discussed, and numerous data are given in a table concerning spectra of impurity crystals. The data were obtained from publications by A. F. Prikhot'ko, M. T. Shpak, E. V. Shpol'skiy, L. A. Klimova, E. A. Girdzhiyauskayte and A. V. Solov'yev.

The next chapter contains data on the luminescence of crystals at low temperatures. Numerous crystals have particularly bright luminescence at low temperatures, which was in most cases found to be due to impurities. However, also so-called "pure" crystals (V. A. Arkhangel'skaya, P. P. Feofilov, Ref 56) occasionally show bright luminescence and have certain characteristic features in their spectra. The first investigations of molecule crystals at low temperatures were carried out

by I. V. Obreimov, A. F. Prikhot'ko, and K. Shaballas (Ref 57) (anthracene, 20° K); figure 2 shows this absorption- and luminescence spectrum, which was recorded by A. F. Prikhot'ko and I. Ya. Fugol' (Ref 65). Figure 1 in a similar manner shows the absorption line spectrum and the "blue" luminescence spectrum of one and the same CdS crystal at 20° K. A large number of molecule- and semiconductor crystals has already been investigated at low temperatures; the results obtained by these investigations are discussed in short. Finally, the quasiequilibrium distribution in the excited state is discussed which was investigated on the basis of the example of the optical and photoelectric properties of CdS crystals by numerous authors (Rashba, Broude, Yeremenko, N. N. Chikovani etc.) There are 2 figures, 2 tables, and 75 references, 53 of which are Soviet.

S/181/60/002/01/24/035
B008/B014

24.7600

AUTHORS: Boyko, I. I., Rashba, E. I., Trofimenko, A. P.

TITLE: Thermally Stimulated Conductivity of Semiconductors

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 1, pp. 109-117

TEXT: The theory of thermally stimulated conductivity was established on the basis of a sufficiently general semiconductor model (Fig. 1). It is shown that the depth of the local level can be determined by studying the curves of thermally stimulated conductivity at different rates of heating. A preliminary comparison was made between theory and experiment. CdS samples with an admixture of Au were investigated. The gold was introduced at 550-650°C. Measurements were made by means of an apparatus described in Ref. 5. The rate of heating could be changed within the range 0.5 ÷ 1.5 deg/sec. Three peaks of thermally stimulated conductivity were found in the samples under consideration. At a heating rate of v = = 0.5 deg/sec, the peaks are found at 110, 240, and 290°K approximately. The relative values of the high-temperature maxima changed considerably from sample to sample (Fig. 2). The 240°K peak of that sample which did

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not show the highest high-temperature maximum was studied in detail. From this the authors concluded that the temperature dependence of β and τ is negligible. Fig. 3 illustrates the determination of the adhesion level from measuring points. ε is determined by the slope of the straight. They yield almost the same values of the activation energy $\varepsilon = 0.34$ ev. Fig. 4 shows curves representing the electron concentration n(T) for three values of v. As may be seen, there is satisfactory agreement between theory and experiment. The greatest divergencies occurred at the end of the n(T) curves within the low-temperature range. The dependence on $n(T) \sim \exp\left(-\frac{\varepsilon}{kT}\right)$ found in experiments was considerably smaller than that predicted by theory. This is probably due to the fact that the sample had a smaller number of centers the activation energy of which was somewhat below 0.34 ev. It was theoretically found (equation (27)) that the recombination near the n(T) maximum was mainly monomolecular.

The authors thank Engineer A. I. Sheretun for having prepared the samples.

There are 4 figures and 5 references, 2 of which are Soviet.

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Thermally Stimulated Conductivity of Semiconductors

S/181/60/002/01/24/035
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ASSOCIATION: Institut fiziki AN USSR, Kiyev (Physics Institute of the AS UkrSSR, Kiyev)

SUBMITTED: April 8, 1959

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81642
S/181/60/002/06/31/050
B006/B056

24.7700

AUTHOR: Rashba, E. I.

TITLE: The Properties of Semiconductors With a Loop of Extrema. I. Cyclotron and Combination Resonance in a Magnetic Field That Is Perpendicular to the Loop Plane

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 6, pp. 1224 - 1238

TEXT: In Ref. 1 the author, together with V. I. Sheka, showed that in semiconductors with wurtzite lattice a new type of band structure occurs, in which, in a certain approximation, an extremum is attained, not in isolated points of the Brillouin zone, but along a curve (of the extremum loop); the center of this loop is on a symmetry axis. Sheka found that such a loop may also occur in Sb-type lattices. Gurevich, G. Ye. Pikus, and G. L. Bir also carried out investigations in this direction. It was the aim of the present paper to investigate the specific peculiarities of semiconductors having extremum loops, in order to find ways of identifying these semiconductors and to determine their parameters. The following papers also have this aim. Here, the author describes a

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The Properties of Semiconductors With a Loop of Extrema. I. Cyclotron and Combination Resonance in a Magnetic Field That Is Perpendicular to the Loop Plane

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theoretical investigation of the absorption of radiowaves in semiconductors having an extremum loop. Formulas are derived for the determination of the frequencies and intensities of transitions, and it is shown that, in consequence of spin-orbit coupling, transitions with variation of spin (which are excited by the Lorentz force) have a considerable intensity. In part 1 of the paper, which closely follows the lines of Ref. 1, and takes over results obtained there as well as the terminology introduced, the wave functions and the energy spectra are studied. Extremum loops occur both when the energy levels on the symmetry axis in the $\vec{k}$-space are not split by spin-orbit interaction, and also when such a splitting occurs (in a wurtzite lattice the former case applies to the points $\Gamma_1 - \Gamma_4$, $\Delta_1 - \Delta_4$, K_1, K_2, P_1 and P_2, the latter to Γ_5, Γ_6, Δ_5, Δ_6). The author confines his investigations to the first case. Part 2 deals with a perturbation-theoretical investigation of the transitions occurring under the influence of an electromagnetic wave, and in part 3 cyclotron-combination resonance and paramagnetic resonance are investigated for the following limiting cases: a) Low temperature, low

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The Properties of Semiconductors With a Loop of Extrema. I. Cyclotron and Combination Resonance in a Magnetic Field That Is Perpendicular to the Loop Plane

S/181/60/002/06/31/050
B006/B056

carrier concentration, weak magnetic fields, b) high temperatures, weak magnetic fields, c) strong magnetic fields, d) paramagnetic resonance absorption; it is shown that the paramagnetic resonance is negligibly small. The author thanks S. I. Pekar for discussion, and I. I. Boyko for taking part in the calculations. An appendix deals with the determination of the effective mass of the carriers. There are 1 table and 22 references: 13 Soviet, 8 American, and 1 Japanese.

ASSOCIATION: Institut fiziki AN USSR, Kiyev (Institute of Physics of the AS UkrSSR, Kiyev)

SUBMITTED: October 7, 1959

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B3008

The Properties of Semiconductors With a Loop of Extrema. II. Magnetic Susceptibility in a Field Perpendicular to the Loop Plane

S/181/60/002/008/027/045
B006/B063

a) high temperatures ($\Delta \ll kT$); b) weak magnetic fields ($\Delta \ll \hbar\omega^*$); c) low temperatures; weak magnetic fields ($kT \ll \Delta$; $\hbar\omega^* \ll \sqrt{kT\Delta}$); d) arbitrary temperatures; extremely weak magnetic fields ($\Omega \to 0$). The next section deals with the susceptibility of a degenerate electron gas in the case of weak fields. The "oscillations" of magnetic susceptibility are studied next for a) a low carrier concentration and b) a high carrier concentration. The peculiarities occurring due to the presence of a range of negative effective mass and the existence of two close-lying Fermi surfaces are then examined. These peculiarities lead to characteristic pulsation phenomena. Such pulsations are expected to occur also in other crystals (not only in hexagonal CdS, which is under consideration) as, e.g., in chemical compounds with metal-type conductivity and degenerate semiconductors, i.e., in crystals without inversion centers. Mention is made of V. I. Sheka and L. D. Landau. There are 6 references: 5 Soviet and 1 British.

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86420

24.2600 (1035, 1043, 1158)

S/181/60/002/011/004/042
B006/B056

AUTHORS: Rashba, E. I. and Romanov, V. A.

TITLE: A Photoelectric Method Used to Discover the Depth Inhomogeneity of a Semiconductor

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 11, pp. 2689 - 2692

TEXT: A knowledge of the depth inhomogeneity of semiconductors is of importance for a number of problems as, e.g., for the diffusion of impurities. The authors have developed a method for determining the "depth dependence" of the carrier lifetime. First, it is shown theoretically that by studying the frequency dependence of the complex amplitude of photoconductivity (especially of τ_{eff}), the depth inhomogeneity of τ may be found and studied, for $\tau_{eff}(\omega) = \frac{1}{\omega} \arctan \phi(\omega)$, where $\phi(\omega)$ is the phase delay of the photocarriers with respect to the exciting light. The theoretical solution of the problem is restricted to small gradients of $\tau(z)$. For the purpose of experimentally verifying the above-described rules, some Ge specimens were examined. Fig. 1 shows $\tau_{eff}(\omega)$

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A Photoelectric Method Used to Discover the Depth Inhomogeneity of a Semiconductor

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for p-type Ge, into which from one side Ni had been diffused in vacuo at 800°C within 1.5 min. On the other side there was an Au layer which acted as a getter. The specimens were 1.8 mm thick, the lifetime gradient being $L_d \, d\ln\tau/dz \simeq 0.2$. An inhomogeneous function $\tau(z)$ may also easily be achieved by using specimens in which τ depends on the time of exposure; by constant unilateral exposure τ becomes a function of z. Fig.2 shows $\tau_{eff}(\omega)$ for homogeneous n-type Ge specimens of 3.5 mm thickness with noticeable hyperlinearity within the range of low intensities.

V. Ye. Lashkarev, Member of the AS UkrSSR, is thanked for his interest and advice, and A. N. Kvasnitskaya for placing the Ge single crystals at their disposal. There are 2 figures and 2 Soviet references.

ASSOCIATION: Institut fiziki AN SSSR Kiyev (Institute of Physics of the AS USSR, Kiyev)

SUBMITTED: May 7, 1960

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S/181/60/002/011/004/042
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большом. В эффективное время $\tau_{эфф.}$ в обоих случаях буд

разом, изучение частотной зависимости комплексной ампл
оводимости (в частности, $\tau_{эфф.}$) позволяет обнаружить и и

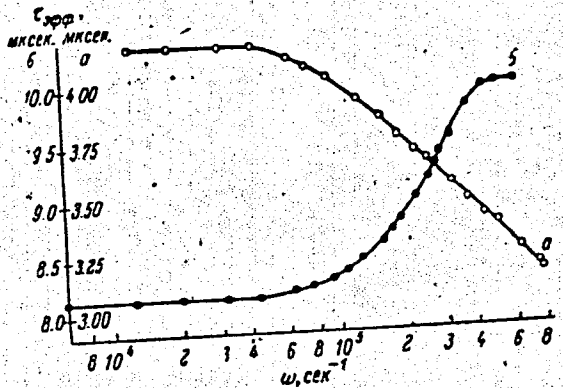

Fig. 1

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Legend to Fig.1: Frequency dependence of the effective duration of photoconductivity for Ge specimens with unilaterally diffused nickel; a - exposure from the nickel-containing side, b) exposure from the side without nickel.

Legend to Fig.2: Frequency dependence of τ_{eff} for a hyperlinear homogeneous Ge specimen which is alloyed with Sb; a) $\tau_{eff}(\omega)$ when exposed to weakly modulated light; b) $\tau_{eff}(\omega)$ with additional weak exposure from the same (front) side; c) $\tau_{eff}(\omega)$ with the same exposure from the rear.

24.2600 (1035, 1043, 1158)

S/181/60/002/011/005/042
B006/B056

24.2420

AUTHOR: Rashba, E. I.

TITLE: A Method of Experimentally Verifying the Possibility of Introducing a Universal Surface Recombination Rate When Investigating the Kinetics of Photoelectric Effects

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 11, pp. 2693 - 2695

TEXT: Photoelectric processes in a semiconductor are, in general, considered to take place within a neutral region. With an exposure of this region, which varies with the frequency ω, the surface recombination rates on the boundaries of this region is a complicated complex function of ω. The introduction of $s(\omega)$ on the boundaries of the region is trivial if one confines oneself to the study of a single photoelectric effect with a given light absorption coefficient k. This, however, becomes important if $s(\omega)$ is universal with sufficient accuracy, i.e., if $s(\omega)$ conincides for various effects and does not depend on k. The author has developed a method of investigating the universality of $s(\omega)$ for various photoelectric effects in the case of considerable light absorption. The

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A Method of Experimentally Verifying the Possibility of Introducing a Universal Surface Recombination Rate When Investigating the Kinetics of Photoelectric Effects

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$-D(\omega)\partial p'/\partial \nu = s(\omega)p'$ (D - diffusion coefficient; ν - external normal). D, s, u, and τ_p are complex functions of ω. From the results obtained it may be concluded that, if $s(\omega)$ is uniform for the photoelectric effects considered, the ratio between two arbitrary complex amplitudes becomes a complex function of ω and does not depend on the state of the surface and, therefore, remains unchanged when the surface is treated, when adsorption occurs, or when an external field is applied. This may be checked immediately by way of experiment. V. Ye. Lashkarev, Member of the AS UkrSSR, and V. A. Romanov are thanked for discussions. There are 2 references: 1 Soviet and 1 French.

