51-4-4/25

AUTHOR: Agranovich, V.M.

TITLE: On the effect of the solvent on the optical activity of molecules of the dissolved substance. (O vliyanii rastvoritelya na opticheskuyu aktivnost' molekul rastvorennogo veshchestva.)

PERIODICAL: "Optika i Spektroskopiya" (Optics and Spectroscopy) 1957, Vol.2, No.4, pp.426-432 (U.S.S.R.)

ABSTRACT: Theoretical paper. It is assumed that the solute molecules do not form covalent bonds with those of the solvent. The solvent is taken to be non-active and transparent in that region of frequencies where the solute absorbs light. S.I.Pekar's method (Zh.Eksper. i Teor.Fiz.,Vol.22,641,1952) of adiabatic approximation is employed. Nuclei of the solvent molecules are regarded as a "slowly moving" subsystem which executes small oscillations about certain equilibrium positions. The valence electrons of the solute molecule are regarded as a "rapidly moving" subsystem. It is assumed that the electron states follow adiabatically the comparatively slow motion of the solvent nuclei. Perturbation theory is used to obtain the energy state of the solution. Only the average effect of the solvent on the solute molecule is taken into account. This is permissible for those molecules which are only slightly deformed on interaction with the solute. Interaction of an electromagnetic wave with the

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On the effect of the solvent on the optical activity of molecules of the dissolved substance. (Cont.)

solution is then considered. The interaction operator is regarded as a small perturbation of the solution which causes a transition of the solution from its ground state (defined as the state in which a solute molecule is in its lowest energy level) to an excited state (a solute molecule is now in its first excited level). Average values of the dipole electric and magnetic moments induced by light are obtained. From these values polarizability can be found. Finally, θ the angle of rotation of the plane of polarization per unit length of light beam in solution is found to be

$$\theta = \frac{8\pi^2 N_1}{3} \cdot \frac{n^2 + 2}{\lambda_0} \omega \, \mathrm{Re} \, \beta$$

where n = refractive index of the solution, λ_0 = wave-length of light in vacuo, N_1 = number of molecules per unit volume, ω = frequency, $\mathrm{Re}\,\beta$ = real part of β ("gyration"). Away from the solute absorption band the dispersion of θ is given by the curve for an isolated solute molecule with its

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51-4-4/25

On the effect of the solvent on the optical activity of molecules of the dissolved substance. (Cont.)

natural frequency displaced. In the solute absorption band the dispersion of θ is asymmetric with expoential fall at its limits and it strongly depends on temperature. There are one figure and seven references, all Slavic.

SUBMITTED: August 20, 1956.

AVAILABLE: Library of Congress

Card 3/3

51-6-8/26

AUTHOR:	Agranovich, V. M.
TITLE:	A Theory of Natural Optical Activity of Molecular Crystals. (Teoriya yestestvennoy opticheskoy aktivnosti molekulyarnykh kristallov.) 2. Quantum Theory. (2. Kvantovaya teoriya.)
PERIODICAL:	Optika i Spektroskopiya, 1957, Vol.II, Nr.6, pp. 738-746. (USSR)
ABSTRACT:	This mathematical paper is a sequel to Part 1 (Ref.1) which dealt with classical calculations of the optical activity of molecular crystals. The author studies the interaction of a plane electromagnetic wave with a crystal. He deduces general formulae for specific rotation and its dispersion. He also discusses summation rules. There is a mathematical appendix and 11 references, 6 of which are Slavic.
SUBMITTED:	November 22, 1956.
AVAILABLE:	Library of Congress.

Card 1/1

51-1-6/18

AUTHOR: Agranovich, V. M.

TITLE: On the Concentration Dependence of the Quantum Yield of Luminescence of Solid Organic Phosphors with Admixtures. (O kontsentratsionnoy zavisimosti kvantovogo vykhoda lyuminestsentsii tverdykh organicheskikh lyuminoforov s primesyami).

PERIODICAL: Optika i Spektroskopiya, 1957, Vol.III, Nr.1, pp.29-37. (USSR)

ABSTRACT: There are two theories of the luminescence mechanism in mixed organic phosphors, such as anthracene in naphthalene or anthracene in polystyrene. Birks (Ref.5) suggested radiative mechanism with luminescence of the admixture being due to absorption of luminescence of the basic substance. A radiationless mechanism was suggested by others, with transfer of energy achieved by resonance interaction between excited molecules of the basic substance and molecules of the admixture. This paper is an attempt to elucidate theoretically the role of both these mechanisms at various admixture concentrations. The total quantum yield (Eq.22) is obtained as the sum of two quantum yields due to the two mechanisms of

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51-1-5/18

On the Concentration Dependence of the Quantum Yield of Luminescence of Solid Organic Phosphors with Admixtures.

luminescence. It was found that as concentration of admixture is increased the quantum yield due to radiative mechanism J^{II}_{I} begins to fall while the quantum yield due to the radiationless mechanism J^{I}_{I} continues to increase until saturation is reached. This supports the conclusion reached in Refs. 6-8 that Birks' mechanism holds only for low admixture concentrations. At very high admixture concentrations a concentration quenching effect occurs and the total quantum yield begins to decrease. There is 1 figure and 13 references, 6 of which are Slavic.

SUBMITTED: December 6, 1956.

AVAILABLE:

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AGRANOVICH, V.M.

RUBACH, O.M. (Kiiv); AGRANOVICH, V.M. (Kiiv)

Stressed state of circular plates stiffened by radial ribs [with summary in English]. Prykl. mekh. 3 no.1:38-50 '57. (MLRA 10:5)

1. Institut budivel'noi mekhaniki AN URSR.
(Elastic plates and shells)

51-1-14/18

AUTHOR: Agranovich, V. M.

TITLE: On the Effect of Re-absorption on the Duration of Fluorescence of Molecular Crystals. (K voprosu o vliyanii reabsorbtsii na dlitel'nost' fluorestsentsii molekulyarnykh kristallov.)

PERIODICAL: Optika i Spektroskopiya, 1957, Vol.III, Nr.1, pp.84-87. (USSR)

ABSTRACT: A phenomenological exciton theory of molecular crystals (Refs.1, 2) gives the relationship between the duration of fluorescence, coefficient of re-absorption, length of diffusion displacement of exciton and absorption coefficient of the incident light. For many molecular crystals it is possible to regard fluorescence transitions as occurring from exciton bands which correspond to the lowest level of excitation in an isolated molecule. To determine fluorescence yield it is therefore sufficient to know exciton density in the energy bands which correspond to the lowest levels of excitation. The number of such bands is equal to the number of molecules in a unit cell. The width of such bands is about 0.05 eV. Bands can, in general, overlap. If they do not overlap, the width

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On the Effect of Re-absorption on the Duration of Fluorescence of Molecular Crystals.

of forbidden intervals between the bands is about 0.01 eV. At room temperature thermal motion causes blurring and diffusion of such bands. As a result an electron-vibration-rotation band is formed in place of the exciton bands. By a purely mathematical argument the author finds the quantum yield Q for this particular case (Eq.16). To determine Q it is necessary to measure duration (lifetime) of fluorescence at very large and at very small values of the coefficient of absorption of the exciting light, and to obtain the relative distribution of fluorescence in thin crystals, where re-absorption of light can be neglected. There are 4 references, all of which are Slavic.

SUBMITTED: January 9, 1957.

AVAILABLE:

Card 2/2

AGRANOVICH, V.M.

[redacted]

AUTHOR	AGRANOVICH, V.M., DAVYDOV, A.S.
TITLE	Optical Model of Interaction between Nucleons and Nuclei in the Resonance Region of the Compound Nucleus. (Opticheskaya model' vzaimodeystviya nuklonov s yadrami v oblasti rezonansov sostavnogo yadra.- Russian)
PERIODICAL	Zhurnal Eksperim. i Teoret. Fiziki 1957, Vol 32, Nr 6, pp 1429-1436 (U.S.S.R.)
ABSTRACT	The energy dependence of the real part and the imaginary part of the effective potential is investigated here by taking account of all components of the compound nucleus. For the purpose of not complicating the problem by taking account of COULOMB'S interaction, the authors here investigate only the interaction between one neutron and one nucleon. The dependence of the real part of the optical potential upon energy: At first the formula for the real part of this potential is given. Next, the authors determine the energy dependence of the relative motion of the mean value of the real part of the optical potential. The authors are interested here in the domain of energies which correspond to the resonances of the cross sections of the nuclear reactions. At energies of the relative motion $\mathcal{E} >$ 30 MeV

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[redacted]

Optical Model of Interaction between Nucleons and Nuclei in the Resonance Region of the Compound Nucleus.

56-6-20/56

ASSOCIATION: not given.
PRESENTED BY: -
SUBMITTED: 17.8. 1956
AVAILABLE: Library of Congress.

CARD 3/3

AGRANOVICH, V. M.

p.L.

PHASE I BOOK EXPLOITATION SOV/3898
SOV/31-M-14

Akademiya nauk UkrSSR. Institut teploenergetiki

Teploobmen i gidrodinamika (Heat Transfer and Hydrodynamics) Kiyev, 1958. 190 p. (Series: Its: Sbornik trudov, no. 14) 2,000 copies printed.

Eds. of Publishing House: Ya.L. Kaplan and N.M. Labinova; Tech. Ed.: M.I. Yefimova; Editorial Board: I.T. Shvets (Resp. Ed.), Academician, Academy of Sciences UkrSSR; G.M. Shchegolev (Deputy Resp. Ed.), Candidate of Technical Sciences; N.M. Kondak (Resp. Secretary), Candidate of Technical Sciences; V.I. Tolubinskiy, Corresponding Member, Academy of Sciences UkrSSR; I.I. Chernobyl'skiy, Doctor of Technical Sciences; M.M. Nazarchuk, Candidate of Technical Sciences; P.I. Lavrov, Candidate of Technical Sciences; P.D. Shvetsov, Professor; and N.M. Pyatyshkin, Candidate of Technical Sciences.

PURPOSE: This collection of articles is intended for scientific workers and technical personnel in the fields of heat transfer and hydrodynamics.

COVERAGE: This collection of 18 articles deals with experimental and theoretical studies of problems in heat transfer and hydrodynamics as they affect steam and gas turbines and heat-transfer devices. The results of theoretical investigations of heat transfer in turbine components and in elements of heat-utilizing apparatus are described, and new calculation methods are suggested. Several problems of the thermodynamics and aerodynamics of steam and gas turbines are discussed. References follow each article.

TABLE OF CONTENTS:

On the basis of a theoretical analysis of the system of equations describing the temperature field of a bladed rotor, the authors present a method for taking into account the thermal resistance of the blade stems. This method may be used for calculations of steady-state heat conditions as well as unsteady-state conditions.

The authors present a simplified method for approximating the temperature fields and stresses in a drum-type turbine rotor. The method does not take axial variation of temperature into account but considers each section of the rotor as part of an infinitely long hollow cylinder with boundary conditions corresponding to those for the particular section under consideration. Results calculated by the approximate method are compared with those determined by more accurate calculations. An analysis of the discrepancies leads to the conclusion that the simplified method is sufficiently accurate for most engineering purposes. The following personalities are mentioned: V.I. Fedorov, V.M. Agranovich, and N.N. Shel'menko, all of the Heat-Engine Laboratory, Institut teploenergetiki AN UkrSSR (Institute of Heat-Power Engineering, Academy of Sciences UkrSSR).

Dorfman, A.Sh. Simple Calculation Method for a Laval Nozzle 26
The author presents the results of an experimental study of the process of heat transfer during the condensation of steam. A detailed description of the experimental apparatus and the methods employed is given, as well as a qualitative description of the physical phenomena involved in the process of condensation on the basis of the results obtained.

51-4-5-7/29

AUTHOR: Agranovich, V.M.

