TYABLIKOV, S.V.

USSR / Magnetism . Antiferromagnetism F - 5

Abs Jour : Ref Zhur - Fizika, No 4, 1957, No 9541

Author : Tyablikov, S.V.

Inst : ~~Mathematical Institute~~ Institute imeni Steklov, Academy of Sciences USSR, Moscow

Title : Concerning the Theory of Antiferromagnetism

Orig Pub : Fiz. metallov i metallovedeniye, 1956, 2, No 2, 193-205

Abstract : With the aid of one of the variants of the method of approximate second quantization, the author computes the magnetization and susceptibility of an antiferromagnetic as a function of the temperature and of the external magnetic field. For weak fields, the results are in agreement with those obtained by Hulten (Hulten, L., Proceedings Royal Academy of Sciences, Amsterdam, 1936, 39, 190):

$$M \sim 1 + c_1 T^{3/2}, \left(0 < 1 - \frac{\mu H}{2|J_{12}|} \ll 1\right)$$

Card : 1/2

USSR / Magnetism. Antiferromagnetism

F-5

Abs Jour : Ref Zhur - Fizika, No 4, 1957, No 9541

Abstract : where c is the certain constant and J_{12} is a quantity that characterizes the exchange interaction of the anti-parallel spins. In stronger fields one obtains the following formulas for the magnetization:

$$M \sim 1 + c_1 T^{3/2}, \left(0 < 1 - \frac{\mu H}{2|J_{12}|} \ll 1\right)$$

and:

$$M \sim 1 - c_1 T^{3/2}, \left(0 < \frac{\mu H}{2|J_{12}|} - 1 \ll 1\right)$$

Card : 2/2

TYABLIKOV, S.V.

USSR / Magnetism. Ferromagnetism F-4

Abs Jour : Ref Zhur - Fizika, No 4, 1957, No 9504

Author : Tyablikov, S.V., Gusev, A.A.
Inst : *Mathematics Institute imeni V.A. Steklov, Academy of Sciences USSR; **Foreign Literature Press.

Title : Dependence of the Constants of Magnetic Anisotropy of Cubic Crystals on the Temperature and on the Field.

Orig Pub : Fiz. metallov i metallovedeniye, 1956, 2, No 3, 385-390

Abstract : Using the method of approximate second quantization, the authors calculate the dependence of the magnetic-anisotropy constants of crystals of the cubic system on the temperature and on the external magnetic field under the assumption that the terms of the Hamiltonian of the system, responsible for the anisotropy, can be represented in the form of the fourth form relative to the spin operators.

Card : 1/1

TYABLIKOV, S.V.

USSR / Magnetism. Ferrites F-6

Abs Jour : Ref Zhur - Fizika, No 4, 1957, No 9549

Author : Tyablikov, S.V.
Inst : Mathematics Institute imeni V.A. Steklov, Academy of Sciences USSR, Moscow

Title : Calculation of Magnetization of Ferrites as Function of the Temperature and Fields.

Orig Pub : Fiz. metallov i metallovedeniye, 1956, 3, No 1, 3-10

Abstract : The author calculates the dependence of the magnetization on the temperature and on the field for ferromagnetic semi-conductors, which are represented in accordance with the Neel model as an aggregate of two ferromagnetic lattices with non-vanishing total magnetic inserted in eahh other.

Card : 1/1

Tyablikov, S. V.

The ground state of an antiferro...

TYABLIKOV, S.V.

SUBJECT USSR / PHYSICS CARD 1 / 2 PA - 1390
AUTHOR TOLMACEV, V.V., TJABLIKOV, S.V.
TITLE A Method for the Computation of the Statistical Sums for Ferromagnetica in Consideration of the Restrictions Imposed upon the Filling Numbers of the Spin Waves.
PERIODICAL Dokl.Akad.Nauk, 108, fasc. 6, 1029-1031 (1956)
Issued: 9 / 1956 reviewed: 10 / 1956

The present representation of this method takes into account that the projection of the spin of every atom (in $\hbar$ /2 units) assumes only the two values $\pm$ 1 if one electron corresponds to each atom.
At first the HAMILTONIAN of the ferromagneticum is written down, after which one passes from spin operators to BOSE operators. Also on this occasion one electron is supposed to correspond to each atom. The HAMILTONIAN in this new variable is written down as a sum of three summands $\mathcal{H} = E_0 + \mathcal{H}_1 + \mathcal{H}_2$, and each summand is explicitly given. The equations $\mathcal{H}\phi = E\phi$ for the determination of eigenfunctions and eigenvalues are to be investigated only within the space of the filling-up numbers $n_f = 0,1$. However, in order to simplify further computations, this equation is examined in all spaces of all possible filling-up numbers; the restriction to $n_f = 0,1$ is taken into account by the introduction of an operator $P = \prod_{(f)} \{ \Delta(n_f) + \Delta(n_f - 1) \}$. Here $\Delta(n) = 1$ and $\Delta n = 0$ is true for n=0 and $n \neq 0$ respectively. This operator P projects

Dokl.Akad.Nauk, 108, fasc. 6, 1029-1031 (1956) CARD 2 / 2 PA - 1390

the functions applying within the space of all possible filling-up functions on to the functions in the space with $n_f = 0, 1$.