ASSOCIATION: Institut fiziki AN USSR Kiyev (Institute of Physics of the AS UkrSSR, Kiyev)

SUBMITTED: May 7, 1960

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86421

A Method of Experimentally Verifying the Possibility of Introducing a Universal Surface Recombination Rate When Investigating the Kinetics of Photoelectric Effects

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Method is based upon the general results of Refs. 1,2. In a homogeneous semiconductor, the absorption of a light quantum within the region of intrinsic absorption is accompanied by an electron-hole pair production: $\partial p/\partial t = D_p \Delta p - u_p(\nabla\vec{E})p - R_p(n,p,\{f_{i\alpha}\}) + G(\vec{r},t)$ and $\partial n/\partial t = D_n \Delta n + u_n(\nabla\vec{E})n - R_n(n,p,\{f_{i\alpha}\}) + G(\vec{r},t)$; here, $R_{n,p}(\ldots)$ is the rate at which electrons and holes, respectively, fall out of the conduction band; $G(\vec{r},t)$ is the pair production rate; $\{f_{i\alpha}\}$ is the degree of occupation of a state (of α-th charge and i-th kind) of local centers. After introducing primed variables ($n = n_o + n'e^{i\omega t}$, the others in an analogous manner, and $G(\vec{r},t) = G(\vec{r})e^{i\omega t}$) one obtains:

$$D_p \Delta p' - u_p(\vec{E}_o\nabla)p' - u_p p_o(\nabla\vec{E}') - p'/\tau_p(\omega) + G(\vec{r}) = 0;$$

$$D_n \Delta n' + u_n(\vec{E}_o\nabla)n' + u_n n_o(\nabla\vec{E}') - n'/\tau_n(\omega) + G(\vec{r}) = 0;$$

$$n' = q(\omega)p'; \quad \partial p/\partial t + R_p = \partial n/\partial t + R_n; \quad p'/\tau_p(\omega) = n'/\tau_n(\omega);$$

$$D(\omega)\Delta p' - u(\omega)(\vec{E}_o\nabla)p' - p'/\tau_p(\omega) + G(\vec{r}) = 0;$$ and finally the relation

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22063
S/181/61/003/004/029/030
B102/B209

34.7700(1035,1043,1160,1158)

AUTHORS: Rashba, E. I. and Boyko, I. I.

TITLE: The properties of semiconductors with an extremum loop. III. The behavior in a magnetic field parallel to the plane of the loop

PERIODICAL: Fizika tverdogo tela, v. 3, no. 4, 1961, 1277-1289

TEXT: This rather comprehensive article is the continuation of two previous papers in which the authors published a theory of cyclotron resonance and combined resonance, as well as of magnetic susceptibility (FTT, II, 1224 and 1874, 1960) for semiconductors with a loop of extrema (cf. FTT, sb., II, 162, 1959) in the case of a $\vec{H}$-field perpendicular to the loop plane. The same effects have been studied for an $\vec{H}$-field parallel to the loop plane. The first section of the paper deals with the quasi-classical wave functions and the conditions of quantization. The authors proceed from the matrix Hamiltonian of a band electron in the field $\vec{H}$ x lying in the loop plane:

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The properties of ...

$$H=\begin{Vmatrix} A(k_x^2+k_y^2)+Bk_z^2 & iak_-+\beta_0\mathcal{H} \\ -iak_++\beta_0\mathcal{H} & A(k_x^2+k_y^2)+Bk_z^2 \end{Vmatrix}; \qquad (1)$$

In contrast to the case where the field is perpendicular to the loop plane, neither the spectrum nor the exact wave functions can be determined in the case of a parallel field, and therefore a quasi-classical treatment of the (two-component) functions is chosen. The $\hat{k}$-operators are replaced by operators with

$$\pi_{x,y}=\sqrt{\frac{c}{e\mathcal{H}}}\sqrt[4]{\frac{A}{B}}\hbar k_{x,y},\ \pi_z=\sqrt{\frac{c}{e\mathcal{H}}}\sqrt[4]{\frac{B}{A}}\hbar k_z. \qquad (2)$$

Since $[\hat{k}_y, \hat{k}_z] = -ie\mathcal{H}/\hbar c$, the commutative relation $[\pi_y, \pi_z] = -i\hbar$ holds for the new operators. With the notations $m_0 = \sqrt{m^* m_B}$, $\omega_0 = e\mathcal{H}/m_0 c$, $b = \hbar m_0/2m$, $E = (E-Ak_x^2)/\omega_0$, $\pi_\pm = \pi_x \pm i\pi_y$ the authors obtain the Schrödinger equation

$$H_1F=\begin{Vmatrix} \frac{1}{2}(\pi_y^2+\pi_z^2) & b+i\sqrt{\frac{2\Delta}{\omega_0}}\pi_- \\ b-i\sqrt{\frac{2\Delta}{\omega_0}}\pi_+ & \frac{1}{2}(\pi_y^2+\pi_z^2) \end{Vmatrix} F=EF;\quad F=\begin{pmatrix} f_1 \\ f_2 \end{pmatrix}. \qquad (3)$$

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The properties of ...

where $f_1 = \exp(i\sigma/h)$ and $f_2 = \exp(i\varphi/h)$. With $p_z = ih\frac{\partial}{\partial y}$ one finds

$$\left.\begin{aligned}\left[\frac{\pi_y^2}{2}+\frac{1}{2}\left(\frac{d\sigma}{d\pi_y}\right)^2-\frac{ih}{2}\frac{d^2\sigma}{d\pi_y^2}-E\right]e^{\frac{i}{h}\sigma}+\left[b+i\sqrt{\frac{2\Delta}{\omega_0}}\pi_-\right]e^{\frac{i}{h}\varphi}=0,\\ \left[b-i\sqrt{\frac{2\Delta}{\omega_0}}\pi_+\right]e^{\frac{i}{h}\sigma}+\left[\frac{\pi_y^2}{2}+\frac{1}{2}\left(\frac{d\rho}{d\pi_y}\right)^2-\frac{ih}{2}\frac{d^2\rho}{d\pi_y^2}-E\right]e^{\frac{i}{h}\varphi}=0.\end{aligned}\right\} \quad (5)$$

As usual, σ and φ are expanded in power series of h/i, which results in a sequence of systems of equations for the determination of σ_i and φ_i. Setting $\sigma_0 = \varphi_0$ and $\rho = \exp(\varphi_1 - \sigma_1)$ one obtains the following solution of the zero-order system:

$$\frac{1}{2}\left(\frac{d\sigma_0^{\mp}}{d\pi_y}\right)^2 = -\frac{\pi_y^2}{2}+E\pm\left|b+i\sqrt{\frac{2\Delta}{\omega_0}}\pi_-\right|, \quad (8)$$

$$\rho^{\mp} = \mp\frac{\left|b+i\sqrt{\frac{2\Delta}{\omega_0}}\pi_-\right|}{b+i\sqrt{\frac{2\Delta}{\omega_0}}\pi_-} \equiv \mp\delta. \quad (9)$$

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Finally, in quasi-classical approximation,

$$F = C_1 \frac{\cos\frac{\sigma_0^-}{\hbar}}{\sqrt{\frac{d\sigma_0^-}{d\pi_y}}}\begin{pmatrix}\frac{1}{\sqrt{\vartheta}}\\ -\sqrt{\vartheta}\end{pmatrix} + C_2 \frac{\cos\frac{\sigma_0^+}{\hbar}}{\sqrt{\frac{d\sigma_0^+}{d\pi_y}}}\begin{pmatrix}\frac{1}{\sqrt{\vartheta}}\\ \sqrt{\vartheta}\end{pmatrix}; \qquad (12)$$

is obtained from Eqs. (8) and

$$e^{\sigma_1^\mp} = \frac{1}{\sqrt{\xi^\mp \frac{d\sigma_0^\mp}{d\pi_y}}}, \quad e^{\beta_1^\mp} = \sqrt{\frac{\xi^\mp}{\frac{d\sigma^\mp}{d\pi_y}}}. \qquad (10)$$

Confining themselves, to weak magnetic fields (b = 0), the authors then examine the condition under which quasi-classical approximation is applicable to some types of classical trajectories. Moreover, the conditions of quantization are discussed; among other things, the authors obtain a normalized quasi-classical wave function of the following form:

$$F_\mp(\pi_y) = \sqrt{\frac{2\nu_\mp}{\omega_0 \pi_y^\mp}}\begin{pmatrix}\frac{1}{\sqrt{\vartheta}}\\ \mp\sqrt{\vartheta}\end{pmatrix}\cos\left(\frac{1}{\hbar}\int_{\pi_{y1}^\mp}^{\pi_y}\pi_y^\mp(\pi_y)\,d\pi_y - \frac{\pi}{4}\right). \qquad (21)$$

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Here, $\tau^{\mp}_{y1}$ and $\tau^{\mp}_{y2}$ are the left and the right pivot, and $\nu_{\mp}$ is the classical angular frequency of the respective branches. The second section is devoted to the isoenergetic sufaces. First, the cases $E > 0$ and $E < 0$ are examined. For $E > 3\Delta$ Fig. 2 shows sections through the isoenergetic surfaces, formed by intersection with the planes k_x = const. In the third section, the authors study the oscillating part χ_{osc} of magnetic susceptibility at $-\Delta \leqslant \zeta \leqslant 0$ and $s = 1/2$, using the formula of I. M. Lifshits and A. M. Kosevich:

$$\chi_{osc} = -\frac{kT}{\pi\hbar^2\pi}(\zeta+\Delta)\left(\sqrt{\frac{\Delta}{|\zeta|}}-1\right)^{-1/2}\left(\frac{em_0m^*}{c\hbar\pi}\right)^{1/2}\sum_{\nu=1}^{\infty}\frac{(-)^{\nu}}{\sqrt{\nu}}\times$$

$$\times\frac{\sin\left(2\pi\nu\frac{\zeta+\Delta}{\hbar\omega_0}+\frac{\pi}{4}\right)}{\mathrm{sh}\left(2\pi^2\nu\frac{kT}{\hbar\omega_0}\right)}. \qquad (29)$$

In the fourth section, cyclotron resonance is discussed; for the conductivity $\sigma(\omega)$ at $E < 0$ and $\omega_0\tau \gg 1$, the authors obtain

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$$\sigma(\omega)=\sigma_0\frac{|\zeta|(\Delta+\zeta)}{\sqrt{\Delta\cdot|\zeta|}}\frac{1}{\sqrt{\omega_0\tau}}\frac{\sqrt{\sqrt{1+\tau^2(\omega_0-\omega)^2}+\tau(\omega_0-\omega)}}{\sqrt{1+\tau^2(\omega_0-\omega)^2}}, \qquad (31)$$

For $\tau\longrightarrow\infty$, the expression

$$\sigma(\omega)\sim\left|\frac{\omega_0}{\omega-\omega_0}\right|^3\exp\left\{-\left(\frac{2}{\pi}\right)^2\frac{\Delta}{kT}\left(\frac{\omega_0}{\omega-\omega_0}\right)^2\right\}; \qquad (32)$$

follows. The fifth section describes an investigation of band-to-band transitions. By approximation,

$$H_y=\frac{e}{c}\mathcal{A}_y\begin{vmatrix}\sqrt{\frac{\omega_0}{m^*}}\pi_y & \frac{e}{\hbar}\\ \frac{e}{\hbar} & \sqrt{\frac{\omega_0}{m^*}}\pi_y\end{vmatrix},\quad H_x=\frac{e}{c}\mathcal{A}_x\begin{vmatrix}\sqrt{\frac{\omega_0}{m^*}}\pi_x & 0\\ 0 & \sqrt{\frac{\omega_0}{m^*}}\pi_x\end{vmatrix}. \qquad (33)$$

with

$$(F_{n^+n^-},H_1F_{n^-})=\frac{-2\sigma e}{ich\omega_0}\sqrt{2\pi\hbar\nu_{n^+}\nu_{n^-}}\frac{\pi_x}{\pi_\perp\pi_y}\left|\frac{d\pi_x^+}{d\pi_y}-\frac{d\pi_x^-}{d\pi_y}\right|^{-1/2}\varphi_{n^+n^-}\mathcal{A}_{y1} \qquad (35)$$

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is obtained. The respective intersections of the phase trajectories can be seen from Fig.4. The Eqs.

$$\frac{d\pi_y^-}{d\pi_y} - \frac{d\pi_y^+}{d\pi_y} = 2\frac{\pi_0}{\pi_\perp}\frac{\pi_y}{\pi_y}, \text{ where } \pi_0 = \sqrt{\frac{c}{e\mathcal{H}}}\sqrt[4]{\frac{A}{B}}\hbar k_0. \qquad (38)$$

and

$$(F_{n^+}, H_1 F_{n^-}) = \frac{-2e\varepsilon}{lc\hbar\omega_0}\sqrt{\pi\hbar v_{n^+} v_{n^-}}\,\frac{\pi_0}{\sqrt{\pi_0\pi_\perp|\pi_y||\pi_y|}}\,\varphi_{n^+n^-}\sigma_{y^*} \qquad (39)$$

hold at the intersections of the trajectories. There are 4 figures and 13 references: 1 Soviet-bloc and 2 non-Soviet-bloc. The most recent reference to an English-language publication reads as follows: F. Stern, J. Phys. Chem. Sol. 8, 277, 1959.

ASSOCIATION: Institut fiziki AN USSR Kiyev (Institute of Physics, AS UkrSSR, Kiyev)

SUBMITTED: October 6, 1960

Card 7/9

24915 S/181/61/003/006/012/031
B102/B201

9,4300

AUTHORS: Rashba, E.I. and Sheka, V.I.