TITLE: On Capture of "Free" Excitons by Impurities in Molecular Crystals (O zakhvate "svobodnykh" eksitonov primesyami v molekulyarnykh kristallakh)

PERIODICAL: Optika i Spektroskopiya, 1958, Vol IV, Nr 5, pp. 588-594 (USSR)

ABSTRACT: In certain mixed organic crystals (e.g. anthracene in naphthalene) an effective transfer of energy of electron excitation proceeds from the base (solvent) to the luminescent impurity. A large number of experimental papers deal with the mechanism of luminescence of such mixed organic phosphors (e.g. Ref 1). An analysis of the experimental data on photoluminescence and radioluminescence suggests that "free" excitons may play an important role in luminescence (Refs 2-4). The present paper is an attempt to construct a theory of the processes occurring on interaction of "free" excitons with impurities in mixed organic crystals. It is assumed that impurity molecules replace the solvent (base) molecules at the crystal lattice sites. It is suggested that at high impurity concentrations the electron excitation energy is transferred from the base to

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On Capture of "Free" Excitons by Impurities in Molecular Crystals

the luminescent impurity by a non-radiative process due to capture of excitons of the base by impurity molecules. This process dominates over re-absorption of luminescence of the base by impurities; the latter is more important at low impurity concentrations. Probability of capture of a "free" exciton by an impurity molecule is calculated. It is found that this probability depends on temperature, the energy spectrum of electron excitations of the impurity and on the displacement of molecules from the equilibrium positions on change of the electron excitation state. In the light of the theory put forward here the author discusses measurements of the luminescent yield of the naphthacene impurity in anthracene on excitation with light in the absorption band of anthracene (Ref 11). The author thanks A.S.Davydov, I.M. Lifshits, V.V. Antonov-Romanovskiy, M.D. Galanin and L.A. Tumerman for their advice. There are 12 references, 11 of which are Soviet and 1 American.

SUBMITTED: July 26, 1957

1. Luminescence - Theory

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S/112/60/000/006/004/032

Translation from: Referativnyy zhurnal, Elektrotekhnika, 1960, No. 6, p. 57,
2.4095

AUTHORS: Agranovich, V. M., Gerashchenko, O. A., Nazarchuk, M. M.

TITLE: An Approximate Method of Determining Temperature Fields and Stresses in a Drum Turbine Rotor at Starting

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PERIODICAL: Sb. tr. In-t teplo-energ. AN UkrSSR, 1958, No. 14, p. 20-25

TEXT: The rotor is considered as a combination of hollow conical and cylindrical solids of revolution. Assuming that the working medium temperature at starting is approximated for each point by an exponential time function and that the temperature change along the length of the rotor is linear, the authors carry out an approximate calculation of the rotor temperature field, neglecting the axial heat flow. The obtained result is substituting in S. P. Timoshenko formulae from which the radial and tangential components of thermal stresses and the time they reach their maximum value at starting are determined.

M. A. T.

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24(7) SOV/48-22-11-22/33

AUTHORS: Alentsev, M. N., Neporent, B. S., Agranovich, V. M.

TITLE: Discussion of the Lectures Held by B. I. Stepanov, B. S. Neporent, M. N. Alentsev, and L. A. Pakhomycheva (Preniya po dokladam B. I. Stepanova, B. S. Neporenta, M. N. Alentseva i L. A. Pakhomychevoy)

PERIODICAL: Izvestiya Akademii nauk SSSR, Seriya fizicheskaya, 1958, Vol 22, Nr 11, pp 1379-1379 (USSR)

ABSTRACT: M. N. Alentsev comments on the lecture given by Stepanov as follows: The equation specifying the energy of individual frequencies of the emission spectrum is determined only by the distribution of the molecules on the excited levels and by the probability of the corresponding transitions, if a forced emission and an interaction of the excited molecules is practically absent. Hence the luminescence spectrum under these conditions must be similar to the spectrum of thermal emission, and that means $W_\nu^{lum} = \frac{D'}{D}\alpha_\nu u_{\nu,T}$. This conclusion demonstrates that if Stepanov's relation is satisfied, this only indicates that the equilibrium distribution of the molecules with an excited

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Discussion of the Lectures Held by B. I. Stepanov, B. S. Neporent, M. N. Alentsev, and L. A. Pakhomycheva

electron state is stabilized with respect to the oscillation energy. If this relation is not satisfied, it can be proved that at the moment of emission the distribution is not an equilibrium one. It then corresponds to a distribution characterized by a temperature $T' \neq T$.

B. S. Neporent comments on the lecture held by M. N. Alentsev: It appears to be difficult to approve of the assumption that the excited molecules in solutions do not reach a thermal equilibrium in due time. This assumption is at variance with the experimental data on the transfer rate of the oscillation energy. Moreover it does not furnish an explanation of the divergencies found in several investigations.

V. M. Agranovich agrees with Stepanov concerning the joint relations between the luminescence- and absorption spectra. He rejects, however, his conception concerning earlier papers (A. S. Davydov, S. I. Pekar, M. A. Krivoglaz, and others) and thinks that the equation found by him should be compared with the results presented by other, earlier theories.

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AUTHORS: Agranovich, V. M., Stavinskiy, V. S. SOV/56-34-3-25/55

TITLE: On theTheory of Photonuclear Reactions (K teorii fotoyadernykh reaktsiy)

PERIODICAL: Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, 1958, Vol. 34, Nr 3, pp. 700-706 (USSR)

ABSTRACT: The present work computes the cross section of the capturing of γ-quanta by the nuclear material within that range of energy which corresponds to great resonance. First the operator of the interaction of the electromagnetic field with the system of nucleons is put down. For reasons of simplicity the author investigates a system of A nucleons being in a sufficiently great volume V. Within the frame of the model of the self-consisting field the ground state of such a system corresponds to a completely filled Fermi surface with the maximum wave number k_F. A formula is deduced for the absoption probability of the γ-quantum per second. In the deduction of the matrix element occuring in it the interaction of the electromagnetic field with the magnetic moments of

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On the Theory of Photonuclear Reactions SOV/56-34-3-25/55

the nucleons is neglected. This matrix element can be different from zero only at certain values. The course of computation is pursued step by step. A function contained in the expression for the initially mentioned cross section is put down explicitly. These functions are shown in a diagram for various values of the parameters used. In all ceses the capture cross section of the γ-quantum has a clearly marked resonance. Here $M/2 < M^* < M$ holds, where M denotes the mass of free nucleons, and M^* the effective mass. The curves F(x) were computed for the two limit values of the effective mass. With an increase of the effecive mass from $M^*=M$ to $M^*=M/2$ the values of the cross section decreased by 50% at the maximum, the half with increasing by 20-30%. The position of the resonance of the photocapture and the width of this resonance depend only little on M^*. The computation carried out here can only difficultly be compared with experiment in a quantitative respect due to the lacking of ample measuring results. In qualitative respect the existing measuring results for medium and heavy nuclei (only for such nuclei the comparison of the theory with the experiment is legiti-

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mate) do not contradict the consequences of the computation carried out here. The reasons for the existing differences are nevertheless shown. The model of an infinite nuclear material used here can not lead to the observed dependence of the capture cross section of the γ-quantum on A. The reasons for this are briefly given. The taking into account of finite dimensions of the nucleus leads to a better agreement between theory and experiment. There are 2 figures and 19 references, 4 of which are Soviet.

SUBMITTED: September 30, 1957

24(3)

AUTHORS: Agranovich, V. M., Rukhadze, A. A. SOV/56-35-4-24/52

TITLE: On the Propagation of Electromagnetic Waves in a Medium **Taking Account** of Spatial Dispersion (O rasprostranenii elektromagnitnykh voln v srede pri uchete prostranstvennoy dispersii)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958, Vol 35, Nr 4, pp 982 - 984 (USSR)

ABSTRACT: V.L.Ginzburg and S.I.Pekar (Refs 2,1) developed a method for the investigation of the propagation of electromagnetic waves in media, taking the spatial dispersion of the dielectricity constant into account. Whereas Ginzburg dealt with the problem by the phenomenological method, Pekar employed microscopical means of determining the connection between the polarization $\vec{P}$ and the electric field strength $\vec{E}$. The two methods in some essential points lead to different results, and the authors of this paper endeavor to clear matters up by trying to improve Ginzburg's method. First it is shown that, for the

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On the Propagation of Electromagnetic Waves in a Medium SOV/56-35-4-24/52
Taking Account of Spatial Dispersion

purpose of investigating the connection between the macroscopic quantities $\vec{P}$ and $\vec{E}$, the microscopical method is not suited. The equation of motion for the wave is obtained from an energy equation by development of $\vec{P}$,$\vec{E}$, and $\vec{D}$ according to Fourier (Fur'ye) components and corresponding transformation. For the case that the medium contains no free charges, an equation is set up (Maxwell) for the connection between $\vec{D}$ and $\vec{P}$. For transversal and longitudinal waves the refraction index is further represented in dependence on ω, and an equation is given for $n(\omega)$ also for anisotropic media; the properties of the medium are represented by the corresponding tensor components. The latter equation shows, according to Ginzburg (Ref 3) that taking account of the spatial dispersion in cubic crystals leads to a weak anisotropy of the refraction index. In conclusion, the authors thank V.L.Ginzburg for valuable discussions. There are

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On the Propagation of Electromagnetic Waves in a Medium SOV/56-35-4-2[illegible]/[illegible]
Taking Account of Spatial Dispersion

5 references, 4 of which are Soviet.

SUBMITTED: May 9, 1958

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SOV/56-35-5-17/56

24(5)

AUTHORS: Agranovich, V. M., Rukhadze, A. A.

TITLE: Energy Losses of the Electron in a Medium With Spatial Dispersion (Energeticheskiye poteri elektrona v srede s prostranstvennoy dispersiyey)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958, Vol 35, Nr 5, pp 1171-1174 (USSR)

ABSTRACT: Ginzburg (Ref 1) already investigated the propagation of electromagnetic waves in a general form in a medium in consideration of spatial dispersion. Taking account of this dispersion is especially important near the eigenfrequencies of the medium. For this frequency range a theory of the optical properties of the medium has already been developed by the authors of the present paper (Ref 3) as well as by Pekar (Ref 2). The influence exercised by the consideration of spatial dispersion on the energy losses of electrons moving in the medium is now to be investigated. For this purpose the authors base their investigations on the Maxwell (Maksvell) equations for an electron moving with the velocity v in an anisotropic medium with an arbitrary spatial dispersion law. In this system the quan-

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tities $\vec{E}$, $\vec{D}$, and $\vec{H}$ are represented by their Fourier (Fur'ye) components and an expression for the energy loss F suffered by the electron on one unit of length of its path is written down. In nonrelativistic approximation this amounts to:

$$F = -\frac{ie^2}{2\pi^2 v}\int\frac{(\vec{q}\vec{v})}{(\vec{q},\varepsilon\vec{q})}\,d\vec{q}.$$

The example of an isotropic nongyrotropic medium with an arbitrary dispersion law is investigated and also for this case F is explicitly given. Also for the case of an excitation of a longitudinal wave in a medium, if spatial dispersion is taken into account, a formula for F is given (also in the relativistic case). Explicit expressions are derived also for the ε-tensor. Finally, also for an isotropic nongyrotropic medium (according to reference 5) a formula is derived for the relativistic case for the total energy losses $F = F(\omega,k)$. The authors finally thank V. L. Ginzburg for his constant interest in this work and for his valuable discussions. There are 5 Soviet references.

24(5) SOV/56-35-5-36/56

AUTHORS: Agranovich, V. M., Stavinskiy, V. S.