In zero-th approximation $Z_o = Sp(e^{-\mathcal{H}_o/\Theta})$ is true for the sum of states, on which occasion the trace is extended to the space of the numbers $n_f = 0, 1$. $Z_o = Sp(P \exp[-\mathcal{H}_o/\Theta])$ is true in the space of all possible filling-up numbers. The computation of Z_o is simplified considerably by making use of an orthonormalizing system; the rather complicated expression found is explicitly given. There follows herefrom at low temperatures

$$Z_o \approx 1 + \sum_{(v)} e^{-E(v)/\Theta}.$$

According to information received from N.N.BOGOLJEBOV similar ideas were already developed by DYSON in manuscripts meanwhile received while the present work was being printed.

INSTITUTION: Mathematical Institute V.A.STEKLOV of the Academy of Science in the USSR

48-6-13/23

SUBJECT: USSR/Physics of Magnetic Phenomena

AUTHORS: Bogolyubov, N.N. and Tyablikov, S.V.

TITLE: Approximate Methods of Secondary Quantization in the Quantum Theory of Magnetism (Priblizhennyye metody vtorichnogo kvantovaniya v kvantovoy teorii magnetizma)

PERIODICAL: Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya, 1957, Vol 21, #6, pp 849-853 (USSR)

ABSTRACT: The problem of a rigorous calculation of the energetic spectrum for ferromagnetic materials is extremely difficult, and therefore, approximate methods were devised for its treatment.

These methods enter into two stages of calculations:

1. The constructing of a simplified "model" Hamiltonian which conveys characteristic peculiarities of a studied dynamic system;
2. The formulation of an approximate method for such a simplified Hamiltonian.

The starting point in constructing the simplified Hamiltonian is a rigorous Hamiltonian of the system in secondary quantization presentation. However, only a part of the atomic wave functions is accounted in actual calculations, following the ideas

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48-6-13/23

TITLE: Approximate Methods of Secondary Quantization in the Quantum Theory of Magnetism (Priblizhennyye metody vtorichnogo kvantovaniya v kvantovoy teorii magnetizma)

of Ritz.

Then an approximate method is applied to this simplified Hamiltonian. The resulting form coincides with the form of the second variation in the quasi-classical treatment.

Since in this approximation the Hamiltonian is a quadratic form of Bose-operators, its diagonalization does not present any difficulties.

This method of calculating the energetic spectrum of weakly-excited states was applied by the authors to the theory of ferromagnetic materials and led to the known results in the Bloch theory of spin waves. When spin-spin and spin-orbital interaction terms are included into the Hamiltonian, it is possible to calculate the temperature- and field intensity-dependence of the magnetic anisotropy (4, 5) and the magnetostriction (6). The methods developed were also applied to the theory of antiferromagnetism (2).

Card 2/3 There are 11 references, 10 of which are Russian.

48-6-13/23

TITLE: Approximate Methods of Secondary Quantization in the Quantum Theory of Magnetism (Priblizhennyye metody vtorichnogo kvantovaniya v kvantovoy teorii magnetizma)

ASSOCIATION: Physical Department of the Moskva State University imeni Lomonosov.

PRESENTED BY:

SUBMITTED: No date indicated.

AVAILABLE: At the Library of Congress.

Card 3/3

TYABLIKOV, S.V.

SUBJECT: USSR/Physics of Magnetic Phenomena 48-6-29/35

AUTHORS: Gusev, A.A. and Tyablikov, S.V.

TITLE: On Dependence of Magnetic Anisotropy Constants on Temperature and Field Intensity in Cubic Crystals (O zavisimosti konstant magnitnoy anizotropii kubicheskikh kristallov ot temperatury i polya)

PERIODICAL: Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya, 1957, Vol 21, #6, p 887 (USSR)

ABSTRACT: The Hamiltonian of a system of electrons causing ferromagnetism in the Heitler-London model can be presented as a series expanded by even powers of spin operators.

When the cubic symmetry of the lattice is taken into account up to the terms of the fourth power, it is possible, by means of an approximate second quantization method, to determine the energetic spectrums of the system, to calculate the free energy and to find formulae for the constants of magnetic anisotropy as functions of temperature and magnetic field intensity.

An approximate expression is given for the first constant of magnetic anisotropy in a cubic ferromagnetic monocrystal.

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TITLE: On dependence of Magnetic Anisotropy Constants on Temperature and Field Intensity in Cubic Crystals (O zavisimosti konstant magnitnoy anizotropii kubicheskikh kristallov ot temperatury i polya)

This report in details was published in "ФММ", 1956, Vol 2, p 385. No references are cited.

ASSOCIATION: Moskva State University imeni Lomonosov.

PRESENTED BY:

SUBMITTED: No date indicated.

AVAILABLE: At the Library of Congress.

Card 2/2

TYABLIKOV, Sergey Vladimirovich; GUSEV, A.A., red.

[Methods in the quantum theory of magnetism] Metody kvantovoi teorii magnetizma. Moskva, Nauka, 1965. 334 p. (MIRA 16:4)

KRYMOV, Yu.S.; TVERSKOY, B.A.

Changes in the energy of particles in a dipole field in transitions between various drive surfaces. Geomag. i aer. 4 no.2:397-399 Mr-Ap '64. (MIRA 17:4)

1. Moskovskiy gosudarstvennyy universitet Institut yadernoy fiziki.

20-114-6-20/54

AUTHORS: Tyablikov, S. V., Tolmachev, V. V.