TITLE: Combined resonance of band electrons in crystals with zinc-blende type lattice

PERIODICAL: Fizika tverdogo tela, v. 3, no. 6, 1961, 1753-1774

TEXT: A report on the subject mentioned in the title was delivered at the Fourth All-Union Conference on Semiconductor Theory, which took place at Tbilisi on October 22, 1960. The present study is in continuation of a paper by Rashba (Ref.1: FTT, II, 1224, 1960), where it had been shown that the existence of spin-orbit interaction may lead to the possible appearance of a new type of band electron resonance, which can be jointly caused by the electron vector of the h-f field and a change of electron spin levels. It is thus designated as combined resonance which may arise in semiconductors with extremum loops (cf. Ref.2: Rashba, Sheka, FTT II, 2, 162, 1959). A theory of the combined resonance of band electrons is developed here for crystals with zinc-blende-type lattice, and the angular dependence of resonance is calculated. The results point to a marked anisotropy of

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the intensity of the resonance effect. The frequencies of the combined resonance prove to be linear combinations of the spin resonance frequency and of the cyclotron resonance. It should be possible to estimate the extent of band splitting (which is related to the absence of an inversion center) from measurements of the intensity of the combined resonance. Crystals with inversion center display a twofold degeneracy of the bands in the entire $\vec{k}$-space, while crystals without an inversion center display no such band degeneracy. In the latter crystals, however, there appears, e.g., near the center $\vec{k}=0$ of the Brillouin zone a small but finite band "divergence" (caused by spin-orbit interaction) which is hardly measurable. In the authors' opinion, a study of the combined resonance would make it possible to find a usable method of measuring the parameters of the relativistic band divergence. The crystals considered here (e.g., InSb, ZnS) belong to the space group T_d^2. The Hamiltonian is first determined and examined for the system concerned. It is put in the form $H = H_0 - H_1$, where $H_0 = A\hat{k}^2 + \frac{g\beta_0}{2}(\vec{\sigma}\vec{k})$, and $H_1 = \delta_0(\vec{\sigma}\hat{\vec{k}})$; $A = \hbar^2/2m^*$, m^* is the effective mass, $\beta_0 = e\hbar/2m_0c$, m_0 is the mass of the free electron; $\vec{\sigma}$ is the Pauli matrix,

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δ_0 is the parameter characterizing the band divergence; $\hat{\vec{k}} = \hat{k}_y\hat{k}_x\hat{k}_y - \hat{k}_z\hat{k}_x\hat{k}_z$ (the other components have to be obtained by cyclic permutation). The operator of the quasimomentum is related to the vector potential in the usual manner: $\hat{\vec{k}} = -i\nabla + e\vec{A}/c\hbar$. The further investigation is restricted to small δ_0, so that H_1 may be regarded as a perturbation. The absorption in the antinode of the electric field is described by the imaginary part $\varepsilon''(\omega)$, and by $\mu''(\omega)$ in the antinode of the magnetic field. Formulations for the matrix elements of the transition are examined next; the magnetic field $\vec{H}$ is designated by the polar angle θ and the azimuth Φ; representation

$$S=\begin{Vmatrix}\alpha & \beta\\ \gamma & \delta\end{Vmatrix}=\begin{Vmatrix}\cos\frac{\theta}{2}\exp\left[\frac{i}{2}\left(\frac{\pi}{2}+\Phi\right)\right] & \sin\frac{\theta}{2}\exp\left[\frac{i}{2}\left(\frac{\pi}{2}-\Phi\right)\right]\\ -\sin\frac{\theta}{2}\exp\left[\frac{i}{2}\left(\Phi-\frac{\pi}{2}\right)\right] & \cos\frac{\theta}{2}\exp\left[-\frac{i}{2}\left(\frac{\pi}{2}+\Phi\right)\right]\end{Vmatrix}. \quad (18)$$

is used.

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$$\sqrt{2}\,\frac{\nu_0 m^*}{\hbar^2}\,\frac{e\mathcal{H}}{ch}\,\frac{q_\alpha}{j-l-q_\alpha+\beta^*}\sum_{\beta\gamma}B_{(\alpha\beta\gamma)}\langle l|a_\beta a_\gamma|j\rangle.$$

(30) is obtained for the matrix element, and

$$\langle l-|V_\alpha|j+\rangle=\sqrt{2}\,\frac{\nu_0}{\hbar}\,\frac{e\mathcal{H}}{ch}\,\frac{l-j-\beta^*}{l-j+q_\alpha-\beta^*}\sum_{\beta\gamma}B_{(\alpha\beta\gamma)}\langle l|a_\beta a_\gamma|j\rangle. \quad (31)$$

for the angular dependence of the resonance effect. The unitary B-matrix is given by

$$B=\begin{vmatrix} -\frac{1}{\sqrt{2}}(\sin\Phi+i\cos\theta\cos\Phi) & -\frac{1}{\sqrt{2}}(\sin\Phi-i\cos\theta\cos\Phi) & \sin\theta\cos\Phi \\ \frac{1}{\sqrt{2}}(\cos\Phi-i\cos\theta\sin\Phi) & \frac{1}{\sqrt{2}}(\cos\Phi+i\cos\theta\sin\Phi) & \sin\theta\sin\Phi \\ \frac{i}{\sqrt{2}}\sin\theta & -\frac{i}{\sqrt{2}}\sin\theta & \cos\theta \end{vmatrix}. \quad (20)$$

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its elements are explicitly given by

$$
\left.
\begin{aligned}
B_{(111)} &= 0,\\
B_{(133)} &= -2B_{(113)} = \frac{2}{3}B^{*}_{(222)} = \\
&= \cos 2\Phi \cos 2\Theta - \frac{i}{2}\sin 2\Phi \cos\Theta\,(2\cos^2\Theta - \sin^2\Theta),\\
B_{(122)} &= -\frac{1}{2}B_{(233)} = \frac{3}{4}i\sin 2\Phi \sin\Theta \sin 2\Theta,\\
B_{(333)} &= -2B_{(123)} = \frac{6}{5}B^{*}_{(223)} = \\
&= \frac{3i}{2\sqrt{2}}[\cos 2\Phi \sin 2\Theta - i\sin 2\Phi \sin\Theta\,(2\cos^2\Theta - \sin^2\Theta)],\\
B_{(113)} &= \frac{3}{4\sqrt{2}}[\sin 2\Phi \sin\Theta\,(1+\cos^2\Theta) + i\cos 2\Phi \sin 2\Theta].
\end{aligned}
\right\} \quad (32)
$$

for the case concerned. As may be seen from (31), transitions with a change of the orbital quantum number by 0, ±1, and ±2 are possible in the combined resonance. Using (31), the angular diagrams of combined resonance

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Combined resonance of band ...

are then examined. For the individual perturbation operators, the distribution of the various transitions in the combined resonance according to the types of angular diagrams is represented as follows:

	V_+		V_-		V_z	
	+ → −	− → +	+ → −	− → +	+ → −	− → +
I	$l \to l-2$			$l \to l+2$		
II	$l \to l$	$l \to l \pm 2$	$l \to l \pm 2$	$l \to l$	$l \to l-1$	$l \to l+1$
III	$l \to l+2$	$l \to l$	$l \to l$	$l \to l-2$	$l \to l+1$	$l \to l-1$
IV	$l \to l+1$	$l \to l \pm 1$	$l \to l \pm 1$	$l \to l-1$	$l \to l, l+2$	$l \to l, l-2$
V	$l \to l-1$			$l \to l+1$	$l \to l-2$	$l \to l+2$

Finally, the intensity of the combined resonance is examined, namely, 1, for a nondegenerate electron gas, 2, for a degenerate one of low concentration, and 3, for a degenerate one of high concentration. The criteria for the application of this theory are finally discussed briefly. There are 1 table and 8 references: 4 Soviet-bloc and 4 non-Soviet-bloc.

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S/181/61/003/006/012/031
B102/B201

X

ASSOCIATION: Institut poluprovodnikov AN USSR Kiyev (Institute of Semiconductors, AS UkrSSR, Kiyev)

SUBMITTED: December 29, 1960

Card 7/7

9,4300

AUTHORS: Rashba, E. I. and Sheka, V. I.

TITLE: Combined resonance in n-type InSb

PERIODICAL: Fizika tverdogo tela, v. 3, no. 6, 1961, 1863 - 1870

TEXT: The present paper formed the subject of a lecture delivered on October 22, 1960 at the Fourth All Union Conference on Semiconductor Theory held at Tbilisi. The paper is in continuation of an earlier paper (Ref. 1: FTT, III, 6, 1732, 1961) in which a report was given on the investigations of the combined resonance of the band carriers in crystals having zinc blende type of lattice. There it was assumed that the extremum of the band is reached at $\vec{k} = 0$. This, for example, is the case in n-type InSb to which the results of Ref. 1 are applied with a view particularly to estimating the intensity of the combined resonance in this lattice. First, the Hamiltonian of the band electrons and the determination of various constants are discussed. Next, the intensities of the combined resonance and the paramagnetic resonance are compared. Fig. 2 shows the scheme of the electron transitions in InSb for the

combined resonance (A), the cyclotron resonance (B), and the paramagnetic resonance (C). The distance between the nearest levels with opposite quantum numbers σ is $1/\beta^* = 2m_0/gm^*$ times smaller than the distance between the Landau levels. The ratio of the intensities of combined and paramagnetic resonance is determined by the formula $\eta^{-1}(\alpha,\sigma,\Delta j,\zeta)=\frac{\varepsilon''_\alpha(\omega_{c.res.})}{\varepsilon'\mu''d(\omega_{p.res.})}$.

In InSb, $m^*/m_0 = 0.013$, $\beta^* = -0.33$, $\varepsilon' = 17$, and $L = \frac{8}{\varepsilon'^2}\left(\frac{\delta_0 m_s m^* c}{\hbar^3}\right)^2 \approx 10^2$.

The following special cases are now investigated: 1)Nondegenerate electron gas. a) High temperature, $\lambda \ll 1$

$$\eta_1(\sigma,\Delta j)=\frac{\Gamma\left(\frac{5}{2}-\Delta j\right)}{\sqrt{\pi}}\frac{1+b_{0,2-\Delta j}}{\lambda^2}\left|\frac{\Delta j-\sigma\beta^*}{\beta^*}\right| \qquad (11)$$

holds. The intensity of the combined resonance is always substantially higher than that of the paramagnetic resonance. b) Low temperature, $\lambda \gg 1$. The intensity ratio is given by

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$$\eta_1(\sigma, \Delta j)=\frac{\Gamma\left(\frac{5}{2}-\Delta j\right)}{\sqrt{\pi}\lambda^{2-\Delta j}}\left(\delta_{1,\sigma}+\delta_{1,-\sigma}e^{-\lambda|\beta^\circ|}\right)\sum_{r=0}^{\Delta j}a_r\left(\frac{1}{2}\right)^r+\frac{9}{16}\delta_{0,\Delta j}. \quad (12)$$

For $\Delta j = 0$, $\eta^{-1}(\sigma,0) = 9/16$, i. e. the combined resonance exceeds the paramagnetic resonance 28, 10, and 125 times for α values 1, 2, and 3. For $\Delta j = 2$ and $\sigma = 1$, $\eta^{-1}(1,2) = 310$, 330, and 230. In the remaining cases the combined resonance is weaker than the paramagnetic one when λ is not too small. 2) Degenerate electron gas. Low concentration. One has

$$\eta_1(\sigma, \Delta j, N)=\frac{2^{2-\Delta j}}{5-2\Delta j}\left(\frac{\pi^2N}{k_x^3}\right)^{2(2-\Delta j)}\sum_{r=0}^{\Delta j}a_r\left(-\frac{1}{2}\right)^r+$$

$$+\delta_{0,\Delta j}\left\{-\frac{1}{3}\left(\frac{\pi^2N}{k_x^3}\right)^2+\frac{1}{16}\right\}, \quad (13)$$

It is found (notations as above) that $\eta^{-1}(1,0) = 3$, 1, and 14; $\eta^{-1}(1,2) = 100$, 110, and 78; $\eta^{-1}(-1,2) = 154$, 0, and 34. 3) Degenerate electron gas. High concentration. One has

$$\eta_1(\sigma, \Delta j, \zeta)=\frac{4}{15\sqrt{\pi}}\Gamma\left(\frac{5}{2}-\Delta j\right)(1+\delta_{0,2-\Delta j})\left|\frac{\Delta j-\sigma\beta^\circ}{\beta^\circ}\right|\zeta^2. \quad (14)$$

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B102/B214

The intensity of the combined resonance is always higher than that of the paramagnetic resonance. The table gives the intensity ratios for a degenerate electron gas for maximum values of the coefficients $B(\alpha,\sigma,\Delta j)$. Finally, the results are briefly discussed and compared with those of Bemski. The authors thank K. B. Tolpygo for discussions. There are 3 figures, 2 tables, and 9 references: 2 Soviet-bloc and 7 non-Soviet-bloc. The most important references to English-language publications read as follows: L. M. Roth, B. Lax, S. Zwerdling. Phys. Rev., 114, 90, 1959; H. Welker, H. Weiss, Solid State Physics, 3, 1, 1956; G. Bemski, Phys. Rev. Lett., 4, 62, 1960.

Table

	σ				
	1	1	1	−1	−1
	Δj				
	2	1	0	2	1
1	190	950	9.8	210	120
2	210	55	3.4	0.00	5.7
3	150	290	45	46	110

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25680
S/181/61/003/007/002/023
B102/B202

24.7400 (1160, 1395, 1143)

AUTHORS: Broude, V. L. and Rashba, E. I.

TITLE: Exciton absorption in mixed molecular crystals

PERIODICAL: Fizika tverdogo tela, v. 3, no. 7, 1961, 1941 - 1949

TEXT: The authors attempted to develop a simplified theory of the excitonic light absorption in molecular mixed crystals. In previous papers the authors had developed a theory of the impurity absorption of light in molecular crystals for the case that the impurity absorption band lies near the region of exciton absorption of the solvent crystal. They also studied experimentally the absorption spectra of crystalline solutions of the deutero-substitutes of benzene. The results of these studies are utilized in this paper. The authors consider a crystalline substitution solution. They assume molecules of different kinds to be present in a fixed position in the lattice sites. i denotes the kind, n counts the unit cells, and α the molecules therein, N is the number of cells in the crystal. The authors confine themselves to solutions of molecules in which one or several atoms are substituted by isotopes; in

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Exciton absorption ...

this case it can be assumed approximately that the integrals of resonant interaction between the molecules $M_{\underline{n}\alpha;\ \underline{m}\beta}$ are independent of the isotopic composition; $\varepsilon^{0}_{\underline{n}\alpha}$ denotes the excitation energy of the molecules $\underline{n}\alpha$, $D_{\underline{n}\alpha,\ \underline{m}\beta}$ the change of the excitation energy of a $\underline{n}\alpha$ molecule on its incorporation into the crystal caused by interaction with a $m\beta$ molecule. With these designations the excitation amplitudes $a_{\underline{n}\alpha}$ of the molecules are determined by minimizing the energy functional

$$E=\sum_{n\alpha}\left(\varepsilon^{0}_{n\alpha}+\sum_{m\beta}D_{n\alpha,\ m\beta}\right)|a_{n\alpha}|^{2}+\sum_{\substack{n\alpha,\ m\beta\\ n\alpha\neq m\beta}}a_{n\alpha}M_{n\alpha,m\beta}a_{m\beta} \qquad (1)$$

and by satisfying the normalization condition $\sum_{\underline{n}\alpha}|a_{\underline{n}\alpha}|^{2}=1$. For a one-component system (1) passes into the corresponding formula by A. S. Davydov. $a_{i\alpha}$ is then introduced as the new excitation amplitude; $a_{\underline{n}\alpha}=N^{-1/2}a_{i\alpha}$, which is an approximation substantiated by experimental facts. Thus,