TITLE: The Theory of the "Second Moment" in the Model of the Atomic Nucleus of Lane, Thomas, and Wigner (K teorii "vtorogo momenta" v modeli atomnogo yadra Leyna, Tomasa i Vignera)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958, Vol 35, Nr 5, pp 1285-1287 (USSR)

ABSTRACT: The conception of a "second moment" was introduced in a paper by the above-mentioned authors (Ref 1) for the qualitative characterization of the error which is permitted when substituting the hamiltonian of the shell model for the hamiltonian of the nucleus. It holds that $H = H_o + H_1$. Here H denotes the hamiltonian of the nucleus, H_o - the hamiltonian of the nucleus in the shell model, H_1 - an operator establishing the correlation of the states of individual nucleons in the shell model. The nuclear wave function can be represented as a development

$$(\psi_E, H_o\psi_E) = \sum_b |c_b(E)|^2 E_b$$

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The Theory of the "Second Moment" in the Model of the Atomic Nucleus of Lane, Thomas, and Wigner

according to a complete system of orthogonal functions. In the case of the validity of a condition given by the authors it is easy to determine the "second moment" of the nuclear model, which, according to the definition given, is $W^2(E) = \sum_b (E_b - E)^2 \left|C_b(E)\right|^2$. Here E denotes the nuclear energy and the aforementioned condition is $\left|C_b(E)\right|^2 \sim \exp(-E_b/kT)$. The authors next derive formulae for the dependence of the "second moment" on the excitation energy E and on the number A of nucleons in the nucleus. There are 10 references, 5 of which are Soviet.

SUBMITTED: June 23, 1958

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25(1) SOV/21-59-1-6/26

AUTHORS: Vaynberg, D.V. and Agranovich, V.M.

TITLE: On the Stressed State of Certain Multilinked Bodies (O napryazhennom sostoyanii nekotorykh mnogosvyaznykh tel)

PERIODICAL: Dopovidi Akademii nauk Ukrains'koi RSR, Nr 1, 1959, pp 21-25 (USSR)

ABSTRACT: This article deals with the plane problem of the elastic equilibrium of a circular or polygonal plate with a number of similar holes distributed, so that the region acquires a cyclic symmetry. The authors perform a series of calculations, by way of an integral equation, substituting the function of a contour's point ω (t) for the functions of Kolosov and Muskhelishvili φ (z) and ψ (z). The designations used are standard mathematical. Among them Lk (k-1,2,...,m) are the inner region's contours, z_{m+1} is the outer contour comprising all 5 contours under

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considerations, L is the total region's boundary, function $f(t_0)$ is determined by the data of forces prevailing upon the contours, real numbers are b_i, Ozk is an axle, Γ_1 is upper boundary of contour L_1, Γ_2 is upper part of arc of contour L_{m+1}. The authors make references to Sherman's method, and to a method of Shvarts. They also discuss a simplified alternating method based on the position of a number of "elementary" two-linked regions formed by the outer contour and the contour of one of the holes. A diagram presents the results of the calculations of stresses of contour holes in a double-linked region, wherein R stands for disc radius and δ for disc's thickness. There are one diagram, one table, and four Soviet references.

ASSOCIATION: Institut stroitel'noy mekhaniki AN UkrSSR (Institute of Structural Mechanics of AS UkrSSR)

PRESENTED: September 29, 1958, by F.P. Belyankin, Member of AS UkrSSR

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SOV/51-6-2-22/39

AUTHORS: Agranovich, V.M. and Konobeyev, Yu.V.

TITLE: On the Free-Path Length of an Exciton in a Molecular Crystal (O dline svobodnogo probega eksitona v molekulyarnom kristalle)

PERIODICAL: Optika i Spektroskopiya, 1959, Vol 6, Nr 2, pp 242-245 (USSR)

ABSTRACT: The authors calculated theoretically the mean free path of a "non-localized" (free) exciton interacting with the acoustical branch of lattice vibrations. For the cubic lattice, when the interaction with only the nearest neighbours is considered and the effective exciton mass approximation is used, the authors obtained a value of 20 Å for the mean free path of an exciton in a molecular crystal under the conditions of thermal equilibrium at 300°K. The diffusion coefficient of excitons was found to be of the order of 1 cm^2/sec. This value is one order higher than the values obtained by the direct measurements (Refs 1-3). This difference between the observed and calculated

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On the Free-Path Length of an Exciton in a Molecular Crystal SOV/51-6-2-22/39

diffusion coefficients may be due to either the importance of the "localized" excitons, or due to lattice defects distributed in such a way that the distances between them are less than the calculated value of the exciton mean free path. There are 8 references, 5 of which are Soviet, 1 Czech and 2 English.

SUBMITTED: June 25, 1958

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24(4), 24(6) SOV/51-6-5-15/34

AUTHORS: Agranovich, V.M. and Konobeyev, Yu.V.

TITLE: The Effect of Re-Absorption on the Yield and Duration of Luminescence of Molecular Crystals. I. (Vliyaniye reabsorbtsii na vykhod i dlitel'nost' lyuminestsentsii molekulyarnykh kristallov. I)

PERIODICAL: Optika i Spektroskopiya, 1959, Vol 6, Nr 5, pp 648-658 (USSR)

ABSTRACT: In previous work on phenomenological theory of excitons in molecular crystals (Refs 1-3) it was implicitly assumed that reflection of luminescencelight from crystal surfaces can be neglected. Experimental evidence (Ref 4) shows that if this reflection is neglected the luminescence curves may be affected in some cases. For this reason the authors discuss here a kinetic equation which describes the distribution of excitons in a molecular crystal and which allows for internal reflection of luminescent light from crystal surfaces. For the case when the exciton diffusion coefficient is sufficiently small, exact formulae are obtained which give the quantum yield and duration of luminescence of crystals in the form of plane-parallel plates of any thickness. From the formulae which give the quantum yield the luminescence spectracan be deduced. The paper is entirely theoretical. There are 2 tables and 8 Soviet references.

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SUBMITTED: May 12, 1958

24(7) SOV/48-23-1-9/36

AUTHOR: Agranovich, V. M.

TITLE: On the Influence of the Migrational Energy of Electronic Excitation Upon the Luminescence of Molecular Crystals (O vliyanii migratsii energii elektronnogo vozbuzhdeniya na lyuminestsentsiyu molekulyarnykh kristallov)

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1959, Vol 23, Nr 1, pp 40 - 49 (USSR)

ABSTRACT: The specific feature of the migrational processes of the energy resulting from electronic excitation offers the possibility of superimposing the emission and absorption spectra to a large extent. Therefrom the author assumed that the energy migration takes place in two ways: 1) as a resonance interaction of uniform molecules (exciton mechanism) and 2) as a reabsorption mechanism. Up till now, either of both mechanism has been neglected in discussions. Bowen (Boyen) (Ref 1) neglected (2) and Birks (Ref 2) neglected (1). In this paper the author gives a comparative assessment of both mechmisms. He points especially to papers published by Galanin (Ref 7), Birks (Ref 2) and Wright (Rayt)(Ref 8)

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who obtained an approximate expression for the period of fading as well as the quantum yield of crystal luminescence according to the reabsorption mechanism. In comparing both mechanism three problems are dealt with:1) The author discusses some questions and results of the general phenomenological theory of energy migration within molecular media. For this case, a deduction is offered in which the "technical" quantum yield is obtained irrespective of luminescence polarization. Here, the author based the study on the function $C_1(w,t)$ (denoting the exciton concentration in the current w with respect to time t) as an integrodifferential equation with the following characteristics: D - diffusion coefficient of the exciton, P - total probability of exciton disappearance per second, $\eta(\nu)$ - quantum yield at an excitation by light of the frequency ν, $E(\nu)$ - the probable density of emission of one quantum of the frequency ν by one exciton per second on the radiation toward any direction, $k(\underline{\nu})$ - absorption coefficient of light of the frequency ν, $\bar{k}$-absorption coefficient of the incident light. With disregard to the

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exciton diffusion ($D=0$) and the reflection at the surface and with the q approximation, i.e.

$q=\int_0^\infty E(\nu)\eta(\nu)d\nu < 1$ the author obtained two expressions:

$\varphi(x)= C_0(0,\gamma)$, $\gamma=\frac{\bar{k}}{k_0}$; $k_0= k(\nu_0)$; ν_0 = mean value of the frequency of luminescence light for which the reabsorption has a maximum. 1) $q < 0.4$ and 2) $0.4 \leq q < 1$; the latter values are given in table 1 . Tables 2 and 3 give the values of the functions $\Theta(x)$ and $\omega(x)$ for q from 0.4 to 0.95, according to which the periods of fading τ_I and τ_{II} can be determined. The author gives the deduction and calculation of τ_I and τ_{II} in another paper (Ref 12). The formulae obtained agree with results mentioned by Galanin (Ref 7). Results of the general form (with respect to exciton diffusion) are being worked out at present. The author discusses the remaining two problems (2) on the energy transfer of electronic

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excitation in organoluminophores with impurities only in brief. The scheme of this energy migration is illustrated in a figure. 3) The author deals also with the probability of a capture of free excitons by the impurity. It is stated that within the crystal an exciton wave emanates from the basic substance and the wave function in the impurity crystal can be determined according to Lifshits's method (Ref 17). In conclusion, the author mentions that a few authors (Ref 18) detected a temperature-dependant maximum of luminescence yield of the impurity at high concentrations of this impurity. There are 2 figures, 5 tables, and 18 references, 14 of which are Soviet.

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21(7)

AUTHORS: Agranovich, V. N., Pafomov, V. Ye., Rukhadze, A. A.

SOV/56-36-1-32/62

TITLE: On the Cherenkov Radiation of an Electron Moving in a Medium With Spatial Dispersion (O cherenkovskom izluchenii elektrona, dvizhushchegosya v srede s prostranstvennoy dispersiyey)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 1, pp 238-243 (USSR)

ABSTRACT: The present paper deals with Vavilov-Cherenkov radiation in an isotropic gyrotropic medium in consideration of spatial dispersion. The formula for the total losses, which corresponds to this case, is written down. In consideration of spatial dispersion, Cherenkov radiation propagates on the surface of cones with the aperture angle ϑ_i. The next chapter of this paper deals with the distribution of intensities over these cones. The formula for the total intensity of Cherenkov radiation here takes the form of a sum of the intensities distributed over the individual Cherenkov cones. For a more intense study of the distribution of the intensity of Cherenkov radiation, the author investigates several possibilities of taking the spatial dispersion of the medium into account. For

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frequency ranges which are far from the eigenfrequencies of the medium it is possible to determine the solution for the decomposition of "direct" dispersion. Within this frequency range it holds uniquely that

$n^2(\omega) = \varepsilon_c(\omega)/(1+\alpha(\omega))$; and Cherenkov radiation will be distributed over the surface of a single cone. In the domains near the eigenfrequencies of the medium, spatial dispersion may be of essential influence and in this case a development of the "inverse" dispersion must be used. Assuming that the condition $\varepsilon_0^2 |\beta| \ll 1$ holds, one may say that Cherenkov radiation is concentrated almost entirely upon the first cone. Also with $\beta > 0$ Cherenkov radiation is distributed over one cone, but with $\beta < 0$ it is distributed over two. In nongyrotropic media the new Cherenkov radiation is real only in the immediate neighborhood of the absorption line center, and in this case the new Cherenkov radiation is of the same order of magnitude as the intensity of the ordinary Cherenkov radiation. In real substances Cherenkov radiation [illegible]

On the Cherenkov Radiation of an Electron Moving in a Medium With Spatial Dispersion SOV/56-36-1-32/62

in the optical spectral range can be observed in films of about $\sim 10^{-4}$ cm. The authors then investigate Cherenkov radiation in an isotropic gyrotropic medium in consideration of spatial dispersion, confining themselves to decomposing "inverse" dispersion. Such a radiation occurs if the condition $v > c/n_i(\omega)$ is satisfied. Here $n_i(\omega)$ denotes one of the solutions of the equation $n^2(\omega) = \varepsilon_1(\omega, n^2\omega^2/c^2)$. An expression is written down for the total intensity of Cherenkov radiation. In a gyrotropic medium absorption is not of essential importance, and the new waves of Cherenkov radiation can actually be observed experimentally. The third and last chapter deals with the emergence of Cherenkov radiation through the surface of the medium. The results obtained in this paper by calculation make it possible to decide upon the most favorable geometric experimental conditions for the investigation of the special features of Cherenkov radiation in media with spatial dispersion. In conclusion, the authors thank V. L. Ginzburg for his interest

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in this work and for discussions. There are 5 Soviet references.