TITLE: Distribution Functions for the Classic Electron Gas (Funktsii raspredeleniya dlya klassicheskogo elektronnogo gaza)

PERIODICAL: Doklady Akademii Nauk SSSR, 1957, Vol. 114, Nr 6, pp. 1210-1213 (USSR)

ABSTRACT: According to the author's opinion various methods (mentioned here), in spite of their effectiveness in the calculation of concrete problems, are not suitable for the removal of difficulties in the construction of a radial function in systems with pure Coulomb interaction. It was the object of the present paper to improve the convergence of the development by N. N. Bogolyubov for small intervals. First the system of nonlinear integral equations obtained by N. N. Bogolyubov for Debye's expression G(r) for the radial function is written down. In it the author replaces the unknown functions and in this manner obtains the system –

$$V(|q|) = \Phi(|q|) - \bar{\Phi}(|q|) + \frac{1}{v}\int dq_1 \left\{ e^{-\bar{\Phi}(|q_1|)/\theta} C(|q_1|) - 1 \right\}.$$

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20-114-6-20/54

Distribution Functions for the Classic Electron Gas

$$\cdot \int_{\infty}^{|q-q_1|} dr \frac{d\Phi(r)}{dr} = e^{-\bar{\Phi}(r)/\theta} C(r); \quad C(|q|) = \exp\left\{-\frac{1}{\theta} V(|q|)\right\}.$$

For the solution of this problem the author puts down

$\frac{1}{\theta}\Phi(|q|) = v\Psi(|q|)$, $\frac{1}{\theta}\bar{\Phi}(|q|) = v\,\bar{\Psi}(|q|)$. For the determination of V and C the series developments are put down according to exponents of v:

$$C(|q|) = C_0(|q|) + v\,C_1(|q|) + v^2C_2(|q|) + \dots\dots\dots$$

$$V(|q|) = V_0(|q|) + v\,V_1(|q|) + v^2V_2(|q|) + \dots\dots\dots$$

The thus obtained equations of zeroth and first approximation and the correction of first approximation are written down. A Coulomb potential with Debye screening is obtained:

$$\bar{\Phi}(|q|) = \frac{e^2}{|q|} e^{-|q|/r_d}.$$

Then the solution of second approximation equations is written down. In disregard of second and higher approximation corrections the following expression is obtained for the radial function:

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Distribution Functions for the Classic Electron Gas 20-114-6-20/54

$G(r) = \exp\left\{-\frac{e^2}{\Theta}\frac{1}{r}e^{-r/r_d}\right\}$ This function can be obtained without ternary approximation. The here discussed considerations might, after several alterations, be applied to systems of charged particles with different sign of charge. There are 2 references, 2 of which are Slavic.

ASSSOCIATION: Mathematical Institute imeni V. A. Steklov of the AS USSR (Matematicheskiy institut im. V. A. Steklova Akademii nauk SSSR)

PRESENTED: December 27, 1957, by N. N. Bogolyubov, Member of the Academy

SUBMITTED: December 14, 1956

Card 3/3

TYABLIKOV, S.V.; TOLMACHEV, V.V.

Classical theory of strong electrolytes. Nauch. dokl. vys. skoly; fiz.-mat. nauki no.1:101-109 '58. (MIRA 12:3)

1. Matematicheskiy institut im. V.A. Steklova. (Electrolytes)

16(1)

AUTHOR: Tyablikov, S.V. SOV/155-58-5-31/37

TITLE: Generalized Variation Principle for the Several-Bodies Problem

PERIODICAL: Nauchnyye doklady vysshey shkoly. Fiziko-matematicheskiye nauki, 1958, Nr 5, pp 183-191 (USSR)

ABSTRACT: In /"Ref 2_7 N.N. Bogolyubov formulates a generalized variation principle for the several-bodies problem of quantum mechanics by seeking the minimum of the functional corresponding to the mean system energy on an extended class of "vacuum" functions. In the present paper the author derives the equations of this generalized method and the conditions for the stability of the solutions in a somewhat modified form which is easier for the representation in coordinates. - There are 5 references, 4 of which are Soviet, and 1 German.

ASSOCIATION: Matematicheskiy institut Akademii nauk imeni V.A.Steklova (Mathematical Institute, AS imeni V.A. Steklov)

SUBMITTED: May 6, 1958

Card 1/1

HUNGARY/Magnetism - Ferromagnetism. F

Abs Jour : Ref Zhur Fizika, No 4, 1960, 8899

Author : Siklos Tivadar, Tyablikor SZ. V.

Inst : -

Title : On the Quantum Theory of Ferromagnetic Anisotropy of Uniaxial Crystals.

Orig Pub : Magyar tud. akad. Kosp. fiz. Kutato int. Kozl., 1958, 6, No 5, 408-419

Abstract : The anisotropy of magnetic properties of ferromagnetic crystals is considered as a result of anisotropic interaction between the electrons of the unfilled atomic shells. The energy spectrum of the electrons of magnetic uniaxial ferromagnetic crystals are calculated as functions of the saturation magnetization, measured in directions parallel to an perpendicular to the principal axes of the crystal, on the temperature, and on the external magnetic field.

Card 1/1

TYABLIKOV, S. V.

AUTHORS: Tolmachev, V. V., Tyablikov, S. V. 56-1-11/56

TITLE: A New Method in the Theory of Superconductivity. II. (O novom metode v teorii sverkhprovodimosti. II).