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Exciton absorption ...

$$E=\sum_{i\alpha} f_i\left[\varepsilon_i^0+\sum_j D_{ij}f_j\right]|a_{i\alpha}|^2+\sum_{i,j,\alpha,\beta} a_{i\alpha}f_iM_{\alpha\beta}f_ja_{j\beta}\,. \qquad (2)$$

is obtained where f_i is the relative concentration of the components ($\sum_i f_i = 1$), with the normalization condition $\sum_{i\alpha} f_i|a_{i\alpha}|^2 = 1$. Here $M_{\alpha\beta} = \sum_{\underline{m}} M_{\underline{n}\alpha,\,\underline{m}\beta}$ and $D_{ij} = \sum_{\underline{m}} D_{\underline{n}\alpha,\,\underline{m}\beta}$, if all $\underline{n}\alpha$ sites contain molecules of the kind i, all others such of the kind j. The system of equations

$$(\varepsilon_i - E)a_{i\alpha}+\sum_{j\beta} M_{\alpha\beta}f_ja_{j\beta}=0, \qquad (3)$$

$$\varepsilon_i=\varepsilon_i^0+\sum_j D_{ij}f_j=\varepsilon_i[\{f_j\}].$$

is derived therefrom. $(\varepsilon_i - E_\tau)\, a_{i\alpha}^\tau = b_\alpha^\tau$, follows from (3) and from the orthogonality condition, i. e., the excitation amplitude in molecules of different kinds is inversely proportional to the distance of their terms

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from the absorption band (τ numbers the eigenvectors of the system (3)). Thus, the order of (3) can be reduced to an order which is equal to the number σ of the molecules in a unit cell: $\sum_{\beta} M_{\alpha\beta} b_\beta = \mathcal{E} b_\alpha$; $\frac{1}{\mathcal{E}} = \sum_j f_j/(E - \varepsilon_j)$; this system is equal to an analogous system in the theory of pure crystals, but with the difference that the transition energy is equal to E.

$$G_l^{\lambda\rho} = \frac{1}{\delta_\rho^2} \frac{\left| \sum_\alpha B_{\alpha\rho_{\alpha l}}^{\alpha} \right|^2}{\sum_i \frac{f_i}{(\varepsilon_i - E_{\lambda\rho})^2}} \quad (13)$$

is found for the transition probability under the action of light (whose electrical vector is polarized along $\vec{l}$) by using the square of the matrix element of the component of the dipole moment of the transition along $\vec{l}$, as referred to the unit cell. The following relations are also given: $\sum_\lambda E_{\lambda\rho} = \mathcal{E}_\rho + \sum_i \varepsilon_i$ and $\frac{1}{\mathcal{E}_\rho} = \sum_j \frac{f_j}{E_{\lambda\rho} - \varepsilon_j}$ (15). Function

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$$F\left(\frac{E}{\varepsilon}\right)=\frac{\left[\frac{f_1}{E+\varepsilon}+\frac{f_2}{E-\varepsilon}\right]^2}{\frac{f_1}{(E+\varepsilon)^2}+\frac{f_2}{(E-\varepsilon)^2}}. \qquad (16)$$

can be used in the form of

$$F\left(\frac{E}{\varepsilon}\right)=\frac{\left(\frac{E-E_{min}}{\varepsilon}\right)^2}{[1-(f_1-f_2)^2]+\left(\frac{E-E_{min}}{\varepsilon}\right)^2}. \qquad (17)$$

if $E_{min} = \varepsilon(f_1 - f_2)$; $(\varepsilon = (\varepsilon_1 - \varepsilon_2)/2)$. The theoretical results are then compared with the experimental ones under simpler assumptions. Using formulas (13) and (15), the authors found the results shown in Tables 1 and 2 (which are compared with those of Ref. 6) assuming that the concentration of the i-th component tends to zero and the frequency of the bands corresponding to it goes to ε_i, and that D_{ij} is a linear function

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25680
S/181/61/003/007/002/023
B102/B202

Exciton absorption ...

of the deuteron atoms in the j-molecules. Ref. 6: C. K. Ingold et al: J. Chem. Soc. (L.), 971, 1936; C. K. Ingold et al. J. Chem. Soc. (L.), 406, 1948. There are 2 figures, 2 tables, and 6 references: 5 Soviet-bloc and 1 non-Soviet-bloc.

ASSOCIATION: Institut fiziki AN USSR (Institute of Physics of the AS UkrSSR)
Institut poluprovodnikov AN USSR Kiyev (Institute of Semiconductors AS UkrSSR, Kiyev)

SUBMITTED: January 4, 1960

Card 6/8

27290

S/181/61/003/008/020/034
B102/B202

24.7700 (1138, 1144, 1160)

AUTHORS: Rashba, E. I. and Sheka, V. I.

TITLE: Properties of semiconductors with extremum loops. IV. Angular dependence of combined resonance in a strong magnetic field

PERIODICAL: Fizika tverdogo tela, v. 3, no. 8, 1961, 2369-2376

TEXT: The author devised a theory of combined resonance in semiconductors with extremum loops in a strong magnetic field in order to determine the angular dependence of the resonance intensity. If the depth Δ of the loop is sufficiently large and if the characteristic energy of the electrons contributing to the various effects is lower than Δ or of the same order of magnitude, a large number of methods exists for determining the existence of an extremum loop and also for determining Δ (cyclotron resonance, magnetic susceptibility, galvanomagnetic effect, optical properties etc.) if $\Delta \ll E_{char}$. However, only one method can be applied: Study of combined resonance which has been predicted by Rashba. In strong magnetic fields

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spin-orbit coupling is destroyed if the Zeeman energy is considerably higher than the spin-orbit separation of the bands in the effective region of the k space; with spin resonant frequency an absorption which is induced by the electric vector of the h-f field occurs simultaneously with paramagnetic resonance. This resonance is designated as combined resonance. Its intensity is by orders of magnitude higher than that of paramagnetic resonance and may come close to that of cyclotron resonance. Δ can be directly determined from its intensity. The authors now determine the angular dependence of combined resonance by a method that had been devised in a previous paper (FTT, III, 1735, 1961). The designations are taken from this previous paper and from Ref. 3 (Rashba, FTT, II, 1224, 1960) [Abstracter's note: For this reason, the author omits the formulas obtained. In order to be able to follow the theoretical considerations the mentioned previous papers should be known]. If the Zeeman energy is very high compared with the characteristic band separation Δ_{char} combined resonance can be observed if $h\nu > \Delta$, where ν is the frequency of the electromagnetic wave. With $\nu \sim 10^{11}$ cps semiconductors with $\Delta \leq 10^{-5}$ ev can be studied. The shift of the ceiling of the valence band from k = 0 by 10^{-4} ev

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B102/B202

for InSb brings out the importance of this range of values. In crystals consisting of light elements Δ may be considerably smaller. If ν is increased by transition into the far infrared, the Δ range can be extended. In crystals with large g factor ν can be strongly increased without extension beyond the range of practically attainable magnetic fields. In n-type InSb, where the extremum is not shifted from k = 0, the spin-orbit coupling may be destroyed and the limiting case of combined resonance can be observed at any frequency ν if the carrier concentrations and the temperatures are sufficiently low. A limitation is given only by the finiteness of the relaxation time. The intensity ratio of combined and cyclotron resonance is of the order of $\sim\Delta/E_{char}$ for $\Delta_{char} \leq h$. There are 12 references, 9 Soviet-bloc and 3 non-Soviet-bloc. The three references to English-language publications read as follows: R. C. Casella. Phys. Rev. Lett., 5, 371, 1960; W. Shockley. Phys. Rev. 90, 491, 1953; S. J. Czyzak et al. J. Opt. Soc. A, 47, 240, 1957.

ASSOCIATION: Institut poluprovodnikov AN USSR Kiyev (Institute of Semiconductors AS UkrSSR, Kiyev)

Card 3/4

PEKAR, S. I.; FASHBA, E. I.; SHEKA, V. I.

"Combined resonance on impurity centers and in inhomogeneous magnetic fields."

report submitted for Intl Conf on Physics of Semiconductors, Paris, 19-24 Jul 64.

S/053/61/074/001/003/003
B117/B212

AUTHORS: Rashba, E. I., Tolpygo, K. B.

TITLE: Fourth Conference on the Theory of Semiconductors

PERIODICAL: Uspekhi fizicheskikh nauk, v. 74, no. 1, 1961, 161-175

TEXT: This is a report on the IV Vsesoyuznoye soveshchaniye po teorii poluprovodnikov (4th All-Union Conference on the Theory of Semiconductors) which took place from October 17-22, 1960. This conference had been convened by the komissiya po poluprovodnikam AN SSSR (Comission of Semiconductors AS USSR) in cooperation with the AN Gruz. SSR (AS Gruzinskaya SSR) and Tbilisskiy gosuniversitet im. Stalina (Tbilisi State University imeni Stalin). Over 250 experts and representatives of Soviet 25 cities took part. Over 80 lectures were given and discussed during the general meetings, the section meetings, and the seminars. The chairman of the organizing committee, S. I. Pekar dedicated his address in memory of the late Academian Abram Fedorovich Ioffe. E. L. Andronikashvili, Academian of the AS Gruzinskaya SSR, described the role of A. F. Ioffe, which he had played in creating a large number of Institutes of Physics and Institutes of Physics and Technology in many cities of the

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Fourth Conference on ...

USSR and also his role in the education of young scientists. K. B. Tolpygo, A. I. Gubanov, G. G. Taluts, V. A. Myamlin, reported on interesting papers of foreign participants read at the International Conference on Semiconductor Physics. This conference took place in Prague from August 28 to September 2, 1960 and about 600 persons from 24 countries took part in it. Most of the papers submitted for discussion dealt with the investigations of optical properties of semiconductors: S. I. Pekar, M. S. Brodin, B. Ye. Tsekava "Optical anisotropy of cubic crystals, additional light waves in crystals, and their experimental identification." R. F. Kazarinov, O. V. Konstantinov: "Doppler shift of absorption lines of excitons." Ye. F. Gross, B. P. Zakharchenya, O. V. Konstantinov: "Inversion effect of a magnetic field in the absorption spectrum of excitons of the CdS crystals." A. A. Demidenko: "Micro-theory of the Frenkel'exciton with and without taking into account the delay in cubic crystals." V. S. Mashkevich: "Electromagnetic waves in a medium having a continuous energy spectrum (taking into account spatial dispersion)." V. L. Strizhevskiy: "Analysis of various properties of dispersion and absorption of light by an exciton in crystals." V. T. Cherepanov and V. S. Galishev: "Anisotropy of quadrupole-type absorption of light by an exciton in cubic crystals." Ye. F. Gross, A. G. Zhilich, B. P. Zakharchenya, A. A.

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Kaplyanskiy: "Effect of a magnetic field and a crystal deformation on the exciton ground state of Cu_2O." S. A. Moskalenko: "The energy spectrum of excitons in non-deformable ion crystals." V. M. Agrynovich: "Theory of excitons in molecule crystals." I. G. Zaslavskaya: "Calculation of the energy of excited exciton states during an intermediate binding." S. V. Vonsovskiy, P. S. Zyryanov, A. N. Petrov, G. G. Taluts: "The effect of electric and magnetic fields on the form of exciton absorption lines." L. E. Gurevich, I. P. Ipatova: "Theory of long-wave absorption of light by crystals." V. M. Agranovich and V. L. Ginzburg: "Dispersion of X-rays in crystals by forming excitons." L. N. Ovander: "Raman effect in crystals." E. I. Adirovich: "The Exciton as a wave for phase transformation." Z. S. Kachlishvili: "Elastic scattering of a non-localized exciton on impurity centers." A. S. Selivanenko: "Calculation of the dispersion cross section of free excitons at lattice defects of a molecule crystal." A. A. Vorob'yev: "Self-absorption and additional absorption in ion crystals and the energy of the lattice." V. M Agranovich, E. I. Rashba, I. B. Levinson, I. M. Lifshits, M. I. Kaganov, V. I. Perel', A. G. Zhilich, S. I. Pekar, S. A. Moskalenko, L. N. Demidenko, V. L. Bonch-Bruyevich took part in the discussion. The following references were quoted: Ref.2: Ye. F. Gross, A. A Kaplyanskiy,

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Fourth Conference on ...