ASSOCIATION: Fizicheskiy institut im. P. N. Lebedeva Akademii nauk SSSR (Physics Institute imeni P. N. Lebedev of the Academy of Sciences, USSR)

SUBMITTED: July 10, 1958

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24(2),24(3)

AUTHOR: Agranovich, V. M. SOV/56-37-2-16/56

TITLE: Dispersion of Electromagnetic Waves in Crystals

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 37, Nr 2(8), pp 430-441 (USSR)

ABSTRACT: In this paper the microscopical quantum theory of the dispersion of electromagnetic waves is developed for the concrete model of a molecular crystal. This method of investigation is, however, applicable to any kind of crystals. No account is taken of nuclear vibrations and hence the problem of the complex refractive index must be studied separately. The first section deals with the mathematical problem of the transition to the second quantization. The vector potential is conveniently subjected to a Coulomb calibration which implies that the vector potential of the microfield conforms with the restriction $\operatorname{div}\vec{A} = 0$. In this case the total Hamiltonian of the system, composed of the electrons and the field, may be written down as $\hat{H} = \hat{H}_1 + \hat{H}_2 + \hat{H}_{int}$, $\hat{H}_1$ including the Coulomb interaction of all charges constituting the crystal whereas $\hat{H}_2$ is the Hamiltonian corresponding to the free electromagnetic

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field of the transverse photons. $\hat{H}_{int}$ is the operator of the interaction of all charges with a transverse photon field. The operator $\hat{H}_1$ is then written down explicitly for a molecular crystal. The author then proceeds to the second quantization, for which wave functions are chosen as a frame of reference, describing the steady states of an isolated molecule. The calculation is given step by step, giving the operator $\hat{H}_1$ in the second quantization representation. As an example a crystal with one molecule per unit cell ($\sigma = 1$) is investigated. In the second section the dispersion of electromagnetic waves in molecular crystals is calculated. An expression for the refractive index of light waves is derived. Finally, the following special cases are investigated: 1) One molecule per unit cell of the crystal ($\sigma = 1$); 2) The crystal has cubial symmetry; 3) 2 molecules per unit cell. The author expresses his gratitude to V. L. Ginzburg for valuable advice and discussion of the paper and A. S. Davydov and V. P. Silin for helpful discussion. There are 9 references, 7 of which are Soviet.

SUBMITTED: January 7, 1959

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S/181/60/002/06/26/050
B006/B056

24.3500

AUTHOR: Agranovich, V. M.

TITLE: The Theory of Circular Dichroism in Crystals 21

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 6, pp. 1197-1199

TEXT: In 1948 B. N. Samoylov published results of measurements of the polarization of luminescence and absorption lines of a number of crystals at temperatures of liquid helium and air. On sodium uranylacetate crystals he detected a hitherto unknown effect, viz., an anomalously large circular dichroism and circular polarization of the luminescence lines. This effect has as yet not been satisfactorily explained; to this, the present paper makes a contribution. Details of the shape of exciton bands manifest themselves at low temperatures in the absorption and luminescence spectra; thus, an anomalously large circular dichroism, i.e., very considerable absorption of one of the circularly polarized waves, may be brought into connection with structural differences of the exciton bands. By using the results obtained in Ref. 4, the function

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$E_{\pm}(\vec{q})$, where E denotes the exciton energy, is investigated for cubic crystals in the region of visible electromagnetic oscillations. For low values of the wave vectors $|\vec{q}| \cong q_z$, $E_{\pm}(q_z) = E_0 \pm \gamma q_z + \alpha q_z^2$. Further, $E_+(\vec{q}) = E_-(-\vec{q})$. For the purpose of qualitative investigation, the perturbation theory may be used, i.e., it may be assumed that the photon in the crystal excites an exciton able "to extinguish" interactions with lattice vibrations. In the case of an arbitrary sign of α, one of the curves $E_{\pm}(q_z)$ always has a maximum or a minimum at $q_0 = |\gamma/2\alpha| \gg 2\pi/\lambda_{light} \cong |\vec{Q}|$. The interaction between the polarized exciton waves and lattice vibrations leads to processes that are connected with a change in the wave vector and the exciton wave energy; this change is accompanied by an emission or absorption of phonons. If it is assumed that in the absorption of a linearly polarized photon two excitons with the wave vector Q and different circular polarization occur, it is possible that at $\alpha > 0$ ($\alpha < 0$) the left- (right-) hand polarized wave continues to exist and the others are extinguished and emit photons,

AGRANOVICH, V.M.

Transfer of the electron excitation energy with the aid of the mechanism of virtual excitons. Opt.i spektr. 9 no.1:113-115 Jl '60. (MIRA 13:7)
(Excitons) (Electrons)

S/053/60/071/01/06/011
B006/B011

AUTHOR: Agranovich, V. M.

TITLE: On the Problem of the Part Played by Defects in the Process of Exiton Luminescence of Molecular Crystals

PERIODICAL: Uspekhi fizicheskikh nauk, 1960, Vol. 71, No. 1, pp. 141-149

TEXT: The present paper is a contribution to the theory of exiton luminescence. The investigations had the purpose of showing that two types of processes are likely to exert an influence on the exiton luminescence in the presence of impurities and defects: firstly, exitons can be captured on local defect levels, whereby a subsequent radiation emission results, and secondly, there may occur a conversion of an exiton into radiation and vice versa, but without a localization of the energy on the defect. The author begins with offering a survey of relevant problems treated by publications, and proceeds to describe the present state of research in the field of light absorption in crystals. The conclusions derived from equations (3) and (4), which reproduce the interaction of exitons with lattice vibrations in single-phonon approximation, are dealt with in

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greater detail, especially with respect to the dispersion of the energy of elementary excitations (for cubic crystals cf. Fig. p. 143). The author then passes over to the central subject, and discusses in great detail the possible mechanisms of exiton luminescence in molecular crystals under particular consideration of the effects resulting from delayed interaction. Theoretical evaluations are given concerning th3 process of conversion of exiton energy into light. The possible part played by triplet states in the exiton luminescence of molecular crystals is finally dealt with. The conclusions mentioned at the beginning are then stated. The following Soviet scientists are mentioned: Ya. I. Frenkel', S. I. Pekar, N. N. Bogolyubov, S. V. Tyablikov, A. S. Davydov, E. V. Shpol'skiy, B. N. Samoylov, and Yu. V. Konobeyev. There are 1 figure and 28 references, 18 of which are Soviet.

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AGRANOVICH, V. M., Doc Phys-Math Sci -- "Studies in the theory of electronic states and migration of electron[illegible]-excitation energy in molecular crystals." [Mos], 1961. (Acad Sci USSR. Inst of Chem Phys). (KL, 4-61, 182)

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24.7600 (1043,1155,1158)

S/181/61/003/001/011/042
B006/B056

AUTHORS: Agranovich, V. M., Konobeyev, Yu. V.

TITLE: Theory of the thermal conductivity of dielectrics below the Debye temperature

PERIODICAL: Fizika tverdogo tela, v. 3, no. 1, 1961, 97-99

TEXT: The theory of the thermal conductivity of dielectrics with $T \ll \Theta$ shows unsatisfactory agreement with the experiment. Especially the expression derived by Klemens for the coefficient of thermal conductivity $\varkappa$ is not clear in some respects. The present paper deals in detail with studies by Ziman (Ref. 3), and it is shown in what way an expression for $\varkappa$ that shows better agreement with the experiments may be found. Ziman used a variational principle to solve the Boltzmann equation $Lg(\vec{f},s) = -\frac{N_o(N_o+1)}{\tau}\left[g(\vec{f},s)+\partial N/\partial t\right] = -v_{fsx}\frac{\hbar\omega}{kT^2}N_o(N_o+1)dT/dx \equiv X$ by means of the function $N(\vec{f},s) = N_o(\omega) + g(\vec{f},s)N_o(N_o+1)$. $N_o(\omega) = (\exp\frac{\hbar\omega}{kT}-1)^{-1}$, $\vec{v}_{fs} = \partial\omega(\vec{f},s)/\partial\vec{f}$; s characterizes the polarization; f is the quasi-momentum.

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This Boltzmann equation may be solved by the method of least squares, i.e., by finding the minimum of the functional

$J = \sum_{\vec{f},s}(Lg - X)^2 \equiv \langle Lg - X, Lg - X \rangle$; one obtains, like Ziman, $g = Cf_x$ as a trial function, where C is a constant. The following expression is then obtained for $\varkappa$:

$$\chi = \frac{\frac{12.99}{\pi^2}\frac{k^4}{\theta^2}\left(\frac{T}{\hbar}\right)^3 \int\limits_0^\infty \frac{x^4 e^{2x}dx}{(e^x-1)^4 l_0\left(\frac{kT}{\hbar}x\right)}}{\int\limits_0^\infty \frac{x^8 e^{2x}dx}{(e^x-1)^4 l_0\left(\frac{kT}{\hbar}x\right)}} \qquad (3);$$

the relaxation length, l_0, is defined by $1/l_0 = \sum_\alpha 1/l_\alpha$, where l is the mean free path corresponding to the α-th process. If one confines oneself to four processes which are assumed to play the main part in dielectrics, one obtains

$$1/(l_0 kTx/\hbar) = 1/L + A\varepsilon(T/\theta)^4 x^4/a + S(T/\theta)^2\exp(-\theta/2T) - x^2/a + B(T/\theta)^2 x^2/a,$$

where $x = \hbar\omega/kT$; L is a length of the order of the specimen dimension; ε is the impurity concentration in the crystal; A and B are constants

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which depend on the nature of the impurities and on the grain size; S is a constant related to transfer processes; $\bar{v}$ is the mean velocity of sound; and a is the lattice constant. For that temperature range in which phonon scattering by impurities is the most probable process, the expression for κ is reduced to: $\kappa = \frac{a}{2\pi^2} \frac{k^4\Theta^4}{\hbar^3\bar{v}^2} \frac{0.0383}{A\varepsilon} \frac{1}{T}$ (5); this is 2.3 times the value obtained by Ziman. If the impurities are isotopes, then $A\varepsilon = (6\pi^2)^{1/3} \frac{9\pi}{\sqrt{3}} \frac{\sum_i (M_i - \bar{M})^2 c_i}{\bar{M}^2}$, where c_i is the concentration of the various isotopes. Eq. (5) shows better agreement with the experiment than that by Ziman. For Ge with known isotopic composition, one obtains experimentally at 50°K: κ = 12 v/cm·deg,
according to Ziman 3.1 v/cm·deg,
according to (5) 7.1 v/cm·deg, and
according to Klemens 166 v/cm·deg.
I. Ya. Pomeranchuk is mentioned. There are 6 references: 1 Soviet-bloc and 5 non-Soviet-bloc.

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SUBMITTED: June 15, 1959 (initially)
March 29, 1960 (after revision)

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S/181/61/003/002/006/050
B102/B204

9.4300 (and 1035, 1043)

AUTHORS: Agranovich, V. M. and Konobeyev, Yu. V.