PERIODICAL: Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, 1958, Vol. 34, Nr 1, pp. 66-72 (USSR)

ABSTRACT: The present paper shows the equivalence of the Hamiltonians of the systems of Bardin and Fröhlich, and thus establishes the superconductivity of the Bardin Hamiltonian obtained in this way. For the calculations the Bogolyubov method is used. It is a characteristic feature of the electronphonon interaction discussed here that it is effective only in a very thin layer on the Fermi level, and considerably decreases when the distance from this level is increased. Therefore the electron transitions on the Fermi level can essentially contribute to all effects. In this case the energy of the electron transitions may be regarded as small compared to the energy $\hbar\omega$ of the phonons. Here a typical adiabatic combination occurs. At the beginning the Hamiltonian of the system investigated here is put down. Next the operator form of the perturbation theory is used. The determination of the

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A New Method in the Theory of Superconductivity. II. 56-1-11/56

eigenfunctions and eigenvalues is reduced to the solution of an equation with a certain "deformed" factor. This equation is put down here in an explicit form with an exactness up to the order of magnitude of g^2 inclusive. The authors here investigate the case of the phonon vacuum. The application of the perturbation theory to the operator used here leads to logarithmical divergences if the distance from the Fermi level is increased. Then a canonical transformation is exercised on the operators. The trivial solution of the system of equations with corresponding calculations corresponds to the normal (not superconducting) state of the system. Then asymptotic terms for the non-trivial solution are given. The energy of the elementary excitations is calculated in the first approximation with respect to g^2. After that the authors prove that the superconducting state is more profitable as to energy than is the normal state. The formulae received here are hardly susceptible to a change of the form of the reciprocal actions assumed here. The results discussed as yet were received in the first perturbation theory approximation. But the compensation of the diagrams of the

Card 2/3

A New Method in the Theory of Superconductivity. II. 56-1-11/56

second degree (g^4) does not change the results. There are 2 figures, and 5 references, 2 of which are Slavic.

ASSOCIATION: Mathematical Institute of the AN USSR (Matematicheskiy institut Akademii nauk SSSR).

SUBMITTED: October 17, 1957

AVAILABLE: Library of Congress

Card 3/3

AUTHORS: Tyablikov, S. V., Tolmachev, V. V. SOV/56-34-5-29/61

TITLE: Electron Interaction With Lattice Vibrations (O vzäimodeystvii elektronov s kolebaniyami reshetki)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958, Vol. 34, Nr 5, pp. 1254 - 1257 (USSR)

ABSTRACT: The authors investigate the problem of the stability taking into consideration the interaction of the electrons with the phonon field. The authors start from the following Hamiltonian for the interaction of the electrons with the lattice vibrations

$$H = H_0 + H_{int}, \quad H_0 = \sum_{k,\sigma} \mathcal{E}(k) a^+_{k\sigma} a_{k\sigma} + \sum_q \hbar\omega(q) b^+_q b_q$$

$$H_{int} = \frac{g}{\sqrt{2V}} \sum_{k,k',\sigma} \sqrt{\hbar\omega(k'-k)} \left(a^+_{k'\sigma} a_{k\sigma} b_{k'-k} + a^+_{k\sigma} a_{k'\sigma} b^+_{k'-k} \right)$$

$a^+_{k\sigma}$, $a_{k\sigma}$, and b^+_k, b_k respectively denote the creation- and annihilation operators of the electrons and the phonons re-

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spectively, and F denotes the volume of the domain of the main periodicity. The authors are interested in phonons with sufficiently low energies, where $\hbar\omega \ll \Delta\varepsilon$ denotes the mean difference of the energies in the electron transitions. By means of the so-called adiabatic approximation in the form given by Bogolyubov and Tyablikov (Refs 2, 3) a good conception concerning the phenomena connected with this process can be obtained. The Hamiltonian mentioned above is transformed to a subspace of states every one of which is, with regard to the electrons, a Fermi vacuum. The solution of the resulting equation is not difficult. The corresponding secular equations are written down. The Hamiltonian mentioned above does not contain any Coulomb (Kulon) interaction. If the Coulomb (Kulon) interaction is inserted the criterion for the stability of the crystal lattice will be different. The conclusion, however, that the lattice is unstable in the case of sufficiently high binding constants probably remains valid. Subsequently it is shown that the criterion for the stability of the lattice can be obtained easily by applying the principle of the compensation of the "dangerous diagrams".

Math. Inst. Acad Sci USSR

AUTHORS: Tolmachev, V. V., Tyablikov, S. V. 20-119-2-35/60

TITLE: On the Classical Theory of Strong Electrolytes (K klassicheskoy teorii sil'nykh elektrolitov)

PERIODICAL: Doklady Akademii Nauk SSSR, 1958, Vol. 119, Nr 2, pp. 314 - 317 (USSR)

ABSTRACT: The main aim of the theory of strong electrolytes is the calculation of the correction ΔF for the free energy deriving from the interaction of the ions. A considerable step forward in this field was made by Debye (Debaye), who correctly took into account the electrostatic interaction of the ions. First various expressions for ΔF found by Debye(Debaye), E. Hückel (Gyukkel')(Reference 1) and N. Bjerrum (Reference 2) are put down. The present paper deals with the problem of the static reasoning of the just mentioned corrections by means of correlation functions by N.N Bogolyubov. The system of the equations for the correlations functions and an approach to a solution belonging to it are put down. The course of calculation is followed step by step and the obtained expression for ΔF is mentioned.

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On the Classical Theory of Strong Electrolytes 20-119-2-35/60

Then the author shows the following: in this expression for $\triangle$F the Bjerrum correction is contained (at least for small concentrations of ion pairs of different signs which are close to eachother. For reasons of simplicity the author investigates the special case of the electrolytes with two types of ions with the same absolute values of charge. In this case the above-mentioned formula for $\triangle$F can be simplified. An exact comparison of the here found formula for $\triangle$F with the corresponding expression of the Bjerrum theory will be possible only after the numerical calculation of the integrals. According to the authors the here found results explain sufficiently the basic trends of the Bjerrum theory. The authors thank N. N. Bogolyubov, Member of the Academy, for the discussion on this work. There are 8 references, 4 of which are Soviet.