Fizika tverdogo tela 2, 379 (1960); Ref.3: I. S. Gorban', V. B. Timofeyev, Doklad na XIII Vsesoyuznom soveshchanii po spektroskopii, Leningrad, iyul' 1960 g.; Ref.6: V. M. Buymistrov, S. I. Pekar, ZhETF 32, 1193 (1957); V. M. Buymistrov, Ukr. fiz. zh. 3, Pril. I. 21 (1958). The following papers dealt with the analysis of the band structure of semiconductors: O. V. Kovalev: "Degeneracy of electron energy levels in a crystal." T. I. Kucher: "Hole bands in alkalimetal chlorides." F. M. Gashimzade, V. Ye. Khartsiyev: "Analysis of the energy structure of several semiconductors." Ye. I. Cheglokov, V. A. Chaldyshev: "Symmetry of the solutions for Hartree-Fock equations for crystals." A. Ye. Glauberman, A. M. Muzychuk, M. A. Ruvinskiy, I. V. Stasyuk: "Problems of the multiple-electron theory for solid and liquid semiconductors." A. I. Gubanov: "Various theories of amorphous semiconductors." L. D. Dudkin: "Problems of the chemical bonding of semiconductor compounds of transition metals." A. D. Chevychelov: "Energy spectrum of the elctron for a polymer-chain model." The following persons took part in the discussions: I. B. Levinson, K. B. Tolpygo, N. N. Kristoffel', P. N. Nikiforov, E. I. Rashba, S. I. Pekar, A. Ye. Glauberman, E. L. Nagayev, V. M. Agranovich. The following papers dealt with transfer properties: G. Ye. Pikus, G. L. Bir, E. S. Normantas: "Theory of the deformation

potential and the dispersion of carriers in semiconductors showing a degenerate band." Ye. P. Pokatilov: "Interaction of free electrons with ultrasonics in silicon and germanium." V. L. Gurevich, Yu. A. Firsov: "Theory of the electrical conductivity of semiconductors in a magnetic field on inelastic scattering." A. I. Ansel'm, B. M. Askerov: "Thermomagnetic phenomena in metalloids exposed to a strong magnetic field." L. E. Gurevich, G.M. Nedlin: "Contribution of electrons to thermal conductivity due to entrainement of phonons." I. Ya. Korenblit: "Galvanomagnetic phenomena in Bi_2Te_3." F. G. Baksht: "Faraday effect at free carriers in Bi_2Te_3 exposed to a weak magnetic field." G. I. Kharus, I. M. Tsidil'kovskiy: "Anisotropy of photomagnetic effects in cubic crystals." N. P. Keklidze: "Several electrophysical properties of germanium and silicon at low temperatures." V. B. Fiks: "Entrainement of ions by electrons in semiconductors." I. M. Dykman, P. M. Tomchuk: "Electrical conductivity and thermionic emission in semiconductors." P. M. Tomchuk: "Variational method for determining the electrical conductivity and taking into account also the Coulomb interaction of carriers." Sh. M. Kogan, V. B. Sandomirskiy: "Theory of the external emission of hot electrons from semiconductors." V. A. Chuyenkov: "Conductivity of germanium in

in strong electric fields at low temperatures." V. P. Shabanskiy: "Non-equilibrium processes in impurity semiconductors." O. N. Krokhin, Yu. M. Popov: "Slowing-down time of non-equilibrium carriers in semiconductors." The following persons took part in the discussions: V. A. Chuyenkov, G. L. Bir, I. M. Lifshits, G. M. Nedlin, O. V. Konstantinov, M. I. Kaganov, F. G. Bass, V. L. Bonch-Bruyevich, I. M. Dykman, E. I. Rashba, Z. S. Gribnikov. The following papers dealt with resonance and oscillation effects: I. M. Lifshits, V. M. Nabutovskiy, A. A. Slutskin: "Phenomena of the mobility of charged quasi-particles near singular points of isoenergetic surfaces or orbits." M. Ya. Azbel': "A new resonance effect" and "Quasi-classical quantization near particular classical orbits and quanta oscillations of thermodynamic quantities." E. I. Rashba, I. I. Boyko, V. I. Sheka: "Cyclotron and combined resonance and susceptibility of various semiconductors." V. L. Gurevich, V. G. Skobov, Yu. A. Firsov: "Giant oscillations of sound absorption." M. F. Deygen, A. B. Roytsin: "Paramagnetic resonance with arbitrary sizes of a static magnetic field in electrons localized in semiconductors." V. Ya. Zevin: "Theory of the spin-lattice relaxation of electron localization centers in non-metallic crystals." Yu. V. Chkhartishvili: "Electron spin resonance at the F-center in KCl+NaCl crystals." The following persons took part in the discussions: V. L. Bonch-Bruyevich, I. M. Lifshits, K. B.

Fourth Conference on ...

Tolpygo, V. Ya. Zevin. The following papers were devoted to the theory of local centers and polarons: K. K. Rebane, O. I. Sil'd: "Method of momenta in the theory of electron oscillation transitions." V. M. Buymistrov: "Variational principle for the transitions probability." S. V. Tyablikov, V. A. Moskalenko: "Application of field-theoretical methods to the theory of multiple-phonon transitions." Yu. Ye. Perlin, A. Ye Marinchuk, V. A. Kovarskiy: "Application of the perturbation theory of Wigner-Weißkopf to the problems of electron-phonon interaction in crystals." A. M. Ratner, G. Ye. Zil'berman: "Theory of luminescence of crystals having luminescent impurity centers." A. A. Tsertsavadze: "The mechanism of light absorption by F-centers and excitons in alkali-halide crystals." A. G. Cheban: "Theory of thermal ionization of F'-centers." D. I. Abakarov, Yu. M. Seidov: "Theory of the susceptibility of polaron gas." V. L. Vinetskiy: "The ground state of the bipolaron." R. R. Dogonadze, A. A. Chernenko: "Electrical conductivity of semiconductors with a short length of path of the carriers." The following persons participated in the discussions: K. K. Rebane, E. I. Rashba, N. N. Kristoffel', B. K. Tolpygo, M. I. Kaganov, S. I. Pekar, Yu. Ye. Perlin, A. M. Ratner, M. F. Deygen. Only a few papers dealt with the theory of the crystal lattice: K. B. Tolpygo: "Far-reaching Coulomb forces

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in the dynamics of homeopolar crystals of the diamond type." V. S. Oskotskiy, A. L. Efros: "Theory of crystal lattices having a non-central interatomic interaction." B. Ya. Yurkov: "Theory of the annealing of radiative defects." M. Ya. Dashevskiy, M. S. Mirganovskaya: "The growth and structure of $A^{III}Sb$ monocrystals." The following persons were mentioned: T. I. Kucher and Z. A. Demidenko. The following papers were devoted to the phenomenological theory of semiconductors: I. A Mutrskhulava: "Analysis of local trapping centers by continuous excitation of the semiconductor with light." E. I. Adirovich: "Kinetics of impurity photoconductivity and a new method of determining the effective cross sections of local centers." Yu. V. Gulyayev: "Statistics of electrons and holes in semiconductors showing dislocations." V. M. Fridkin: "Phenomenological theory of the photoelectret state of crystals." G. M. Guro: "Energy structure of a surface layer formed by space charges in semiconductors." Yu. I. Gorkun: "Effect of current electrodes on magnetic resistance." Yu. A. Vdovin, B. M. Grafov, V. A. Myamlin, 7. G. Levich: "Properties of the two-phase boundary electrolyte semiconductor." The theory of semiconducter devices was treated in the following papers: V. M. Val'd-Perlov, A. V. Krasilov, M. Ye. Lisogorskiy and V. L. Aronov: "Parametric diodes. Calculation of parameters." D. A. Aronov,

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P. S. Karageorgiy-Alkalayev: "A possibility to explain the inverse current increase with increasing potential in a semiconductor diode." M. I. Markovich, N. M. Royzin: " Effect of the geometry of the transistor base on its junction characteristics." A. L. Zakharov: "Theoretical analysis of current-potential characteristics of the injection into the blocking layer." Yu. S. Ryabinkin: "Electric field in semiconductors between junctions according to the type of conductivity" and "Effect of the diffusion of carriers on the transfer coefficient of the pin-field transistor." V. A. Chuyenkov was mentioned. The following persons took part in the discussions: Z. S. Gribnikov and V. B. Sandomirskiy. S. I. Pekar noted in his final speech that great success has been achieved in the research of semiconductors. In the participants'name he thanked the members of the organizing committee from Tbilisi which were under the direction of A. I. Gachechiladze (deceased), for the excellent preparation and organization of the conference. A resolution by the conference noted a strong trend toward centralization of investigations on semiconductor theory in Moscow, Leningrad, and Kiyev, and stressed the need of extending this activity to republic capitals and other cities. It was recommended to hold the next conference in Kishinev in 1962. There are 20 references: 14 Soviet-bloc and 6 non-Soviet-bloc.

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24 4400 1158 1395 also 1160 1462

27257
S/020/61/139/005/007/021
B104/B201

AUTHORS: Broude, V. L., Rashba, E. I., and Sheka, Ye. F.

TITLE: Anomalous impurity absorption near exciton bands of molecular crystals

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 139, no. 5, 1961, 1085-1088

TEXT: If, in a molecular crystal, the distance $\mathcal{E}$ of an impurity level from the edge of the exciton band is smaller than, or is of the same order of magnitude of the width M of the exciton band, an absorption of light within the range of the impurity band will lead to the formation of quantum states, in which not only the impurity molecule, but also the adjoining molecule of the solvent will be excited. For $\mathcal{E} \ll M$, the dimensions of the regions in which the excitation is concentrated, are larger than the lattice constant. The structure of the exciton band near its edge displays an influence upon the characteristics of impurity absorption. If, in this case, the impurity molecule does not differ from a molecule of the solvent except by a shift of energy levels,

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impurity absorption will diminish as $\varepsilon^{1/2}$ if an optical transition to the edge of the exciton band with a given polarization of light is forbidden, or will grow as $\varepsilon^{-3/2}$ if such a transition is allowed. Thus, the coefficients of these relations are sharply dependent upon ε, and so are the polarization relations; for $\varepsilon \leq M$, ε itself is a function of the distance 2f between the levels of the molecule of the solvent and the impurity molecules. Thus, the characteristics of impurity absorption permit conclusions to be drawn regarding the structure of exciton bands. Objects suited for these investigations are molecular crystals, in which the molecules of the solvent do not differ from the impurity molecules except by their isotopic composition. Solutions of ordinary naphthalene ($C_{10}H_8$) in octadeuteronaphthalene ($C_{10}D_8$) and in tetradeuteronaphthalene (α-$C_{10}D_4H_4$ and β-$C_{10}D_4H_4$) have been studied. These preparations were supplied to the authors by Professor A. I. Shatenshteyn, and had been prepared in his laboratory at the Institut fizicheskoy khimii im. L. A. Karpova (Institute of Physical Chemistry imeni L. A. Karpov). The naphthalene concentration amounted to some percents. The effects observed are in agreement with those theoretically predicted by E. I. Rashba

27257
S/020/61/139/005/007/021
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Anomalous impurity absorption near ...

(Optika i spektroskopiya, 2, 568 (1957); Dokl. na X soveshch. po spektroskopii, L'vov, iyul' 1956., Fiz. sborn. L'vovsk gos. univ., v. 3, 1, 140, 1957). A close examination of the spectra revealed that whenever an anomaly appeared in the intensity of the impurity bands, also the interval between the impurity absorption bands varied at the same time. It is inferred that the A-component of the Davidov doublet corresponds to a transition to the bottom of the A-band of the crystal. This allows the conclusion to be drawn on the strength of a well-known selection rule that the point $\vec{k} = 0$ lies on the bottom of the A-band, and the effective mass of the exciton in this range is positive. There are 2 figures, 2 tables, and 9 references: 8 Soviet and 1 non-Soviet. The reference to English-language publications reads as follows: D. S. McClure, J. Chem. Phys., 24, 1668 (1954).

ASSOCIATION: Institut fiziki Akademii nauk USSR (Institute of Physics, Academy of Sciences UkrSSR)
Institut poluprovodnikov Akademii nauk USSR (Institute of Semiconductors, Academy of Sciences UkrSSR)

Card 3/4

24.7000

S/181/62/004/004/029/042
B102/B104

AUTHORS: Rashba, E. I., and Gurgenishvili, G. E.

TITLE: On the theory of edge absorption in semiconductors

PERIODICAL: Fizika tverdogo tela, v. 4, no. 4, 1962, 1029-1031

TEXT: Many semiconductors, especially those whose range of intense intrinsic absorption begins with an exciton series, show a series of narrow absorption bands before this range. This series is called the "fore-spectrum". The absorption in this "fore-spectrum", which is $\sim 10^{-3}$-10^{-2} ev distant from the exciton bands, depends considerably on the defects of the semiconductor, its intensity varies within a wide range, but is some orders of magnitude lower than the intensity of the exciton bands. If it is assumed that $f_d \sim f_{ex}$, the calculated defect concentrations are inconsistent with the measured ones. It is now shown that $f_d \gg f_{ex}$ and the anomalously high value of f_d is explained. f_d is the oscillator strength for the absorption in the "fore-spectrum", f_{ex} that of the

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exciton transition. The physical nature of this effect is the same as of the anomaly in impurity absorption in molecule crystals near the exciton bands (Opt. i spektr. 2, 568, 1957; DAN SSSR, 139, 1084, 1961). Under several simplifying assumptions and considering the exciton as a quasiparticle moving as a whole in the field of the defects, $f_d = |c_o|^2 f_{ex}$ if also the frequency difference between exciton band and "fore-spectrum" is neglected. $c_o = 2\sqrt{2\pi/v}\,/\varkappa^{3/2}$, $\varkappa = \sqrt{2m|E|/\hbar}$; v is the unit-cell volume. The resulting relations read $f_d = (E_o/|E|)^{3/2} f_{ex}$, $E_o = \frac{2\hbar^2}{m}\left(\frac{\pi}{v}\right)^{2/3}$. Since E_o is of the order of some ev and $|E|$ of some 10^{-3} ev, f_d exceeds f_{ex} by 4-5 orders of magnitude. Though for the Mott exciton $f_{ex} \ll 1$, f_d can reach $\sim 10^2$-10^3.

ASSOCIATION: Institut poluprovodnikov AN USSR Kiyev (Institute of Semiconductors AS UkrSSR, Kiyev). Institut fiziki AN GSSR Tbilisi (Institute of Physics AS Gruzinskaya SSR, Tbilisi)

SUBMITTED: December 25, 1961

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S/181/62/004/011/037/049
B108/B102

AUTHOR: Rashba, E. I.

TITLE: Theory of impurity absorption near the exciton bands in cases of isotopic substitution

PERIODICAL: Fizika tverdogo tela, v. 4, no. 11, 1962, 3301 - 3320

TEXT: To find out more details of the change in polarization and intensity of the impurity absorption bands in molecular crystals when the impurity levels approach the exciton band of the crystal (Opt. i spektr., 2, 568, 1957), the author studied this effect for the case of isotopic substitution. Particular attention is paid to the long-range interaction. The conductivity of an ideal crystal is

$$\sigma_{ij}(\omega, \mathbf{k}) = \frac{\pi}{\omega} v N \Re \sum_I \mathrm{Res} (\delta^+ \delta^j (E_I, \mathbf{k}) \delta)_{ij} \delta(\hbar\omega_0 + \hbar\omega - E_I). \quad (21)$$

where the I are summed up over all poles of the function $\langle H_\perp^+ (E - H)^{-1} H_\perp \rangle_0$. The Hamiltonian $H_\perp$ is considered to be a perturbation that accounts for

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the basic transverse field of a plane electromagnetic wave passing through the crystal. The above formula is then used for analyzing the impurity absorption with the aid of the Heitler-London model. In the case of isotopic substitution, the position of the impurity absorption bands is fully determined by the density of states in exciton bands with long-range interaction. By estimating the parameters of the theory it is possible to get information on the structure of the exciton bands by comparing the experimental results on impurity absorption with the theory. The results obtained with the Heitler-London model are generalized, yielding the conductivity in the form

$$\delta(\omega)=\frac{\pi\omega}{4h^2}\mathcal{N}\frac{\frac{\partial}{\partial\omega}\varepsilon_2(\omega)}{\frac{1}{N}\sum_{\mathbf{n}}\mathrm{tr}\left[R^I(\hbar\omega,\mathbf{n})\right]^2}\delta(\omega-\omega_I). \qquad (73)$$

where $\mathcal{N}$ is the impurity concentration.