TITLE: The theory of the edges of the exciton absorption bands

PERIODICAL: Fizika tverdogo tela, v. 3, no. 2, 1961, 360-369

TEXT: If one considers the delayed interaction of electrons with one another in a crystal field, new elementary excitations occur already in zero-th approximation besides the excitons and transversal photons, which may be considered to be a "mixture" of these two states; according to Hopfield, they are called polaritons. They are excited by light waves inciding upon the crystal from outside, and the attenuation of light when passing through the crystal is due to interaction between polaritons and lattice vibrations. Consideration of the delay may be of importance for such exciton absorption bands as correspond to greater oscillator forces. In this case, an additional absorption may occur also with positive effective exciton masses at frequencies lower than the limit frequency of the exciton branch; at low temperatures, this additional absorption determines the shape of the long-wave edge of the exciton absorption bands.

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This is here theoretically investigated by the example of a molecular crystal. For reasons of simplicity, only acoustic lattice vibrations are taken into account. First, the suitable formulation of the electron-phonon Hamiltonian in consideration of retardation is discussed. As end form

$$\hat{H}=\hat{H}_0+\hat{H}_{\text{рем.}}+\hat{H}_{\text{эл.}}\equiv V_0+\sum_{\mathbf{k},\rho}\mathcal{E}_\rho(\mathbf{k})\xi^+_{\rho\mathbf{k}}\xi_{\rho\mathbf{k}}+$$

$$+\sum_{\substack{\mathbf{m}_1\mathbf{m}_2\\ x_1,x_2}}A^{x_1x_2}_{\mathbf{m}_1\mathbf{m}_2}u_{\mathbf{m}_1x_1}u_{\mathbf{m}_2x_2}+\frac{1}{2}\sum_{\mathbf{m}}\frac{M\dot{u}^2_{\mathbf{m}}}{2}+\sum_{\substack{\mathbf{k}\rho,\,\mathbf{k}_1\rho_1\\ \mathbf{m}x}}B(\mathbf{k}\rho,\,\mathbf{k}_1\rho_1;\,\mathbf{m}x)\xi^+_{\mathbf{k}\rho}\xi_{\mathbf{k}_1\rho_1}u_{\mathbf{m}x}. \quad (9)$$

Здесь

$$B(\mathbf{k}\rho\ \mathbf{k}_1\rho_1,\ \mathbf{m}x)=\frac{u^*_{\mathbf{k}}(\rho)u_{\mathbf{k}_1}(\rho_1)}{N}e^{i\mathbf{m}(\mathbf{k}_1-\mathbf{k})}[\Phi^x(\mathbf{k}_1)-\Phi^x(\mathbf{k})]. \quad (10)$$

is obtained, where $\xi^+_{\rho\vec{k}}$ and $\xi^-_{\rho\vec{k}}$ are the Bose creation and annihilation operators of the polariton $(\rho\vec{k})$, $\mathcal{E}_\rho(\vec{k})$ is the energy of the polariton

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branch ρ with the wave vector $\vec{k}$, $\Phi^{x}(\vec{k}) = \sum_{\vec{m}_1} \bar{\Phi}^{x}_{\vec{m}\vec{m}_1} e^{ik(\vec{m}_1-\vec{m})}$, u_{sx} is the x-th projection of the displacement vector of the s-th molecule from equilibrium. In the following, the spectrum of the elementary excitations in the concrete case of a crystal with one molecule per elementary cell is investigated. It is assumed that a non-degenerate electron transition in an isolated molecule is allowed in dipole approximation. If here retardation is not taken into account, the lowest elementary excitations are two coinciding branches of transverse photons (polarization j = 1,2) and one exciton branch (polarization in the direction of the dipole moment of the transition in the molecule). For the polariton spectrum one obtains

$$\mathcal{E}^2_{1,2}(q) = \frac{E^2(q) + \frac{c^2q^2 + \omega_0^2 F \sin^2\varphi}{\varepsilon_0}}{2} \pm$$

$$\pm \frac{1}{2}\sqrt{\left(E^2 + \frac{c^2q^2 + F\omega_0^2 \sin^2\varphi}{\varepsilon_0}\right)^2 - \frac{4c^2q^2E^2(q)}{\varepsilon_0^2}}. \quad (12)$$

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The displacement vector is given by

$$u_{\mathbf{k}}(\rho) = T(\mathbf{k}) \sqrt{\frac{kc\,[E(\mathbf{k}) + \mathcal{E}_{\rho}(\mathbf{k})]^2}{\mathcal{E}_{\rho}(\mathbf{k})\left[4kcE(\mathbf{k})\,|T(\mathbf{k})|^2 + (E^2(\mathbf{k}) - \mathcal{E}_{\rho}^2(\mathbf{k}))^2\right]}}, \qquad (13)$$

$$T(\mathbf{k}) = i\sqrt{\frac{2\pi N}{kcV}}\,|\mathbf{P}_{0f}|\sin\varphi(\mathbf{s})\,E(\mathbf{k}). \qquad (14)$$

$E(\vec{q})$ is the exciton energy, F the oscillator force, N/V is the number of elementary cells per unit of volume, $\vec{P}_{of}$ - the dipole moment of the transition into an isolated molecule. In the following, the contour of the absorption bands is calculated, using the Green temperature functions for polaritons and phonons

$$G(\rho\mathbf{k}x_0,\ \rho'\mathbf{k}'x_0') = \frac{i}{\langle S\rangle}\langle T\{\xi_{\rho\mathbf{k}}(x_0)\,\xi^{+}_{\rho'\mathbf{k}'}(x_0')\,S\}\rangle, \qquad (16)$$

$$D_{\alpha\beta}(\mathbf{m}x_0;\ \mathbf{m}'x_0') = -\frac{i}{\langle S\rangle}\langle T\{u_{\mathbf{m}\alpha}(x_0)\,u_{\mathbf{m}'\alpha'}(x_0')\,S\}\rangle, \qquad (17)$$

$$S = Te^{\,i\sum_{\mathbf{m}}\int dr_0\,J^{\alpha}_{\mathbf{m}}(r_0)\,u_{\mathbf{m}\alpha}(r_0)}$$

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After a Fourier transformation,

$$G(\rho, \rho', \mathbf{k}; E) = G^{(0)}(\rho, \mathbf{k}, E)\,\delta_{\rho\rho'} - (2\pi)^2 G^{(0)}(\rho, \mathbf{k}, E) \sum_{\rho''} M_{\rho\rho''}(\mathbf{k}, E) \times \times G(\rho'', \rho', \mathbf{k}; E), \tag{19}$$

где в первом неисчезающем приближении теории возмущений

$$M_{\rho\rho''}(\mathbf{k}, E) = -\frac{i}{\sqrt{N}} \sum_{\rho_1 \mathbf{k}_1 \alpha\beta} \Phi^{\alpha}(\mathbf{k}_1, \mathbf{k})\,\Phi^{\beta}(\mathbf{k}, \mathbf{k}_1)\,|u_{\mathbf{k}_1}(\rho_1)|^2 \times \times u_h^{*}(\rho)\,u_k(\rho'') \int dE'\,G^{(0)}(\mathbf{k}_1, \rho_1; E')\,D^{(0)}_{\beta\alpha}(\mathbf{k}-\mathbf{k}_1, E'-E). \tag{20}$$

Здесь

$$\Phi^{\alpha}(\mathbf{k}, \mathbf{k}_1) = \Phi^{\alpha}(\mathbf{k}) - \Phi^{\alpha}(\mathbf{k}_1).$$

is obtained for the Dyson equation, where (20) holds in first perturbation-theoretical approximation. Thus, finally

$$M_{\rho\rho''}(\mathbf{k}, E) = -\frac{1}{4\pi MN} \sum_{\rho_1 \mathbf{k}_1 j} \frac{(\Phi(\mathbf{k}_1, \mathbf{k})\,\mathbf{e}_j)\,(\Phi(\mathbf{k}_1, \mathbf{k})\,\mathbf{e}_j^{*})}{\omega_j(\mathbf{k}-\mathbf{k}_1)} \times \times \left[\frac{n(\omega_j(\mathbf{k}-\mathbf{k}_1))}{E - \mathcal{E}_{\rho_1}(\mathbf{k}_1) + \omega_j(\mathbf{k}_1-\mathbf{k})} + \frac{1 + n(\omega_j(\mathbf{k}-\mathbf{k}_1))}{E - \mathcal{E}_{\rho_1}(\mathbf{k}_1) - \omega_j(\mathbf{k}-\mathbf{k}_1)}\right] \times \times |u_{\mathbf{k}_1}(\rho_1)|^2\,u_{\mathbf{k}}^{*}(\rho)\,u_{\mathbf{k}}(\rho''). \tag{24}$$

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is obtained for $M_{\rho\rho''}(\vec{k},E)$. The fact that the matrix M has off-diagonal elements, leads to a certain deformation of the polariton spectrum; in the approximation studied here, this deformation is due to virtual phonon exchange of polaritons belonging to different branches. These processes may be, above all, of essential importance if $\vec{k}$ has nearly the same direction as the polarization of the transition in the molecule ($\varphi(\vec{s})$ being small with respect to the energy gap). Further, only the case of large $\varphi(\vec{s})$ is investigated, where the off-diagonal terms remain insignificant. For the purpose of determining the imaginary part of polaron energy with phonons, which is due to interaction, the imaginary part of the mass operator is first determined. By approximation, the following is obtained:

$$\operatorname{Im} M_{\rho\rho}(\mathbf{k}, E) = -\frac{id^3}{4(2\pi)^3 M} \sum_{\rho_1, j} \int d\mathbf{k}_1 \frac{|\mathbf{e}_j \Phi(\mathbf{k}, \mathbf{k}_1)|^2}{\omega_j(\mathbf{k}-\mathbf{k}_1)} \times$$
$$\times \{n(\omega_j(\mathbf{k}_1-\mathbf{k}))\,\delta(E_\rho(\mathbf{k}) - \mathcal{E}_{\rho_1}(\mathbf{k}_1) + \omega_j(\mathbf{k}_1-\mathbf{k})) +$$
$$+ [1 + n(\omega_j(\mathbf{k}-\mathbf{k}_1))]\,\delta(E_\rho(\mathbf{k}) - \mathcal{E}_{\rho_1}(\mathbf{k}_1) - \omega_j(\mathbf{k}-\mathbf{k}_1))\} \times$$
$$\times |u_\rho(\mathbf{k})|^2 |u_{\rho_1}(\mathbf{k})|^2. \qquad (25),$$

$$\left.\begin{aligned} \operatorname{Re} E_\rho(\mathbf{k}) &= \mathcal{E}_\rho(\mathbf{k}) - 2\pi \operatorname{Re} \tilde{M}_\rho(\mathbf{k}, E_\rho(\mathbf{k})), \\ |\operatorname{Im} E_\rho(\mathbf{k})| &= |2\pi \operatorname{Im} M_\rho(\mathbf{k}, E_\rho(\mathbf{k}))|. \end{aligned}\right\} \quad (26)$$

and, in Debye approximation,

$$\operatorname{Im} E_1(\mathbf{k}) = \frac{d^3}{16\pi^2 M} \int d\mathbf{f} \frac{|\Phi(\mathbf{k}, \mathbf{k}-\mathbf{f})|^2}{\omega(\mathbf{f})} \{n(\omega(\mathbf{f}))\,\delta(\mathcal{E}_1(\mathbf{k}) - \mathcal{E}_1(\mathbf{k}-\mathbf{f}) + \omega(\mathbf{f})) + \\ + [1 + n(\omega(\mathbf{f}))]\,\delta(\mathcal{E}_1(\mathbf{k}) - \mathcal{E}_1(\mathbf{k}-\mathbf{f}) - \omega(\mathbf{f})). \quad (27)$$