ASSOCIATION: Matematicheskiy institut im. V. A. Steklova Akademii nauk SSSR(Mathematical Institute imeni V. A. Steklov, AS USSR)

Card 2/2

AUTHOR: Tyablikov, S. V. SOV/20-121-2-15/53

TITLE: On a Variation Principle in the Many-Body-Problem (Ob odnom variatsionnom printsipe v zadache mnogikh tel)

PERIODICAL: Doklady Akademii nauk SSSR, 1958, Vol. 121, Nr 2, pp. 250 - 252 (USSR)

ABSTRACT: In a paper recently published (Ref 1) N.N.Bogolyubov has set up a variation principle in the many-body-problem. The author of the present paper investigates, under which conditions the generalized method of Bogolyubov provides a minimum for the energy of a system in its ground state and under which condition this minimum is obtained by the ordinary method of Fok (Ref 2). A system of N interacting Fermi particles is examined and the Hamiltonian H as well as the expression for $\bar{H}$ is set up for it according to Bogolyubov. For $\mathcal{E}$, the energy of the system under consideration, it is postulated $\mathcal{E}$ = min and there is obtained

$$\delta^2 \mathcal{E} = 2 \sum_{(f,\nu)} E(\delta v^*_{f\nu} \delta v_{f\nu} + \delta u^*_{f\nu} \delta u_{f\nu}) \quad (15)$$

Card 1/2

On a Variation Principle in the Many-Body-Problem SOV/20-121-2-15/53

where E are the eigenvalues and δv, δu the eigenfunctions of the system of equations (16) for $E\delta u_{f_1\nu}$ written down next. It becomes evident that (15) becomes positive, if (16) has no negative eigenvalues. So Fok's solution does not provide a minimum for $\mathcal{E}$ in every case. From (16) also follows N.N.Bogolyubov's criterion for the occurrence of a superfluidity in nuclear matter. The new method is also practical for investigating different problems in the electron theory of solid bodies with regard to the crystal lattice and for determining the criteria for superconductivity taking into consideration the lattice. There are 3 references, which are Soviet.

ASSOCIATION: Matematicheskiy institut im. V.A.Steklova Akademii nauk SSSR (Mathematical Institute imeni V.A.Steklov, AS USSR)

PRESENTED: March 12, 1958, by N.N.Bogolyubov, Member, Academy of Sciences, USSR

Card 2/2

24(0)

SOV/30-59-7-36/50

AUTHOR: Tyablikov, S. V.

TITLE: Investigations Concerning the Theory of Semiconductors (Issledovaniya po teorii poluprovodnikov)

PERIODICAL: Vestnik Akademii nauk SSSR, 1959, Nr 7, p 105 (USSR)

ABSTRACT: From April 2 to 9 the third conference on the theory of semiconductors took place in L'vov. About 120 scientists from Moscow, Leningrad, Kiyev, Khar'kov, Tbilisi, L'vov, Sverdlovsk, Tashkent, Kazan', Tomsk, Chernovtsy and Tartu participated in it. More than 80 reports were presented, among others on the theory of exciton, of electromagnetic waves in crystals in the field of exciton absorption, and the multi-electron theory of semiconductors. Reports were also made on the investigations of the energetic spectrum of conductors for concrete ~~type of crystal~~ lattices, and on a number of studies of problems of kinetics and of spark-overs in semiconductors. Due to time pressure only half of the reports were read, the rest was distributed in the form of summaries of the basic principles. A number of seminars on various questions were held. The conference made evident an increase in the number and quality of research undertakings concerning the theory of semiconductors.

Card 1/1

AUTHOR: Tyablikov, S.V. SOV/126-8-1-22/25

TITLE: The Ground State and the Spectrum of Elementary Excitations of an Isotropic Ferrite

PERIODICAL: Fizika metallov i metallovedeniye, 1959, Vol 8, Nr 1, pp 152-154 (USSR)

ABSTRACT: It has recently been shown that the temperature dependence of the magnetization of ferrites is either T^2 or $T^{3/2}$ (Refs 1-6). The estimates were based on the Neel model. The author (Ref 6) has argued that this is due to different approximations which were made in the introduction of the model of the ferrite. In the present paper a ferrite is looked upon as a combination of two sub-lattices and the Hamiltonian used is given by Eq (1). It is argued that in weak fields the $T^{3/2}$ dependence is probably more correct.
There are 6 Soviet references.

ASSOCIATION: Matematicheskiy institut imeni A.V. Steklova (Mathematical Institute imeni A.V.Steklov)

SUBMITTED: July 28, 1958

Card 1/1

16(1),24(3) SOV/41-11-3-7/16

AUTHOR: Tyablikov, S.V.

TITLE: Lagging and Anticipating Green's Functions in the Theory of Ferromagnetism

PERIODICAL: Ukrainskiy matematicheskiy zhurnal, 1959, Vol 11, Nr 3, pp 287-294 (USSR)

ABSTRACT: The author proposes a method for the calculation of the thermodynamic characteristics of ferromagnetics with the aid of lagging and anticipating Green's temperature functions. The application of this function is very suitable since the analytic continuation in the complex plane is possible. In the first approximation the Green's function has poles on the real axis; herefrom the energy of the elementary excitation is obtained. In the second approximation the notion of the energy of the elementary excitation in the strong sense looses its sense and can be considered approximately only under neglect of the fading. The author mentions Primakov, and the Academician N.N.Bogolyubov. There are 7 references, 3 of which are Soviet, 1 German, 1 English, 1 American, and 1 Dutch.