ASSOCIATION: Institut poluprovodnikov AN USSR, Kiyev (Institute of Semiconductors AS UkrSSR, Kiyev)

SUBMITTED: May 17, 1962 (initially)
July 11, 1962 (after revision)

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RASHBA, E. I.; GURGENISHVILI, G. E.

Theory of edge absorption in semiconductors. Fiz. tver. tela 4 no.4:1029-1031 Ap '62. (MIRA 15:10)

1. Institut poluprovodnikov AN UkrSSR, Kiyev i Institut fiziki AN Gruzinskoy SSR, Tbilisi.

(Semiconductors) (Crystallography) (Absorption)

RASHBA, E. I.

E. I. Rashba, "Resonance Phenomenons in Semiconductors."

report submitted for the Conference on Solid State Theory, held in Moscow, December 2-12, 1963, sponsored by the Soviet Academy of Sciences.

S/181/63/005/004/009/047
B102/B186

AUTHOR: Rashba, E. I.

TITLE: Analysis of the exciton band structure on the basis of electron vibrational spectra

PERIODICAL: Fizika tverdogo tela, v. 5, no. 4, 1963, 1040 - 1045

TEXT: The optical spectra are, up to now, the only source of information on the exciton band structure of molecule crystals; thus, the exciton energy may be determined from the multiplet position in the absorption spectrum and the band edges from the anomalous impurity absorption near the exciton bands. The author of the present paper suggests using the spectra that arise on optical transitions between vibrational and exciton bands for determining the exciton band structure in molecule crystals. The method allows of calculating the total width of the exciton energy bands, the position of the critical points ($\vec{k}=0$), the existence of gaps, etc. Additional possibilities as to the exciton kinetics arise when together with the electron-vibrational absorption spectra the luminescence spectra are measured. A theoretical relation between the frequency dependences of luminescence and absorption is derived which is valid when the two spectra

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Analysis of the exciton band...

are in quasiequilibrium; the temperature dependence of the luminescence spectral distribution has to be verified experimentally. If the Heitler-London approximation is applicable in the case of a narrow vibrational band, the state density distribution in the exciton energy spectrum may be directly measured. In this case the spectral distributions of absorption and luminescence are directly related with the dispersion law.

ASSOCIATION: Institut poluprovodnikov AN USSR Kiyev (Institute of Semiconductors AS UkrSSR, Kiyev)

SUBMITTED: October 19, 1962

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RASHBA, E.I.

Possibility of using combined resonance for producing the maser effect. Fiz. tver. tela 6 no.10:3178-3179 O '64.
(MIRA 17:12)

1. Institut poluprovodnikov AN UkrSSR, Kiyev.

RASHBA, E.I.

Characteristics of the penetration of an electric current through an intrinsically anisotropic semiconductor. Fiz. tver. tela 6 no.11:3247-3250 N '64. (MIRA 18:1)

1. Institut poluprovodnikov AN UkrSSR, Kiyev.

PEKAR, S.I.; RASHBA, E.I.

Combined resonance in crystals in inhomogeneous magnetic fields.
Zhur. eksp. i teor. fiz. 47 no.5:1927-1932 N '64.
(MIRA 18:2)

1. Institut poluprovodnikov AN UkrSSR.

L 3342-66 EWT(l)/EWT(m)/EWP(j) IJP(c) RM

ACCESSION NR: AP5017304 UR/0181/65/007/007/2094/2097

37
33
B

AUTHORS: Broude, V. L.; Vlasenko, A. I.; Rashba, E. I.; Sheka, Ye. F.

TITLE: Electron-vibrational luminescence of impurity centers of large radius

SOURCE: Fizika tverdogo tela, v. 7, no. 7, 1965, 2094-2097

TOPIC TAGS: luminescence spectrum, impurity center, impurity level, vibration spectrum, deuterium compound

ABSTRACT: This is a continuation of earlier work (FTT v. 5, 2361, 1963 and preceding papers) on impurity absorption in molecular crystals. In the present investigation the authors studied the spectra of electron-vibrational luminescence from impurity levels lying near the exciton bands. It is shown that in such states, the excitation in the molecular crystals is not localized entirely on the impurity molecule, but encompasses also near-lying host molecules, so that the electron-vibrational luminescence spectrum contains simultaneously bands corresponding to transitions to the vibrational levels of both

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ACCESSION NR: AP5017304

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the impurity molecules and the host. It is shown that the ratio of the intensities of these bands determines directly the square of the amplitude of the excitation of the impurity molecule in the initial state and in addition is closely related with the parameters of the purely electronic absorption spectrum. The excitation amplitudes of the impurity molecules are calculated approximately for $C_{10}H_8$ dissolved in $C_{10}D_8$, β-$C_{10}HD_7$, and β-$C_{10}H_4D_4$, as well as for α-$C_{10}H_7D$ and β-$C_{10}H_7D$ dissolved in $C_{10}D_8$. Orig. art. has: 1 figure, 2 formulas and 1 table.

ASSOCIATION: Institut fiziki AN UkrSSR, Kiev (Institute of Physics AN UkrSSR)

SUBMITTED: 03Feb65 ENCL: 00 SUB CODE: SS, OP

NR REF SOV: 006 OTHER: 002

Card 2/2

L 57550-65 EWT(1)/EWT(m)/EWG(m)/EEC(t)/EWP(t)/EWP(b) Pz-6 IJP(c) RDW/JD/AT

ACCESSION NR: AP5014579 UR/0181/65/007/006/1777/1782

AUTHOR: Zhad'ko, I. P.; Rashba, E. I.; Romanov, V. A.; Stakhira, I. M.; Tovstyuk, K. D.

TITLE: Anistropy of electric and photoelectric properties of In_2Se

SOURCE: Fizika tverdogo tela, v. 7, no. 6, 1965, 1777-1782

TOPIC TAGS: Dember effect, transverse Dember effect, electron mobility, hole mobility, anisotropic semiconductor

ABSTRACT: A theory of the transverse Dember effect was derived on the basis of the difference in the anisotropy of electron and hole mobility in macroscopic anisotropic semiconductors. The theory attributes the emergences of nonequilibrium carriers at the specimen's rear side to the influence of the field of the transverse photoelectromotive force. In_2Se specimens consisting of single crystals 1 to 3 cm^3 in volume were used to detect experimentally the transverse Dember effect. This material was selected because of its structural anisotropy (the lattice of In_2Se is diamond-shaped (D_{2h}) with parameters a = 4.065 Å, b = 12.24 Å, c = 15.23 Å) and its photosensitivity. The type of conductivity of the specimens was determined from the sign of the thermal emf and the Hall effect, and from the sign of photo

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L 57550-65
ACCESSION NR: AP5014579

emf during illumination of a point tungsten probe. Investigations were made of electron-type specimens with $\rho \sim 10^{-1}$ and $\rho \sim 10^{3}$ ohm·cm and hole-type specimens with $\rho \sim 10^{3}$ ohm·cm. The electron mobility in low ohmic electron-type In_2Se specimens at room temperature was of the order of 500 $cm^2/v \cdot sec$. The hole mobility at room temperature was smaller by at least one order. During illumination of a plate cut out at a 45° angle to the a-axis and containing a b-axis (light beam intensity $\sim 3 \times 10^{15}$ quanta/sec) a photo emf of several millivolts was observed in the direction perpendicular to axis b. A photo emf of the same order was also observed on specimens cut out at a 45° angle to the a-axis but containing a c-axis. No photo emf was observed during the illumination of faces perpendicular to the b-axis. The measured characteristic times for photoconductivity and transverse photo emf coincided and for various n- and p-type specimens were $\tau = 0.1—0.4$ μsec. Thus, at such small τ the contribution to the transverse effect by anisotropic thermal emf caused by the heating of specimens is negligible. Orig. art. has: 13 formulas and 2 figures. [JA]

ASSOCIATION: Institut poluprovodnikov AN UkrSSR, Kiev (Institute of Semiconductors, AN UkrSSR)

SUBMITTED: 08Jan65 ENCL: 00 SUB CODE: SS,EM
NO REF SOV: 004 OTHER: 003 ATD PRESS: 4037

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L 2205-66 EWT(l)/EWT(m)/T/EWP(t)/EWP(b)/EWA(h) IJP(c) JD/AT

ACCESSION NR: AP5017335 UR/0181/65/007/007/2239/2242

AUTHOR: Boyko, I. I.; Zhad'ko, I. P.; Rashba, E. I.; Romanov, V. A.

TITLE: Occurrence of non-equilibrium carriers when current passes through elastically deformed germanium

SOURCE: Fizika tverdogo tela, v. 7, no. 7, 1965, 2239-2242

TOPIC TAGS: germanium, semiconductor carrier, elastic deformation

ABSTRACT: This is a continuation of earlier work (FTT v. 6, 3247, 1964), where it was shown that under certain conditions current flowing through homogeneous organic crystals with anisotropic electric conductivity can give rise to non-equilibrium carriers and to a nonlinear volt-ampere characteristic. The present investigation was devoted to an experimental observation of this effect. The relation between the field intensity and the current density is derived theoretically for this case. The experiments, performed on high-resistivity germanium (40 Ω-cm at 300K), in which the anisotropy was produced by homogeneous compression, resulted in characteristics which were very similar to those derived theoretically. "The authors thank V. Ye. Lashkarev, G. Ye. Pikus, and M. K. Sheynkman for a discussion and V. V. Pakhomov for participating in the calculations." Orig. art. has: 2 figures and 3 formulas.

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L 2205-66

ACCESSION NR: AP5017335

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ASSOCIATION: Institut poluprovodnikov AN UkrSSR, Kiev (Institute of Semiconductors, AN UkrSSR)

SUBMITTED: 22Feb65 ENCL: 00 SUB CODE: SS

NR REF SOV: 002 OTHER: 000

Card 2/2 DP

RASHBA, E.I., BOYKO, I.I.

Kinetics of conductivity electrons in a variable electric field. (MIRA 18:4)
Ukr. fiz. zhur. 10 no.1:113-114 Ja '65.

1. Institut poluprovodnikov AN UkrSSR, Kiyev.

L 16107-65 EWT(l)/EEC(t) Peb IJP(c)/RAEM(i)/ESD(t)/ESD(gs)/SSD/AFWL/ ASD(a)-5/AFETR GG

ACCESSION NR: AP5000352 S/0056/64/047/005/1927/1932

AUTHOR: Pekar, S. I.; Rashba, E. I.

TITLE: Combined resonance in crystals in inhomogeneous magnetic fields

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 47, no. 5, 1964, 1927-1932

TOPIC TAGS: combined resonance, paramagnetic resonance, semiconductor, crystal combined resonance, crystal paramagnetic resonance, ferromagnetic admixture, antiferromagnetic admixture

ABSTRACT: A new type of combined resonance which takes place in semiconductors in inhomogeneous static magnetic fields is described and analyzed. Specifically, spin transitions of current carriers caused by the electric field of electromagnetic waves were studied in this connection. Mixing of movements in coordinate and spin degrees of freedom in such cases is not due to spin-orbit coupling, but to inhomogeneity of the static magnetic field. This inhomogeneity may be inherent in the field, or stem from spontaneous fields of ferro- or

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ACCESSION NR: AP5000352

antiferromagnetics, or from magnetic admixtures in the substance of the semiconductor. The combined resonance was studied under conditions of inherent inhomogeneity and in the spontaneous field of ferro- and antiferromagnetics. The analysis shows that in both these cases the combined resonance coinciding in frequency with the paramagnetic resonance can be considerably more intense than the latter, reaching a ratio of 10^2 to 10^3 over the paramagnetic resonance in the case of inherent inhomogeneity, and a ratio of the order of 10^6 in the spontaneous fields of ferro- and antiferromagnetics. Thus, the paramagnetic resonance can be screened out by the combined resonance. Combined resonance due to inherent inhomogeneity of the magnetic field can develop not only in intraband current carriers but also in local electron centers. Orig. art. has: 9 formulas.

ASSOCIATION: Institut poluprovodnikov Akademii nauk Ukrainskoy SSR. (Institute of Semiconductors, Academy of Sciences, UkrSSR)

SUBMITTED: 21May64 ENCL: 00 SUB CODE: SS, EM

NO REF SOV: 004 OTHER: 005 ATD PRESS: 3146

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L 61062-65 EWA(h)/EWT(1)/T Pz-6/Peb IJP(c) AT

ACCESSION NR: AP5013902 UR/0056/65/048/005/1427/1432

17
16
B

AUTHOR: Rashba, E. I.

TITLE: Redistribution of carriers among the valleys in an electric field

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 48, no. 5, 1965, 1427-1432

TOPIC TAGS: many valley semiconductor, carrier distribution, intevalley redistribution, conductivity anisotropy

ABSTRACT: The article considers the characteristics of the electron conductivity of bounded semiconductor samples cut from a many-valley semiconductor such as n-type Ge, in which the conductivity characteristics are affected by the intervalley redistribution of the carriers in the surface region. Factors governing the magnitude of this effect are also considered. It is shown in particular that weakly damped oscillations, accompanied by leakage of electrons between valleys, may propagate in such semiconductors when certain relationships exist between the electric field and the free transit time. At low temperatures, when the mean free path of the carriers associated with the intervalley scattering is sufficiently long, the conditions for the continuity of the electron current in each of the valleys lead to a strong departure from the equilibrium electron distribution among the valleys

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ACCESSION NR: AP5013902

in the surface layer; this makes some valleys considerably enriched with electrons and the others depleted. When the free transit time associated with the intervalley scattering is ~ 10^{-9} sec, considerable redistribution of the carriers takes place in fields on the order of several V/cm, and at depths up to ~ 10 μ. This results in anisotropy of the conductivity. Orig. art. has: 17 formulas.

ASSOCIATION: Institut poluprovodnikov Akademii nauk UkrSSR (Institute of Semiconductors, Academy of Sciences UkrSSR)

SUBMITTED: 04Dec64 ENCL: 00 SUB CODE: SS, EM

NR REF SOV: 002 OTHER: 001

Card 2/2

ZHAD'KO, I.P.; KASHBA, E.I.; ROMANOV, V.A.; STAKHIRA, I.M.; TOVSTYUK, K.D.