Herefrom it follows that also at very low temperatures, if $n(\omega) \simeq 0$ in the energy range of $\mathcal{E}_1(\vec{k}) < E_{exc}(0)$, Im $E_1(\vec{k})$ is non-vanishing, and therefore polariton attenuation occurs. At T = 0

$$\operatorname{Im} E_1(\mathbf{k})|_{T=0} = \frac{9e^4F^2}{16\pi^2 M d^3 \mu^2 \omega_{0f}^2} \int \frac{d\mathbf{f}}{\omega(\mathbf{f})} (f^2 + 3f_z^2) \times \\ \times \delta(\mathcal{E}_1(\mathbf{k}) - \mathcal{E}_1(\mathbf{k}-\mathbf{f}) - \omega(\mathbf{f})). \quad (30)$$

holds, which may be represented approximately by

$$\operatorname{Im} E_1(\mathbf{k})|_{T=0} \simeq \frac{9\gamma_1 F^2 e^4}{32\pi M d^3 \omega_{0f}^2 s^4 k^3 \mu^2} \left(\frac{\omega_0^2 F E_{\text{экс.}}(0)}{2c^2} \right)^2 \times \\ \times \left[\frac{A^2 + 2A}{1 + A} - 2\ln(1 + A) \right], \quad (33)$$

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$$A=\gamma_2\frac{2sk^3c^2}{\omega_0^2FE_{\text{экс.}}(0)}. \qquad (34)$$

For the absorption coefficient,

$$\varkappa\equiv\frac{\operatorname{Im}E_1(\mathbf{k})|_{T=0}}{v_{\text{гр.}}(\mathbf{k})}=\frac{9\gamma_1F^3\omega_0^2E_{\text{экс.}}(0)\,c^4}{128\pi M\mu^2d^3s^4c^2\omega_{0f}^2}\left(1+\frac{k^4c^2}{M_{\text{экс.}}(s)\,\omega_0^2FE_{\text{экс.}}}\right)\times$$
$$\times\left[\frac{A^2+2A}{1+A}-2\ln(1+A)\right]. \qquad (36)$$

$k,\ \frac{1}{\text{см}}$	A	Δ, эв	$\varkappa,\ \frac{1}{\text{см}}$
$5\cdot10^5$	10^{-3}	0.4	$5\cdot10^{-3}$
10^6	$8\cdot10^{-3}$	0.1	2.5
$2\cdot10^6$	$64\cdot10^{-3}$	0.025	$1.2\cdot10^3$
$4\cdot10^6$	$0\cdot51$	0.006	$6\cdot10^5$
$5\cdot10^6$	1	0.004	$\simeq2\cdot10^6$
$k=k_0\simeq10^7$	8	0	$\simeq10^7$

is obtained. Calculated for benzene crystals, the values given in the table result. The results obtained show that here the long-wave absorption edge due to retardation of the range 100 - 200 cm^{-1} is extended below the exciton energy limit $E_{exc}(0)$. At sufficiently low temperature, this effect remains essential and may in favorable cases produce an effect upon the exciton absorption line widths at low temperatures. A.S.Davydov, S. I. Pekar, and S. V. Tyablikov are mentioned. ~~There are 1 figure~~,

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AGRANOVICH, V.M.

Theory of excitons in molecular crystals. Fiz. tver. tela 3 no. 3:811-818 Mr '61. (MIRA 14:5)
(Excitons) (Crystal lattices)

15.2220 3009, 3309

21.6100

23737

S/089/61/010/006/002/011
B136/B201

AUTHORS: Agranovich, V. M., Semenov, L. P.

TITLE: Theory of irradiation effect upon some properties of graphite

PERIODICAL: Atomnaya energiya, v. 10, no. 6, 1961, 572 - 576

TEXT: Some of the properties of graphite are changed under irradiation: it is dilated and its thermal conductivity is reduced. An accumulation of Wigner energy, which is liberated on heating, also takes place. These problems are discussed theoretically here. Under irradiation, lattice atoms penetrate between weakly bound lattice planes, whereby the distance between them grows larger and the lattice constant along the c-axis rises. Such interstitial positions are particularly stable if situated directly below (or above) an atom of an (α-) plane, and above (or below) the center of the lattice hexagon of the second (β-) plane. (Fig.1). This model is made the starting point of the investigation, ion defects being neglected. Binding energy and compressibility of an ideal graphite single crystal are calculated first. The spherically symmetrical Lenard-Johns potential for the interaction between two atoms in different planes is used in this

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connection. Theoretical and experimental values for the binding energy are E = -243 erg/cm^2 and E = -2.60 erg/cm^2, and for compressibility $\varkappa = 2.59 \cdot 10^{-12}$ and $\varkappa = 2.97 \cdot 10^{-12}$ cm^2/dyne. This good agreement justifies the application of the method to such a crystal as contains a given number of Frenkel' defects per unit volume. Equations

$$\left.\begin{aligned}
&3y\left(\frac{\mathcal{P}_3^6}{r_3^{14}} - r_3^{-8}\right) + \frac{\mathcal{P}_1^6}{r_6^{13}} - \frac{1}{r_6^7} = 0;\\
&\frac{(a+y_c)}{r_1}\left(\frac{\mathcal{P}_1^6}{r_1^{13}} - \frac{1}{r_1^7}\right) + \left(\frac{\mathcal{P}_2^6}{r_2^{13}} - \frac{1}{r_2^7}\right)\frac{y}{r_2} + \\
&\quad + \frac{2y_c}{r_6}\left(\frac{\mathcal{P}_3^6}{r_3^{13}} - \frac{1}{r_3^7}\right) = 0;\\
&\frac{(1+x)}{r_1}\left(\frac{\mathcal{P}_1^6}{r_1^{13}} - \frac{1}{r_1^7}\right) + \frac{(1+x)}{r_2}\left(\frac{\mathcal{P}_2^6}{r_2^{13}} - \frac{1}{r_2^7}\right) - \\
&\quad - \frac{(1-2x)}{r_3}\left(\frac{\mathcal{P}_3^6}{r_3^{13}} - r_3^{-7}\right) = 0;\\
&r_1^2 = (1+x)^2 + (l_0 + y_c)^2;\\
&r_2^2 = y^2 + (1+x)^2;\\
&r_3^2 = (0,5-x)^2 + 0,75 + y_c^2;\\
&r_6^2 = (l_0 + y + y_c)^2.
\end{aligned}\right\} \quad (10)$$

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$$\left.\begin{aligned}
&\frac{(1+x')}{r_7}\left(-\frac{1}{r_7^7}+\frac{\mathcal{P}_1^6}{r_7^{13}}\right)+\\
&+\frac{(1-x')}{r_4}\left(\frac{1}{r_4^7}-\frac{\mathcal{P}_2^6}{r_4^{13}}\right)+\frac{\mathcal{P}_3^6}{r_5^{13}}-r_5^{-7}=0;\\
&\frac{(l_0+y')}{r_7}\left(\frac{\mathcal{P}_1^6}{r_7^{13}}-r_7^{-7}\right)-\\
&-\frac{y'}{r_4}\left(\frac{1}{r_4^7}-\frac{\mathcal{P}_2^6}{r_4^{13}}\right)=0;\\
&r_4^2=(1-x')^2+(y')^2;\ r_5^2=(1+x')^2;\\
&r_7^2=(l_0+y')^2+(1+x')^2.
\end{aligned}\right\} \qquad (11)$$

for the equilibrium state of atoms in the α-and β-planes are numerically solved (Table 1), and thereupon the potential of the interaction energy E_1 of interstitial atoms with the atoms of both planes, and that of the planes among one another (E_2) are determined. To find the equilibrium lattice constant, it is necessary to calculate the minimum of E_1+E_2,

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B136/B201

i. e., the solution of equation $\frac{d}{dl_0}(\Delta E_1+\Delta E_2)=0$. The numerical values of the solution are given in Table 2. The Wigner energy is finally determined: $\Delta W=\Delta E_1+\Delta E_2+\Delta E_3$, where ΔE_3 is the margin of energy in the crystal. Table 3 gives the Wigner energy for some defect concentrations. As an increase of defects with irradiation is unknown, a direct comparison with experimental values is not possible, although it may be performed via the determination of the Wigner energy. The agreement appears to be good up to the region of high defect concentrations, where the neglect of defect interaction leads to deviations. There are 2 figures, 3 tables, and 5 references: 2 Soviet-bloc and 3 non-Soviet-bloc. The reference to the English-language publication reads as follows: B. Baoon, G. Warren, Acta crystallogr., 9, no. 12, 1029, (1956).

SUBMITTED: July 26, 1960

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Theory of irradiation ...

TABLE 1

l_0	x	ν	ν_c	x'	ν'
1,19	0,0185	0,3495	0,2575	0,0527	0,4400
1,20	0,0150	0,3487	0,2500	0,0519	0,4360
1,21	0,0123	0,3475	0,2440	0,0507	0,4320
1,22	0,0100	0,3465	0,2390	0,0498	0,4280
1,23	0,0078	0,3450	0,2340	0,0488	0,4232
1,24	0,0057	0,3440	0,2300	0,0478	0,4190
1,25	0,0040	0,3425	0,2255	0,0467	0,4150
1,26	0,0025	0,3400	0,2220	0,0456	0,4106
1,27	0,0012	0,3370	0,2180	0,0445	0,4065
1,28	0,0000	0,3340	0,2147	0,0434	0,4020
1,29	—0,0013	0,3317	0,2110	0,0423	0,3980
1,30	—0,0025	0,3300	0,2075	0,0413	0,3940
1,31	—0,0036	0,3285	0,2040	0,0404	0,3900
1,32	—0,0048	0,3266	0,2005	0,0397	0,3865
1,34	—0,0067	0,3228	0,1940	0,0386	0,3800
1,36	—0,0086	0,3185	0,1870	0,0372	0,3735
1,38	—0,0102	0,3158	0,1802	0,0358	0,3660
1,40	—0,0115	0,3140	0,1740	0,0343	0,3580
1,42	—0,0128	0,3120	0,1680	0,0328	0,3515
1,44	—0,0139	0,3100	0,1620	0,0314	0,3445
1,46	—0,0150	0,3075	0,1570	0,0300	0,3375

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Tab. 2

d	c_0, Å	r_d	c_0, Å	r_d	c_0, Å
10^{-3}	6,71	$5\cdot10^{-3}$	6,88	$1,5\cdot10^{-2}$	7,00
$2\cdot10^{-3}$	6,77	$6,5\cdot10^{-3}$	6,91	$2\cdot10^{-2}$	7,04
$3\cdot10^{-3}$	6,82	$8\cdot10^{-3}$	6,94	$3\cdot10^{-2}$	7,11
$4\cdot10^{-3}$	6,85	$9\cdot10^{-3}$	6,95	$5\cdot10^{-2}$	7,16

X

Tab. 3

r_d	ΔW, кал/см^3	r_d	ΔW, кал/см^3	r_d	ΔW, кал/см^3
10^{-3}	34,6	$5\cdot10^{-3}$	169,8	$1,5\cdot10^{-2}$	497,0
$2\cdot10^{-3}$	69,0	$6,5\cdot10^{-3}$	210,0	$2,0\cdot10^{-2}$	641,0
$3\cdot10^{-3}$	103,0	$8\cdot10^{-3}$	268,8	$3,0\cdot10^{-2}$	983,2
$4\cdot10^{-3}$	140,0	$9\cdot10^{-3}$	310,0	$5\cdot10^{-2}$	1628,2

AGRANOVICH, V.M.; KONOBEYEV, Yu.V.

Reabsorption in crystals of finite thickness. Part 2.
Opt. i spektr. 11 no.3:369-384 S '61. (MIRA 14:9)
(Crystals—Optical properties)

AGRANOVICH, V.M.; KONOBEYEV, Yu.V.

Effect of the self-absorption of light on the spectral dependence of the photoconductivity of molecular crystals. Opt.i spektr. 11 no.4:498-503 O '61. (MIRA 14:10)

(Crystals--Spectra) (Photoconductivity)

AGRANOVICH, V.M.; GINZBURG, V.L.

X-ray scattering in crystals with formation of excitons. Zhur.eksp. i teor.fiz. 40 no.3:913-919 Mr '61. (MIRA 14:8)

1. Fizicheskiy institut im. P.N.Lebedeva Akademii nauk SSSR.
(X rays--Scattering) (Crystal lattices) (Excitons)

S/903/62/000/000/012/044
B102/B234

AUTHORS: Agranovich, V. M., Odintsov, D. D.