SUBMITTED: March 23, 1959

Card 1/1

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16(1)

AUTHORS: Mitropol'skiy, Yu.A., and Tyablikov, S.V. SOV/41-11-3-8/16

TITLE: Nikolay Nikolayevich Bogolyubov (on the Occasion of his 50th Birthday)

PERIODICAL: Ukrainskiy matematicheskiy zhurnal, 1959, Vol 11, Nr 3, pp 295-311 (USSR)

ABSTRACT: The authors give some biographical data and a survey on the most essential scientific results of Bogolyubov: He was born on August 21, 1909 in Gor'kiy. Since 1923 he was in the seminar of the Academician N.M.Krylov; in 1924 he published his first paper; in 1928 he published his dissertation; in 1930 he became Dr.math.h.c., in 1939 he became a corresponding member of the AS Ukr.SSR, and in 1953 Academician of the AS USSR. Bogolyubov has two Stalin prizes, a Lenin prize, two Lenin orders, four further distinctions, and the Merlani prize (Bologna).

There is a photo of Bogolyubov and a list of his 179 publications with translations in other languages.

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24(0)
SOV/53-69-1-9/11

AUTHORS: Mitropol'skiy, Yu. A., Tyablikov, S. V.

TITLE: Nikolay Nikolayevich Bogolyubov (Nikolay Nikolayevich Bogolyubov) (On the Occasion of His Fiftieth Birthday) (k pyatidesyatiletiyu so dnya rozhdeniya)

PERIODICAL: Uspekhi fizicheskikh nauk, 1959, Vol 69, Nr 1, pp 159-164 (USSR)

ABSTRACT: On August 21, 1959 the well-known Soviet theoretical physicist N. N. Bogolyubov celebrated his 50th birthday. He was born at Gor'kiy, worked at the seminar of N. M. Krylov already in 1923, and wrote his first scientific paper in 1924; in 1925 he was Aspirant at the Chair for Mathematical Physics of the AS USSR, and defended his dissertation in 1928. Two years later he was awarded the title of Doctor h. c. ; in 1939 he became Corresponding Member, AS UkrSSR, in 1947 he was appointed Corresponding Member AS USSR, in 1948 Real Member AS UkrSSR, and in 1953 he became Real Member AS USSR. He began his scientific career as a mathematician and published a number of papers (calculus of variations, theory of periodic functions, differential equations) together with his teacher N. M. Krylov.

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SOV/53-69-1-9/11

Nikolay Nikolayevich Bogolyubov.
(On the Occasion of His Fiftieth Birthday)

Later, he occupied himself with the theory of nonlinear oscillations and developed approximation methods in the field of nonlinear mechanics; he then passed on the asymptotic methods in statistical mechanics and statistical physics, and published, among others, a number of papers in the field of statistical physics of classical systems. He developed a method of distribution functions and of generating functionals for the solution of the main problem of statistical physics - the calculation of thermodynamic functions by means of the molecular characteristics of the substance, in which connection he developed a theory of non-perfect gases. By means of the mathematical apparatus of distribution functions he further dealt with the nonequilibrium processes as well as with problems of quantum systems; he developed a method of approximative second quantization in order to remove the difficulties arising in connection with the symmetry of the density matrix. He further dealt with the theory of the degeneration of non-perfect gases and made the first step towards developing a microscopical theory of the superfluidity of He II. Further work was devoted to problems of supraconductivity, and in

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Nikolay Nikolayevich Bogolyubov.
(On the Occasion of His Fiftieth Birthday)

recent times he paid particular attention to the quantum theory. Besides, he was interested in pedagogical and scientific organization. Since 1936 he held a chair, first at Kiyev, but later at Moskovskiy gosudarstvennyy universitet (Moscow State University), from 1946-49 he was Dean at the mechanical-mathematical department of Kiyev State University imeni T. G. Shevchenko. Bogolyubov further supervised the work of a number of departments of the AS UkrSSR, recently the Otdel teoreticheskoy fiziki Matematicheskogo instituta im. V. A. Steklova AN SSSR (Department of Theoretical Physics of the Mathematics Institute imeni V. A. Steklov of the AS USSR). He is director of the Laboratoriya teoreticheskoy fiziki Ob"yedinennogo instituta yadernykh issledovaniy (Laboratory for Theoretical Physics of the Joint Institute of Nuclear Research). Under his supervision about 50 dissertations of persons aspiring for the degrees of Candidate or Doctor were defended. He founded schools for nonlinear mechanics (Kiyev) and theoretical physics (Moscow, Dubna, Kiyev).

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Nikolay Nikolayevich Bogolyubov. SOV/53-69-1-9/11
(On the Occasion of His Fiftieth Birthday)

He published about 200 scientific papers and 15 monographs, the most important of which are listed in chronological order. Bogolyubov was awarded the Prize imeni M. V. Lomonosov, two Stalin Prizes, and one Lenin Prize (1958). There are 1 figure and 62 references, 60 of which are Soviet.