Anisotropy of the electric and photoelectric properties of In_2Se. Fiz. tver. tela 7 no.6:1777-1782 Je '65. (MIRA 18:6)

1. Institut poluprovodnikov, AN UkrSSR, Kiyev.

L 27749-66 EWT(1)/T IJP(c) GG

ACC NR: AF6018699 SOURCE CODE: UR/0386/66/003/011/0429/0434

AUTHOR: Eroude, V. L.; Rashba, E. I.; Sheka, Ye. F. 48 B

ORG: Institute of Physics, Academy of Sciences Ukrainian SSR (Institut fiziki Akademii nauk Ukrainskoy SSR)

TITLE: Collective effects in vibron spectra of molecular crystals

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki. Pis'ma v redaktsiyu. Prilozheniye, v. 3, no. 11, 1966, 429-434

TOPIC TAGS: light absorption, absorption spectrum, electron transition, naphthalene, paraffin wax, deuterium, vibration spectrum, particle interaction, exciton

ABSTRACT: To check on a hypothesis recently advanced by one of the authors (Rashba, ZhETF v. 50, 1164, 1966) that two-particle absorption plays an important role in the interpretation of electron-vibrational (vibron) transitions in the absorption spectra of molecular crystals, the authors measured the absorption spectra of pure and deuterated naphthalene and paraffin in the region of the first vibron transition and confirmed the presence of a two-particle band in the spectrum which is shifted to the long-wave side relative to the maximum of the state density of the pure-electronic exciton band. The experiments also disclosed the presence of two additional vibron bands corresponding to vibrational excitation at the impurity molecule and in its vicinity. These agree well with Rashba's hypothesis and confirm the strong influence of collective effects (decay processes) on the vibron spectrum and

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ACC NR: AP6018699

the presence in this spectrum of two branches corresponding to single- and two-particle absorption. The latter is estimated to reach 50% of the total vibron transition. It is proposed that the two-particle absorption can play an important role in the interpretation of the known structure background of the absorption of molecular crystals and the determination, from this interpretation, of many new parameters of exciton bands. Orig. art. has: 2 figures.

SUB CODE: 20/ SUBM DATE: 30Mar66/ ORIG REF: 010/ OTH REF: 001

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L 36386-66 EWT(1)/T IJP(c) GG/AT/WW

ACC NR: AP6014047 SOURCE CODE: UR/0056/66/050/004/1064/1080

69
B

AUTHOR Rashba, E. I.

ORG: Institute of Semiconductors, AN UkrSSR (Institut poluprovodnikov Akademii nauk Ukrainskoy SSR)

TITLE: Theory of electron-vibration spectra of molecular crystals

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 50, no. 4, 1966,

TOPIC TAGS: molecular crystal, electron vibration, electron spectrum, phonon interaction, light absorption, excitation energy, absorption band, vibration, phonon, exciton

ABSTRACT: A theory of electron-vibration-light-absorption spectra of molecular crystals corresponding to the simultaneous appearance of electron and intramolecular vibrational excitations has been developed. The basic exciton-phonon interaction mechanism is assumed to be the change $\Delta\nu$ of vibration frequencies during excitation of the molecule. For values of $\Delta\nu$, which are not too small in the energy spectrum of the crystal, it was found that along with two particle excitations, a region of single particle excitations arises throughout the k-space or in part of it. Equations for the position and intensity of absorption bands related to single particle excitations as functions of the structure of the exciton and phonon bands and exciton and phonon coupling constants were obtained. The physical mechanisms which primarily

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L 06135-67 EWT(1) IJP(c) AT

ACC NR: AP6026712 SOURCE CODE: UR/0181/66/008/008/2479/2481

AUTHOR: Gribnikov, Z. S.; Kocholap, V. A.; Rashba, E. I.

ORG: Institute of Semiconductors, AN UkrSSR, Kiev (Institut poluprovodnikov AN UkrSSR)

TITLE: Domain structure of a multitrough semiconductor during passage of strong currents

SOURCE: Fizika tverdogo tela, v. 8, no. 8, 1966, 2479-2481

TOPIC TAGS: semiconductor band structure, semiconductor carrier

ABSTRACT: Many semiconductors and semimetals have a multitrough band structure, and because of the anisotropy of the electric conductivity in each of the troughs, fluxes of electrons belonging to various troughs are oriented at an angle to the total current. If the intertrough relaxation time τ considerably exceeds the intratrough relaxation time, the spatial distribution of the carriers can be determined from a system of associated diffusion equations in which the scattering between troughs α and β is described by terms of the type $(n_\alpha - n_\beta)/\tau_{\alpha\beta}$. Under these conditions, an essential part is played by the characteristic length $L = \sqrt{D\tau}$. The characteristic field is $E_L = \epsilon/eL$, where $\epsilon = kT$ and ϵ_F respectively for a nondegenerate and a degenerate gas. Analysis of the limiting case where $E \gg E_L$ is given. An infinite plate of a monopolar semiconductor with thickness 2d ($-d \leq y \leq d$) is considered to which an electric field E is applied in direction Ox. The boundary conditions for electron fluxes of each of

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ACC NR: AP6026712

the troughs are written down by introducing surface velocities of intertrough scattering $s_{\alpha\beta}$. The case where 2d is considerably smaller than the drift length $L_E = LE/E_L$ is analyzed by means of diffusion equations with $E \gg E_L$. The case where $2d \gg L_E$ is also analyzed. A characteristic feature of almost all the cases considered is the appearance inside the plate at $E \to \infty$ of singular points (domain boundaries) at which the electron concentrations and the electric fields are different; the position of these points is determined by the conditions of the generation-recombination balance. Orig. art. has: 1 figure and 2 formulas.

SUB CODE: 20/ SUBM DATE: 07Feb66/ ORIG REF: 003

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L 08176-67

ACC NR: AP6024888

fects which appear in many-valley unipolar semiconductors in strong electric fields and give rise to the splitting of plates into domains are: nonlinearity of the volt-ampere characteristic, the appearance of a transverse electric field, a considerable rise in the transverse resistivity, rectification of the current in the case of unequal scattering rates and unequal slopes of the valleys, anisotropy of the conductivity, and partial or complete deletion of some electron valleys. Each domain contains as a rule only the electrons that belong to one valley, their number being such as to ensure electric neutrality. The number of domains is equal to or less than the number of valleys; if there are fewer domains than valleys, the electrons not included in the domains are always concentrated in a thin layer next to one of the surfaces of the plate and the surface electron density is greater than the equilibrium value. The sequential order of the domains is governed by the angles that the principal axes of the electric conductivity tnesors, corresponding to the different valleys, make with the surface of the plate. The number of domains and the positions of their boundaries depend on the ratio of the intervalley scattering rates in the interior and on the surface of the plate. The extent to which the simplifying assumptions made are satisfied is discussed. It is suggested in conclusion that the splitting of semiconductors into domains may cause other effects not considered in the paper, as well as appreciable changes in the galvanomagnetic properties. Orig. art. has: 6 figures, 64 formulas, and 2 tables.

SUB CODE: 20/ SUBM DATE: 31Jan66/ ORIG REF: 004/ OTH REF: 007

Card 2/2 nst

ACC NR: AP7003896 SOURCE CODE: GE/0030/67/019/001/0395/0406

AUTHOR: Broude, V. L.; Rashba, E. I.; Sheka, E. F.

ORG: Institute of Physics, Academy of Sciences of the Ukrainian SSR, Kiev

TITLE: A new approach to the vibronic spectra of molecular crystals

SOURCE: Physica status solidi, v. 19, no. 1, 1967, 395-406

TOPIC TAGS: crystal absorption spectrum, exciton, naphthalene, molecular crystal, Coulomb excitation, absorption band

ABSTRACT:
Crystal absorption spectra are considered in the light of a recently developed theory which assumes the presence of interactions between the vibrational, electronic, and vibrational-electronic (vibronic) excitations, in particular a decay of vibronic intramolecular excitations into pure electronic and intramolecular-vibrational excitations of separate molecules [E. I. Rashba, Zh. E. T. F., v. 50, 1966, 1064—1080, transl. Soviet Physics JETP, v. 23, 708—718].. These interactions affect the distribution of one-particle excitations (concurrent propagation of an exciton and a phonon) and two-particle excitations (independent propagation of the exciton and photon). These collective processes are illustrated by means of simplified models. Their influence on absorption spectra is investigated, the most important effect being regarded as a reduction of the vibrational frequency of the molecule

Card 1/2

BUNIN, K.V., prof.; RASHBA, N.I.

Clinical aspects of botulism. Sov.med. 26 no.8:80-84 Ag '62.
(MIRA 15:10)

1. Iz 7-y Moskovskoy gorodskoy bol'nitsy (glavnyy vrach N.G. Zaleskver; nauchnyy rukovoditel' - prof. K.V.Bunin).
(BOTULISM)

BARTOSHEVICH, Ye.N.; RASHBA, N.I.

Observations on the clinical aspects and treatment of lambiasis in adult patients in Alma-Ata. Trudy Inst.kraev.pat. AN Kazakh.SSR 1:10-22 '52. (MLRA 10:2)

(ALMA-ATA—LAMBLIASIS)

RASHBA, O.Ya.

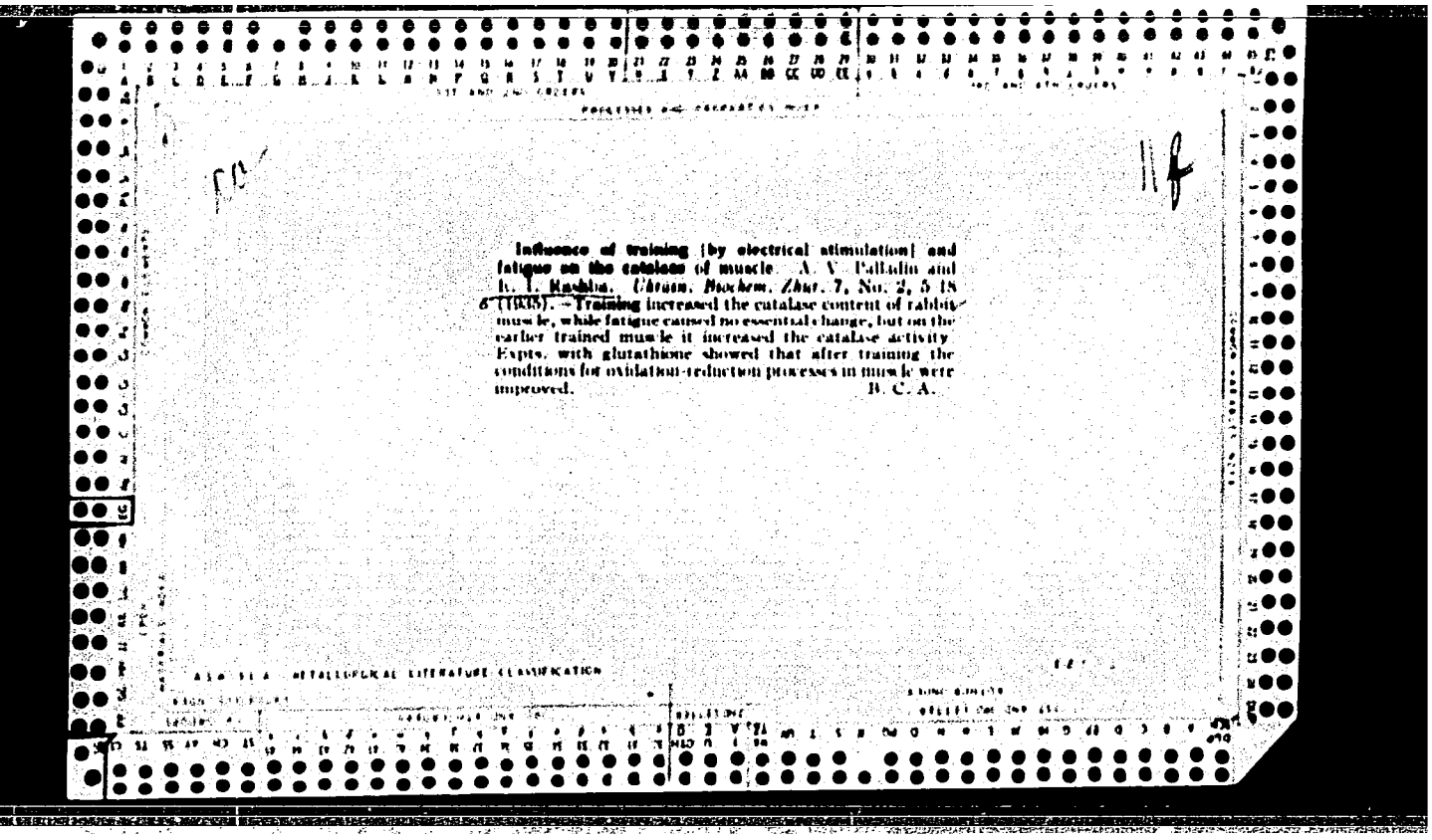
Liquefaction of starch by the amylase of the brain. Ukr.biokhim. zhur. 23 no.4:453-464 '51. (MLRA 9:9)