TITLE: Small-angle neutron scattering

SOURCE: Yadernyye reaktsii pri malykh i srednikh energiyakh; trudy Vtoroy Vsesoyuznoy konferentsii, iyul' 1960 g. Ed. by A. S. Davydov and others. Moscow, Izd-vo AN SSSR, 1962, 161-165

TEXT: Yu. A. Aleksandrov (ZhETF, 31, 726, 1956; 32, 154, 1957; 33, 294, 1957) has observed that on fast neutron scattering through small angles (3-5°) a discrepancy arises between as cross section measured and as calculated, when Schwinger interaction is taken into account. The small-angle anomaly might be due to effects of neutron polarization in the nuclear Coulomb field. In order to find out whether there also are other processes participating, the present authors analyze the fundamental possibilities of the following particular effects: (1) interference between spin-orbital and Schwinger interactions, this effect estimated in Born approximation; (2) excitation of the atom due to interaction of the neutron magnetic moment with the electric field of the electron; (3) the presence of several possible intermediate states between initial and final state; (4) spin-independent

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Small-angle neutron scattering

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neutron-electron interaction. Estimates of these effects show that the small-angle anomalies may not be attributed to them since their contributions are negligibly small. The explanation by means of polarization or other effects quadratic in E need further experimental verifications.

ASSOCIATION: Fiziko-energeticheskiy institut Gosudarstvennogo Komiteta Soveta Ministrov SSSR po ispol'zovaniyu atomnoy energii (Physics and Power Engineering Institute of the State Committee of the Council of Ministers of USSR on Utilization of Atomic Energy)

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S/181/62/004/006/051/051
B178/B104

AUTHORS: Agranovich, V. M., and Kaganov, M. I.

TITLE: Structure of exciton bands in anisotropic crystals

PERIODICAL: Fizika tverdogo tela, v. 4, no. 6, 1962, 1681 - 1683

TEXT: The dependence between exciton energy and the wave vector $\vec{q}$ at small $|q|$ is determined on the basis of a semiphenomenological concept. The dependence of the tensor ε_{ik} on the wave vector (if $|q| \to 0$) and the dependence of the diffraction coefficient on the direction of $\vec{q}$ are studied. Instead of the equation $\vec{D} = \hat{\varepsilon}\vec{E}$ a linear relation is assumed between the polarization vector $\vec{P}$ and the electric field:

$$P_i + \beta_{ik} P_k + \gamma_{ikl} \frac{\partial P_k}{\partial x_l} + \alpha_{iklm} \frac{\partial^2 P_k}{\partial x_l \partial x_m} = \Delta_{ik} E_k. \qquad (1)$$

α, β, γ, Δ are constant tensors near the exciton absorption band. In crystals without inversion center $\gamma \neq 0$, which describes an optical activity. With the aid of

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$$\varepsilon_{jk}(\omega,\ q) = \delta_{jk} + 4\pi B_{js}\Delta_{sk},$$

$$B_{jk}^{-1} = -\omega^2\delta_{jk} + \beta_{jk} + i\gamma_{jkl}q_l - \alpha_{jklm}q_lq_m. \qquad (2)$$

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the dispersion $\omega(\vec{q})$ of the light waves can be calculated:

$$q^2(\mathbf{q},\ \hat{\varepsilon}\mathbf{q}) - \frac{\omega^2}{c^2}[(\mathrm{Sp}\,\hat{\varepsilon})(\mathbf{q},\ \hat{\varepsilon}\mathbf{q}) - (\mathbf{q},\ \hat{\varepsilon}^2\mathbf{q})] + \frac{\omega^4}{c^4}|\det\hat{\varepsilon}| = 0. \qquad (4).$$

If $\hat{\varepsilon}_{ik}$ is an analytic function of the wave vector then $\omega(\vec{q})$ is an analytic function of $\vec{q}$. If retardation is neglected ($c \to \infty$) then (4) changes into

$$(\mathbf{s},\ \hat{\varepsilon}(\omega,\ \mathbf{q})\mathbf{s}) = 0,\quad \mathbf{s} = \frac{\mathbf{q}}{|\mathbf{q}|}, \qquad (5).$$

As in anisotropic crystals, the exciton energy is not an analytic function of the wave vector $\vec{q}$. At small $|\vec{q}|$ the dispersion $\omega(\vec{q})$ for waves which are not purely transverse is obtained from the equations (2) and (5). As an example polarization perpendicular to the optical axis is considered: in this case $n^2 = \frac{q^2c^2}{\omega^2}$. The crystal symmetry unambiguously determines the amounts of the tensor components, thus making it possible to determine the structure of the exciton bands in crystals of whatever symmetry. The ambiguity of the limits of the exciton energy is eliminated by taking account of retardation.

SUBMITTED: August 10, 1961 (initially)
March 5, 1962 (after revision)

36772
S/089/62/012/005/003/014
B102/B104

26.2211

AUTHORS: Agranovich, V. M., Mikhlin, E. Ya.

TITLE: Theory of swelling of porous material

PERIODICAL: Atomnaya energiya, v. 12, no. 5, 1962, 385-391

TEXT: The complex mechanism entailed in the swelling of fissile material is not yet known in detail (cf. B. Hayward, G. Bentle, Second Geneva Conference on Peaceful Uses of Atomic Energy, 1958, Paper No. 617). The authors have developed a theory on the basis of a simplified model, with special consideration of the processes occurring before swelling. The pores are assumed to be evenly distributed, spherical and of equal radius (R), and should begin to grow only when the elastic limit is reached as a consequence of fission fragment (gas) diffusion. This moment is considered as the beginning of swelling. The filling of the pores with gaseous fission products (one kind only) is described by Φ, a variable defined by

$$d\Phi = 4\pi RDc\,dt, \qquad (3a)$$

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$$\Phi = 4\pi \int_0^t R(t')\, c(t')\, D(t')\, dt'. \qquad (3b).$$

Φ(t) can be determined if the gas concentration c is known:

$$\Phi(t) = 4\pi c(0) \int_0^t e^{-n\tau(t')} D(t')\, R(t')\, dt' + \qquad (14)$$

$$+ 4\pi \int_0^t R(t')\, D(t') \int_0^{t'} a(t'')\, e^{n[\tau(t'')-\tau(t')]}\, dt''.$$

$$\tau(t) = 4\pi \int_0^t R(t')\, D(t')\, dt'. \qquad (13);$$

n is the pore concentration and D the gas diffusion coefficient. The swelling kinetics is described by $\nu_m(\Phi) = \frac{n}{m!}\Phi^m e^{-\Phi}$, m = 0,1,2... These relations hold, within the framework of the model, for any D(t) and a(t); a is the total amount of gaseous fragments arising per sec and per cm^3. The period t_c between the moment when fission starts (t=0) and that when swelling begins is calculated. For $t < t_c$ D=const, c(0)=0, and $R(t) = R_0$,

$$\Phi(t) = \frac{b\tau}{n} - \frac{b}{n^2}(1 - e^{-n\tau}), \qquad (15)$$

$$\tau(t) = 4\pi R_0 D t; \qquad (16a)$$

$$b = a/4\pi D R_0. \qquad (16b)$$

Theory of swelling of porous material

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hold; a = const denotes here the fragment formation rate. The gas is considered as being ideal, its pressure in a pore containing $\bar{m}(t)$ gaseous fragments, is $P = \bar{m}(t)kT/V_0$, and, since $\bar{m}(t) = \bar{\Phi}(t)$, $P_{crit} = \bar{\Phi}(t)kT/V_0$ at t_c. With Y, the elastic limit, and γ the surface tension coefficient, $P_{crit} = 2Y/3 + 2\gamma/R_0$ and

$$n\tau - (1 - e^{-n\tau}) = \frac{\left(\frac{2}{3}Y + \frac{2\gamma}{R_0}\right)V_0 n^2}{bkT}. \qquad (20).$$

Two limiting cases are considered: 1) $d \ll 1$,

$$d \equiv \frac{4\pi\left(\frac{2}{3}Y + \frac{2\gamma}{R_0}\right)V_0 n^2}{akT} DR. \qquad (21),$$

then $n^2r^2/2 = d$ or

$$t_c = \sqrt{\frac{\left(\frac{2}{3}Y + \frac{2\gamma}{R_0}\right)V_0}{2\pi D R_0 a k T}}; \qquad (22).$$

2) $d \gg 1$, $nr \gg 1$, $nr = d$, and

$$t_c = \frac{\left(\frac{2}{3}Y + \frac{2\gamma}{R_0}\right)V_0 n}{akT}. \qquad (23).$$

$d \lessgtr 1$ corresponds to $t_c \lessgtr t_0 = 1/4\pi DRn$. If creeping is taken into account and is assumed to satisfy the law $dv_r/dr = -(\sigma_\theta - \sigma_r)^s/K$,

$$P(t) < \frac{2}{3}Y + \frac{2\gamma}{R_0}. \qquad (28)$$

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Theory of swelling of porous material

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$$t_{\text{сп}} > \frac{1}{\alpha} \frac{K}{\left(\frac{2}{3}Y + \frac{2\gamma}{R_0}\right)^s}. \qquad (29).$$

v_r is the radial deformation rate, σ_θ and σ_r are the normal stresses and K and s are empirical constants; the subscript п refers to creep; $(t_{\text{cп}} < t_c)$. If the beginning of swelling is caused by creeping,

$$P(t) \simeq \frac{atkT}{nV(t)} < \frac{atkT}{nV_0}, \qquad (33)$$

$$t_c > t_{\text{cп}} > \left[\frac{(s+1)K}{\alpha}\right]^{1/s+1} \left(\frac{nV_0}{akT}\right)^{s/s+1}. \qquad (35).$$

For uranium, t_c is estimated for the irradiation temperatures 327, 427, 527, 727°C: 1.2 years, 200 hrs, 130 hrs, 60 hrs.

SUBMITTED: July 5, 1961
Card 6/6

S/053/62/076/004/002/004
B102/B104

AUTHORS: Agranovich, V. M., and Ginzburg, V. L.

TITLE: Crystal optics with reference to spatial dispersion and exciton theory. I

PERIODICAL: Uspekhi fizicheskikh nauk, v. 76, no. 4, 1962, 643 - 682

TEXT: This paper is the first part (Introduction, § 1, § 2, and first part of references) of a longer work. The present state of crystal optics in the light of recent years' literature is reviewed. The following topics are discussed: § 1. The tensor of the complex dielectric constant $\varepsilon_{ij}(\omega,\vec{k})$ and normal waves in a medium; properties of $\varepsilon_{ij}(\omega,\vec{k})$, normal electromagnetic waves in matter, transverse and longitudinal waves, ghost longitudinal waves and "polarization waves"; energy and other relations for waves propagated in an anisotropic medium. § 2. $\varepsilon_{ij}(\omega,\vec{k})$ in crystals; introduction of ε_{ij}; weak spatial dispersion ($a/\lambda \ll 1$). There are 2 figures and 3 tables.

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S/053/62/077/004/005/006
B102/B104

AUTHORS: Agranovich, V. M., and Ginzburg, V. L.