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24(5)

AUTHORS: Bogolyubov, N. N., Academician, Tyablikov, S. V. SOV/20-126-1-13/62

TITLE: Green's Retarded and Advance Functions in Statistical Physics (Zapazdyvayushchiye i operezhayushchiye funktsii Grina v statisticheskoy fizike)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 126, Nr 1, pp 53-56 (USSR)

ABSTRACT: The present paper reports on a method of approximation of solving problems in statistical physics. The method is based on the investigation of two-dimensional retardation and advance Green functions. The essential factor is the use of spectral representations of the Lehmann-Callén type (Refs 2, 3). Some previous papers on this subject are pointed out. The authors use Green functions of the type:
$G_r(t - t') \equiv \langle\langle A(t), B(t') \rangle\rangle_r = \theta(t - t') \langle [A(t); B(t')] \rangle$;
$G_a(t - t') \equiv \langle\langle A(t), B(t') \rangle\rangle_a = -\theta(t' - t) \langle [A(t); B(t')] \rangle$, in which $\langle \mathfrak{U} \rangle = Q^{-1} Sp(\mathfrak{U} e^{-H/\mathcal{T}})$ and $Q = Sp(e^{-H/\mathcal{T}})$. The ascertainment of the mean value is carried out by means of a large number of equations so that H includes the term $-\lambda N$. λ denotes the chemical potential, and N the number of particles. A(t), B(t) denote the operators in the Heisenberg representation, they are products of the quantized field

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functions. It is not difficult to obtain branched chains of equations for these Green functions. The resulting chain of equations is not only equal for the retardation and advance Green functions, but it also remains equal for Green functions of the Schwinger type: $G(t - t') = \langle T(A(t)B(t'))\rangle$ with T-products. In spite of this, the retardation and advance functions have the essential advantage over Schwinger's function's that they can be continued into the complex plane. In fact, the authors investigate the Fourier expressions $G_j(t-t') = \int_{-\infty}^{\infty} S_j(E) e^{-iE(t-t')} dE$, $S_j(E) = \frac{1}{2\pi}\int_{-\infty}^{\infty} G_j(t) e^{iEt} dt$ $(j = a, r)$. As at $t < 0$, $G_r(t) \equiv 0$, and at $t > 0$, $G_a(t) \equiv 0$, it results that, under the usual assumptions, $S_r(E)$ can be continued into the upper half-plane, and $S_a(E)$ into the lower one. They are regular analytical functions in these half-planes (outside the real axis). The authors then formulate the following method: A chain of equations is set up for Green functions used. This infinite chain of interlaced equations is then "released" by means of any approximation, and transformed into a finite system. Such an approximation must be chosen quite individually because of the character of the problem, and the

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authors have not yet been able to suggest a problem generally applicable. In particular, the products $\langle B(t')A(t)\rangle = \int_{-\infty}^{\infty} I(w)e^{-iw(t-t')}dw$ are interesting for the physical investigation, for they are functions of correlation. Also the Green functions discussed here are not suitable for a direct use at t' = t. Subsequently, the general expressions are illustrated by some examples, namely on Heisenberg's model of ferromagnetism, and on the usual Hamiltonian by Fröhlich. There are 9 references, 5 of which are Soviet.

ASSOCIATION: Matematicheskiy institut im. V. A. Steklova Akademii nauk SSSR (Mathematics Institute imeni V. A. Steklov of the Academy of Sciences, USSR)

SUBMITTED: February 19, 1959

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SOV/4893

Ferrites (Cont.)

PURPOSE: This book is intended for physicists, physical chemists, radio electronics engineers, and technical personnel engaged in the production and use of ferromagnetic materials. It may also be used by students in advanced courses in radio electronics, physics, and physical chemistry.

COVERAGE: The book contains reports presented at the Third All-Union Conference on Ferrites held in Minsk, Belorussian SSR. The reports deal with magnetic transformations, electrical and galvanomagnetic properties of ferrites, studies of the growth of ferrite single crystals, problems in the chemical and physicochemical analysis of ferrites, studies of ferrites having rectangular hysteresis loops and multicomponent ferrite systems exhibiting spontaneous rectangularity, problems in magnetic attraction, highly coercive ferrites, magnetic spectroscopy, ferromagnetic resonance, magneto-optics, physical principles of using ferrite components in electrical circuits, anisotropy of electrical and magnetic properties, etc. The Committee on Magnetism, AS USSR (S. V. Vonsovskiy, Chairman) organized the conference. References accompany individual articles.

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Ferrites (Cont.)

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A058/A101

Frequency spectrum ...

zero translation velocity. The frequency spectrum is obtained in explicit form for a model in which the fluctuation motion of particles is viewed as isotropic oscillations.

Yu. Nikitin

[Abstracter's note: Complete translation]

X

Card 2/2

TYABLIKOV, S.V.; MOSKALENKO, V.A.

Theorem on statistical averages for Pauli operators. Dokl. AN SSSR 158 no.4:839-842 O '64. (MIRA 17:11)

1. Matematicheskiy institut im. V.A. Steklova AN SSSR i Institut matematiki AN Moldavskoy SSR. Predstavleno akademikom N.N. Bogolyubovym.

VVEDENSKIY, B.A., glav. red.; VUL, B.M., glav. red.; SHTEYNMAN, R.Ya., zam. glav. red.; BALDIN, A.M., red.; VONSOVSKIY, S.V., red.; GALANIN, M.D., red.; ZERNOV, D.V., red.; ISHLINSKIY, A.Yu., red.; KAPITSA, P.L., red.; KAPTSOV, N.A., red.; KOZODAYEV, M.S., red.; LEVICH, V.G., red.; LOYTSYANSKIY, L.G., red.; LUK'YANOV, S.Yu., red.; MALYSHEV, V.I., red.; MIGULIN, V.V., red.; REBINDER, P.A., red.; SYRKIN, Ya.K., red.; TARG, S.M., red.; TYABLIKOV, S.V., red.; FEYNBERG, Ye.L., red.; KHAYKIN, S.E., red.; SHUBNIKOV, A.V., red.