1. Institut biokhimii Akademii nauk URSR, Kiiv.
(STARCH) (AMYLASE)

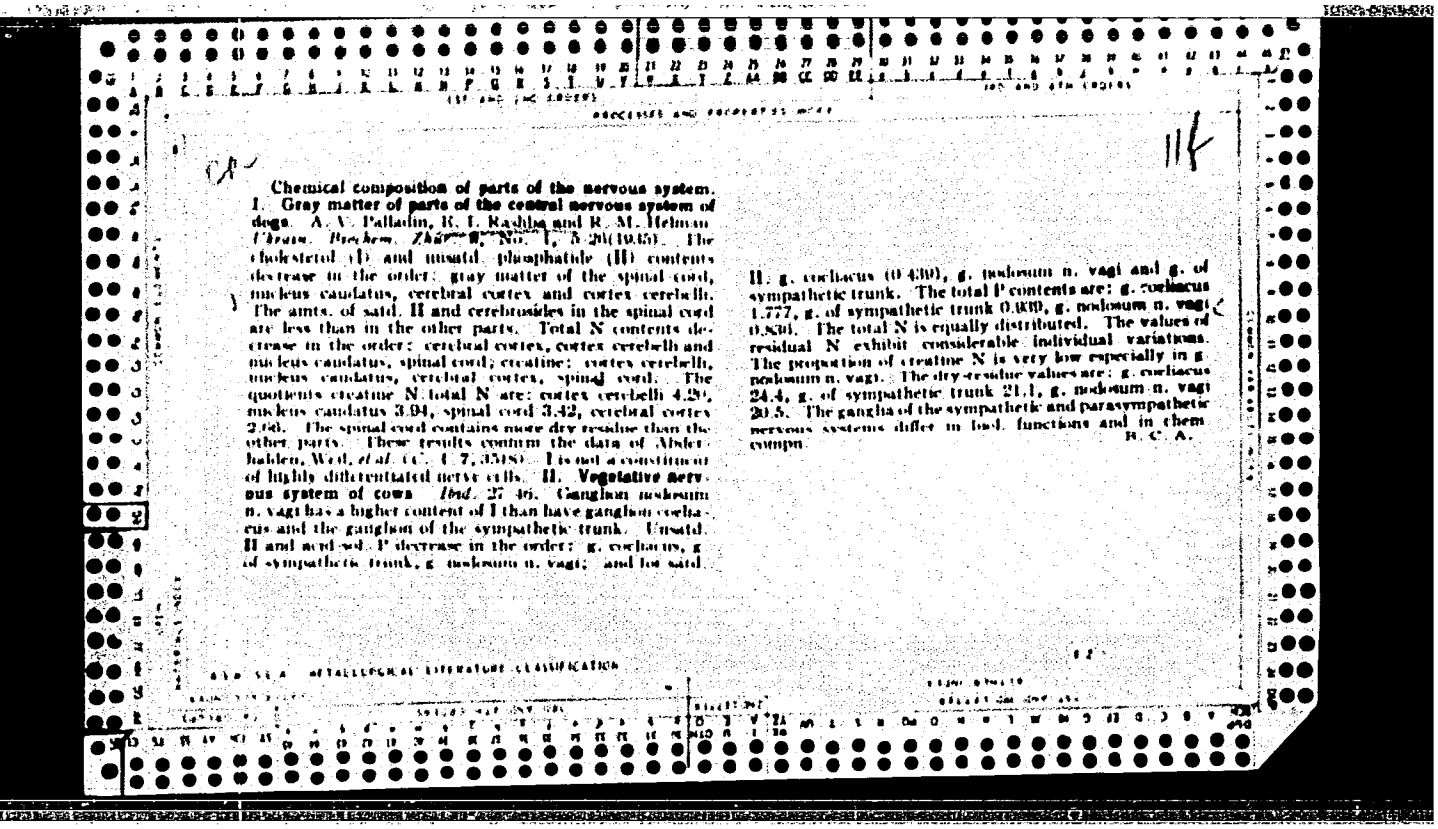
RASHEA, O.Ya.

Methods for the isolation of desoxyribonucleic acid from Bacterium Breslau. Mikrobiol.zhur. 18 no.1:47-51 '56. (MLRA 9:7)

1. Z Institutu mikrobiologii Akademii nauk URSR.
(DESOXYRIBONUCLEIC ACID)

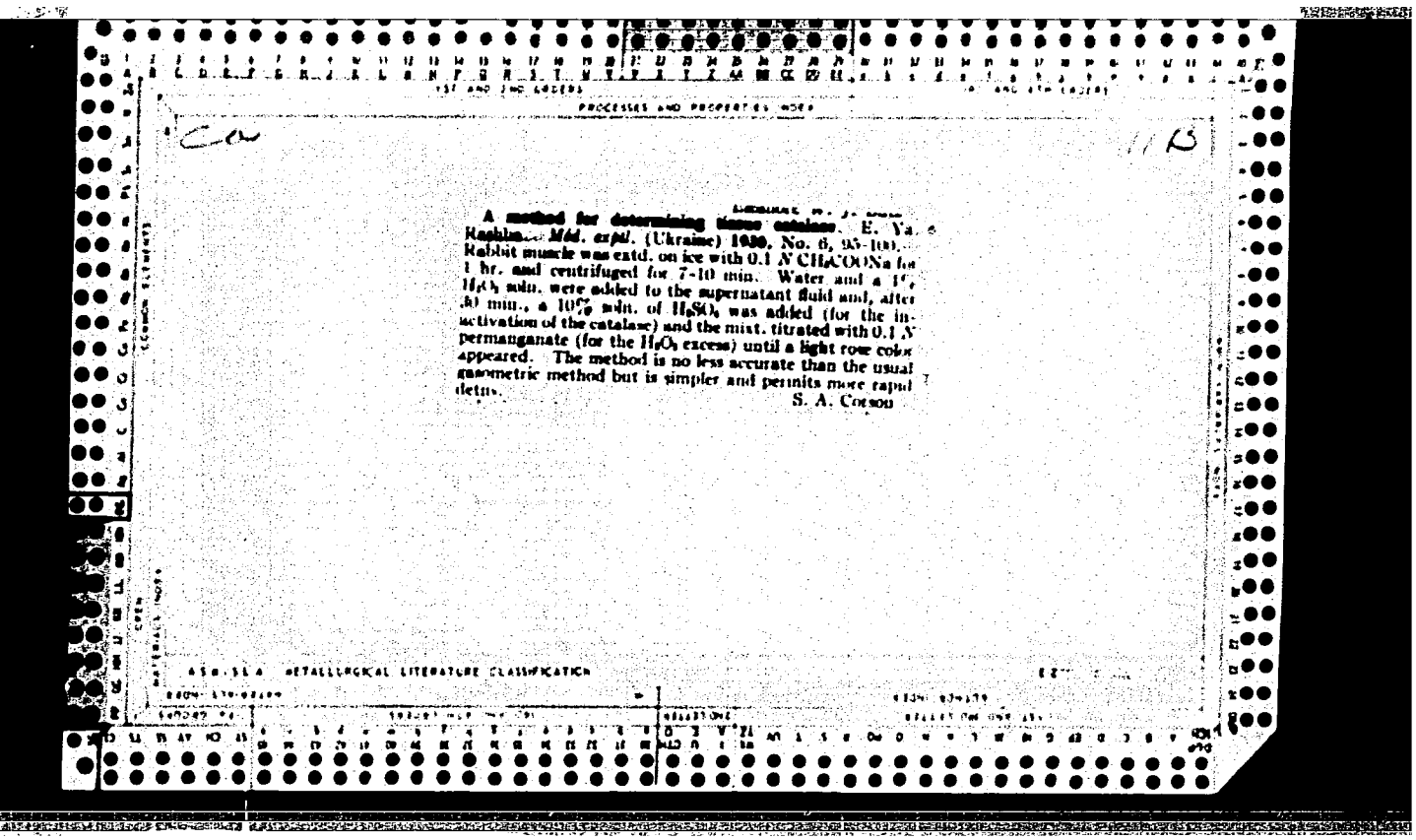


Influence of training [by electrical stimulation] **and fatigue on the catalase of muscle.** A. V. Palladin and L. T. Rashba. *Ukrain. Biochem. Zhur.* 7, No. 2, 5-18 (1935). — **Training** increased the catalase content of rabbit muscle, while fatigue caused no essential change, but on the earlier trained muscle it increased the catalase activity. Expts. with glutathione showed that after training the conditions for oxidation-reduction processes in muscle were improved. B. C. A.



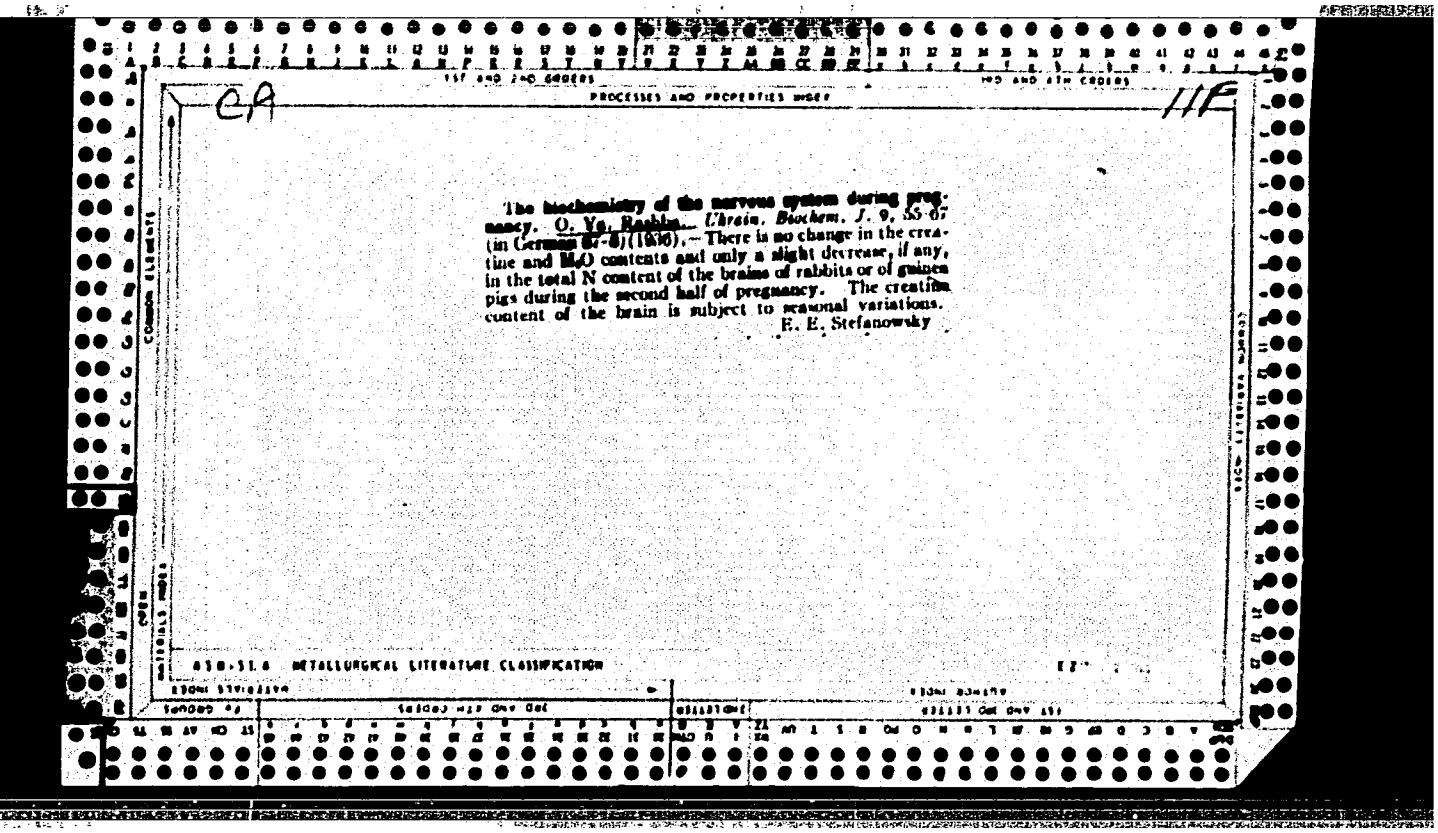
Chemical composition of parts of the nervous system. I. Gray matter of parts of the central nervous system of dogs. A. V. Palladin, R. I. Radilu and R. M. Helman. *Ukrain. Biochem. Zhur.* 8, No. 1, 5-20(1935). The cholesterol (I) and unsatd. phosphatide (II) contents decrease in the order: gray matter of the spinal cord, nucleus caudatus, cerebral cortex and cortex cerebelli. The amts. of satd. II and cerebrosides in the spinal cord are less than in the other parts. Total N contents decrease in the order: cerebral cortex, cortex cerebelli and nucleus caudatus, spinal cord; creatine: cortex cerebelli, nucleus caudatus, cerebral cortex, spinal cord. The quotients creatine N/total N are: cortex cerebelli 4.2%, nucleus caudatus 3.9%, spinal cord 3.42, cerebral cortex 2.6%. The spinal cord contains more dry residue than the other parts. These results confirm the data of Abderhalden, Weil, *et al.* (C. 7, 3518). It is not a constituent of highly differentiated nerve cells. **II. Vegetative nervous system of cows.** *Ibid.* 27-46. Ganglion nodosum n. vagi has a higher content of I than have ganglion coeliacus and the ganglion of the sympathetic trunk. Unsatd. II and acid-sol. P decrease in the order: g. coeliacus, g. of sympathetic trunk, g. nodosum n. vagi; and lie satd. II: g. coeliacus (0.430), g. nodosum n. vagi and g. of sympathetic trunk. The total P contents are: g. coeliacus 1.777, g. of sympathetic trunk 0.639, g. nodosum n. vagi 0.830. The total N is equally distributed. The values of residual N exhibit considerable individual variations. The proportion of creatine N is very low especially in g. nodosum n. vagi. The dry-residue values are: g. coeliacus 24.4, g. of sympathetic trunk 21.1, g. nodosum n. vagi 20.5. The ganglia of the sympathetic and parasympathetic nervous systems differ in bad. functions and in chem. compn.

B. C. A.



A method for determining tissue catalase. E. Ya. Rashkin. *Méd. expl.* (Ukraine) 1930, No. 6, 93-101. Rabbit muscle was extd. on ice with 0.1 *N* CH_3COONa for 1 hr. and centrifuged for 7-10 min. Water and a 1% H_2O_2 soln. were added to the supernatant fluid and, after 30 min., a 10% soln. of H_2SO_4 was added (for the inactivation of the catalase) and the mixt. titrated with 0.1 *N* permanganate (for the H_2O_2 excess) until a light rose color appeared. The method is no less accurate than the usual gasometric method but is simpler and permits more rapid detn.

S. A. Corson



PROCESSES AND PROPERTIES INDEX

CA

IIF

The biochemistry of the nervous system during pregnancy. O. Ya. Rashba. *Ukrain. Biochem. J.* 9, 55-67 (in German 67-8) (1936). — There is no change in the creatine and H_2O contents and only a slight decrease, if any, in the total N content of the brains of rabbits or of guinea pigs during the second half of pregnancy. The creatine content of the brain is subject to seasonal variations.
E. E. Stefanowsky

669.51.6 METALLURGICAL LITERATURE CLASSIFICATION