TITLE: Crystal optics taking account of spatial dispersion and the exciton theory. II

PERIODICAL: Uspekhi fizicheskikh nauk, v. 77, no. 4, 1962, 663 - 725

TEXT: The theory of crystal optics is comprehensively surveyed. Part I (containing sections 1 and 2) appeared in UFN, v. 76, no. 4, 1962, 643 and Part II has the following sections: 3. Crystal optics taking account of spatial dispersion. a) A new wave near the absorption line in a gyrotropic crystal. b) new waves in a non-gyrotropic crystal; c) optic anisotropy of cubic crystals; quadrupole absorption lines; d) effects of mechanical tensions and of external electric and magnetic fields; e) the boundary condition problem; f) experimental investigations of the effects of spatial dispersion in crystal optics. 4. Quantum-mechanical calculation of the tensor $\varepsilon_{ij}(\omega, \vec{k})$. a) A quantum-mechanical expression for $\varepsilon_{ij}(\omega, \vec{k})$; b) mechanical excitons and the tensor $\varepsilon_{ij}(\omega, \vec{k})$ in molecular crystals and

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L 13035-63 EPF(c)/EWT(1)/EWG(k)/EWT(m)/BDS AFFTC/ASD/ESD-3
Pr-4/Pz-4 RM/WW/AT/IJP(C)
ACCESSION NR: AP3000616 S/0181/63/005/005/1373/1376

AUTHOR: Agranovich, V. M.; Konobeyev, Yu. V. 70

TITLE: Diffusion of excitons in molecular crystals ?

SOURCE: Fizika tverdogo tela, v. 5, no. 5, 1963, 1373-1376

TOPIC TAGS: exciton, scattering, diffusion, naphthalene, anthracene, electron, electron excitation, lattice defect, thermal defect, exciton scattering, exciton diffusion, energy transfer, molecular crystal

ABSTRACT: The authors take the experimental data of A. A. Kazzaz and A. B. Zahlan (Phys. Rev., 124, 90, 1961) and analyze them to study the energy transfer of electron excitation from its base substance to an impurity in crystals of naphthalene containing low concentrations of anthracene admixtures. They show that the experimental data obtained by Kazzaz and Zahlan confirm the view that this transfer of energy is effected by "free" excitons, the mean free path of which is determined by the temperature and by scattering through collision either with phonons or with thermal defects in the crystal lattice. Orig. art. has: 4 formulas.

ASSOCIATION: none

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AGRANOVICH, V.M.; KONOBEYEV, Yu.V.

Theory of dielectric permeability of crystals. Fiz. tver tela 5 no.9:2544-2555 S '63. (MIRA 16:10)

AGRANOVICH, V.M.; MIKHLIN, E.Ya.; SEMENOV, L.P.

Kinetics of the swelling of fissionable materials caused by the separation of the gaseous phase from a supersaturated solid solution. Atom. energ. 15 no.5:393-403 N '63. (MIRA 16:12)

AGRANOVICH, V.M.; KONOBEYEV, Yu.V.

Theory of exciton-phonon interaction in molecular crystals.
Fiz. tver. tela 6 no.3:831-841 Mr '64. (MIRA 17:4)

S/0181/64/006/003/0831/0841

ACCESSION NR: AP4019846

AUTHORS: Agranovich, V. M.; Konoboyev, Yu. V.

TITLE: The theory of exciton phonon interaction in molecular crystals

SOURCE: Fizika tverdogo tela, v. 6, no. 3, 1964, 831-841

TOPIC TAGS: exciton, exciton phonon interaction, molecular crystal, Green function, electron phonon interaction, dipole dipole interaction, crystal lattice

ABSTRACT: The authors have used Green's function to investigate the effect of electron-phonon interaction on the spectra of excitons and phonons in molecular crystals. They have assumed that the energy of a crystal is manifested chiefly in dipole-dipole interaction between molecules and that the interaction of excitons with intramolecular vibrations of the nuclei may be neglected. In employing this model of a molecular crystal, they have shown that exciton-phonon interaction may be considered a weak perturbation, not leading to any local deformation of the lattice and, consequently, not leading to the formation of localized excitons. It is concluded, within the framework of the model they have employed for molecular

L 25087-65 EWT(1)/EPA(s)-2/EEC(t) Pt-10/Pl-4 IJP(c) GG

ACCESSION NR: AP5003421 S/0181/65/007/001/0111/0117

AUTHORS: Agranovich, V. M.; Konobeyev, Yu. V.

47
B

TITLE: Theory of long-wave surface excitons in dielectrics

SOURCE: Fizika tverdogo tela, v. 7, no. 1, 1965, 111-117

TOPIC TAGS: exciton, dielectric, polarization, surface state, crystal boundary, crystal conductivity

ABSTRACT: In view of recent experiments performed on absorption lines connected with the excitation of surface excitons, the authors developed, within the framework of the macroscopic approach, a method which makes it possible to determine the polarization and the frequencies of long-wave exciton surface states. It is shown that these characteristics are determined completely by the analytic continuation of the dielectric tensor of the crystal into the region of complex wave vectors, and also in some cases by additional boundary

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ACCESSION NR: AP5003421

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conditions, which must be used to take account of spatial dispersion. The case of surface excitons is considered in some detail for an isotropic medium that borders on vacuum. Two types of surface excitons are found in this case, one with nonzero electric vector, for which there is no need to take account of the spatial dispersion, and one type with zero electric vector and nonzero induction vector, which calls for the use of additional boundary conditions. The approach used is a natural development of the method described by one of the authors previously (Agranovich, with V. L. Ginzburg, UFN, v. 77, 663, 1962), for the investigation of volume excitons with account of spatial dispersion. The limitations of the microscopic approach to the problem are pointed out in the conclusion. "The authors thank V. L. Ginzburg for valuable advice." Orig. art. has: 32 formulas.

ASSOCIATION: None

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AGRANOVICH, Vladimir Moiseyevich; GINZBURG, Vitaliy Lazarevich;
VIRKO, I.G., red.; RAYSKAYA, N.A., red.

[Crystal optics with allowance for spatial dispersion and excition theory] Kristallooptika s uchetom prostranstvennoi dispersii i teoriia eksitonov. Moskva, Nauka, 1965. 374 p. (MIRA 18:5)

L 4068-66 EWT(l)/EWT(m)/T/EWP(t)/EWP(b)/EWA(c) IJP(c) JD/GG

ACCESSION NR: AP5015413 UR/0020/65/162/004/0778/0780

44,55 54

AUTHOR: Agranovich, V. M.; Odintsov, D. D. 44,55 48

B

TITLE: Ion-electron emission of single crystals as a function of target temperature

21,44,55

SOURCE: AN SSSR. Doklady, v. 162, no. 4, 1965, 778-780

TOPIC TAGS: copper, single crystal, secondary electron emission, ion bombardment

ABSTRACT: A method is proposed for calculating the effect which the thermal motion of atoms has on electron emission from a single crystal target bombarded by ions. A formula is derived for the average energy imparted by the first collision of an ion with the atoms of the target. The method proposed in this paper is used in conjunction with a previously derived formula (Ye. S. Mashkova, V. A. Molchanov, D. D. Odintsov, *DAN*, 151, 1074, 1963) to calculate the coefficient of ion-electron emission γ for a copper single crystal target bombarded by 30 kev argon ions. The theoretical curves agree well with experimental data. The effect of variations in temperature on the angular relationships of ion-electron emission in this case is apparently due mainly to changes in the transparency of the crystal (i. e. the probability of the first collision of an ion with atoms of the crystal) rather than

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ACCESSION NR: AP5015413

to the effect of temperature on the electron yield. The agreement between theoretical and experimental data seems to indicate that electrons knocked out by second and subsequent ion-atom collisions do not make any noticeable contribution to electron emission. "The authors are grateful to Ye. S. Mashkova and V. A. Molchanov for giving us the chance to examine their experimental data before publication." Orig. art. has: 2 figures, 1 formula.

ASSOCIATION: none

SUBMITTED: 03Dec64 ENCL: 00 SUB CODE: NP

NO REF SOV: 007 OTHER: 001

BVK.
Card 2/2

L 2331-66 EWT(1)/EPF(c)/T IJP(c) WW/GG

ACCESSION NR: AP5022726 UR/0181/65/007/009/2799/2802

44.55 44,55 29

B

AUTHOR: Agranovich, V. M.; Ovander, L. N.

TITLE: Theory of induced light absorption in crystals 21

SOURCE: Fizika tverdogo tela, v. 7, no. 9, 1965, 2799-2802

TOPIC TAGS: induced absorption, absorption, nonlinear absorption, light interference, frequency doubling, two photon absorption

ABSTRACT: In a theoretical investigation of intensity-induced absorption, an analysis is made of the conditions under which interference effects for two-photon absorption are manifested. The case when the frequency of the two-photon harmonic falls in the exciton absorption band is treated on the basis of the theory of nonlinear effects in a subsystem of excitons with retardation taken into account. It is shown that anharmonicity due to Coulomb interaction can take place when the frequency of the incident wave is almost twice as large as the exciton absorption frequency. Orig. art. has: 12 formulas. [CS]

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L 2331-66

ACCESSION NR: AP5022726

ASSOCIATION: none

SUBMITTED: 25Jan65 ENCL: 00 SUB CODE: SS,OP

NO REF SOV: 006 OTHER: 011 ATD PRESS: 4107

Card 2/2

AGRANOVICH, V.M.; DUBOVSKIY, O.A.

Surface excitons in uniaxial crystals. Fiz. tver. tela 7 no.10:
2885-2889 O '65. (MIRA 18:11)

L 24229-66 EWT(1)/T IJP(c)

ACC NR: AP6014607 SOURCE CODE: UR/0386/66/003/009/0345/0350

54
51
B

AUTHOR: Agranovich, V. M.; Dubovskiy, O. A.

ORG: none

TITLE: Effect of retarded interaction on the exciton spectrum in one-dimensional and two-dimensional crystals

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki. Pis'ma v redaktsiyu. Prilozheniye, v. 3, no. 9, 1966, 345-350

TOPIC TAGS: exciton, photon, crystal structure, luminescence, emission spectrum, half life

ABSTRACT: The authors present an analysis of the effect of retarded interaction in one- and two-dimensional periodic structures, where the conservation laws apply not to the total wave vector, but to only one or two of its projections. The interaction Hamiltonian is expressed in terms of the components of the photon wave vector perpendicular and parallel to the exciton wave vector, using the second-quantization representation and neglecting inessential processes such as umklapp. This leads to an expression for the exciton-photon or photon-exciton conversion with conservation of the parallel wave-vector component. The energies at which

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ACC NR: AP6014607

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singularities appear in the exciton spectrum of planar and chain structures are determined from an analysis of the equations using reasonable values of the exciton lifetime and velocity. It is estimated that retardation comes into play when the dimensions of the crystals exceed the wavelength. The excitons should have in such crystals a lifetime ~10^{-13}--10^{-15} sec, which can be discerned from the luminescence damping time, from the absorption and emission line shapes, and other factors. The authors thank Yu. M. Kagan for discussions and A. S. Davydov and L. N. Ovander for a discussion of this work. Orig. art. has: 14 formulas.

SUB CODE: 20/ SUBM DATE: 06Feb66/ ORIG REF: 004/ OTH REF: 003

Card 2/2 BK

L 26635-66 EWT(1)/EWT(m)/T/EWP(t) IJP(c) JD/AT

ACC NR: AP5025358 SOURCE CODE: UR/0181/65/007/010/2885/2889

AUTHOR: Agranovich, V. M.; Dubovskiy, O. A.

43

13

ORG: None

TITLE: Surface exitons in uniaxial crystals 18

SOURCE: Fizika tverdogo tela, v.7, no. 10, 1965, 2885-2889

TOPIC TAGS: exciton , uniaxial crystal, electrodynamics, crystal surface

ABSTRACT: If surface layer thickness in which a surface exciton was located, significantly exceeded the lattice constant, the problem of determining frequencies and exciton state polarizations could be solved within the limits of phenomenological electrodynamics. The exciton surface state which developed in uniaxial crystals of tetragonal, trigonal and hexagonal systems were examined. The question was examined of the existence of a state of surface excitons in uniaxial crystals depending on the orientation of the optic axis and the crystal surface. It was indicated that the energy of surface excitons with $E \neq 0$ is, generally speaking, a nonanalytic function of the two-dimensional wave vector.

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