[Encyclopedic physics dictionary] Fizicheskii entsiklopedicheskii slovar'. Moskva, Sovetskaia Entsiklopediia. Vol.4. 1965. 592 p. (MIRA 18:1)

S/058/61/000/010/068/100
A001/A101

94,7700

AUTHORS: Tyablikov, S.V., Moskalenko, V.A.

TITLE: Multi-phonon scattering of polarons

PERIODICAL: Referativnyy zhurnal. Fizika, no. 10, 1961, 237, abstract 10E20 ("Uch. zap. Kishinevsk. un-t", 1960, v. 55, 129 - 141)

TEXT: The authors consider scattering of polarons by lattice defects in ionic crystals. Scattering processes are taken into account which are accompanied by production or destruction of an arbitrary number of phonons, these processes being caused by the existence of a relation between the translational motion of the polaron and fluctuation motion of the electron in the polaron potential well. The method of Bogolyubov's adiabatic perturbation theory ("Ukr. matem. zh.", 1950, v. 2, no. 2, 3) is used for the analysis. Shifts of the equilibrium positions of the nuclei and changes in frequencies of lattice oscillations during the changes in the states of polaron translational motion are taken into account. The method of calculating these parameters is developed for the case of weak non-adiabaticity. A finite expression is obtained for the probabili-

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Multi-phonon scattering of polarons

S/058/61/000/010/068/100
A001/A101

ty of multi-phonon scattering by a Coulomb center. The sums of lattice oscillation states, entering this expression, are calculated by means of the Green function method.

M. Krivoglaz

[Abstracter's note: Complete translation]

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81781

S/181/60/002/02/26/033
B006/B067

24.7900

AUTHOR: Tyablikov, S. V.

TITLE: The Theory of Ferromagnetic Resonance

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 2, pp. 361-368

TEXT: In the present paper, the author gives a quantum-mechanical deduction of formulas in the theory of ferromagnetic resonance, which can be applied to a wide temperature range. These formulas concern the ferromagnetic resonance frequency and the susceptibility, and their deduction is based on the use of the two-time Green's temperature functions. The calculation method is greatly similar to that of Ref. 1. The system concerned is described by a Hamiltonian of the form $\mathcal{H} = \mathcal{H}_0 + \mathcal{H}'(t)$ with $\mathcal{H}'(t) = \sum_{(\Omega)} V_\Omega e^{-i\Omega t}$, where $\mathcal{H}_0$ and V_Ω are operators which do not explicitly depend on time, and $\mathcal{H}'$ is regarded as a slight perturbation. Formula (37) is obtained for the resonance frequency E_r: $E_r = \sqrt{A_x A_y} = 2\mu \sqrt{\{H + \sigma\mu(N_x - N_z)\}\{H + \sigma\mu(N_y - N_z)\}}$. It is an

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The Theory of Ferromagnetic Resonance

S/181/60/002/02/28/033
B006/B067

extension of C. Kittel's well-known formula (Ref. 4) to any temperatures. Formula (38) gives explicit expressions for susceptibilities in a plane-polarized radiofrequency field and formula (39) for a circularly polarized radiofrequency field. The ferromagnetic resonance lines were δ-shaped which is due to the fact that in the approximation used here the Green functions show poles only on the real axis. In higher approximations divergency lines are observed instead of poles, and it may be expected that the lines have rather Lorentz shape. A consideration of the interaction with phonons or conduction electrons, for example, also leads to a finite line width. Formula (3) is deduced in an appendix. N. N. Bogolyubov is mentioned. There are 5 references: 3 Soviet, 1 Japanese, and 1 American.

ASSOCIATION: Matematicheskiy institut im. V. A. Steklova AN SSSR Moskva (Institute of Mathematics imeni V. A. Steklov of the AS USSR, Moscow)

SUBMITTED: July 18, 1959

Card 2/2

84060

S/181/60/002/009/001/036
B004/B056

9.1310 2101 1162
2201 1144
2301 1331
3001

AUTHOR: Tyablikov, S. V.

TITLE: The Theory of Ferromagnetic Resonance. II (General Relations)

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 9, pp. 2009-2018

TEXT: The author proves that by means of Green's retarded two-time temperature functions knowledge may be obtained concerning susceptibility χ without any assumptions being necessary as to the Hamiltonian $\mathcal{H}_c$ of the spin system. Some equations are written down from an earlier paper (Ref. 2). For the increment $\delta\overline{M}^{\alpha}(t)$ of the magnetization vector μS:

$\delta\overline{M}^{\alpha}(t) = \mu\delta\overline{S}^{\alpha}(t) = \sum_{(\beta,\Omega)} \chi_{\alpha\beta}(\Omega) h^{\beta}_{\Omega} \exp(-i\Omega t)$ (1.2), where μ is the Bohr magneton, Ω the frequency of the radio-frequency field, h^{β} its intensity, $\chi_{\alpha\beta}$ the susceptibility tensor. A definition is given cf: $\chi_{\alpha\beta}(\Omega) = 2\pi i\mu^2 G^r_{\alpha\beta}(\Omega)$

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The Theory of Ferromagnetic Resonance. II (General Relations)

(1.3), where G^r represents the retarded Fourier expansion of the two-time Green function. Furthermore, $\delta \overline{M}^{\alpha}(t) = \sum_{\substack{(\beta) \\ (\Omega > 0)}} \left\{ \chi_{\alpha\beta}(\Omega) h^{\beta}_{\Omega} \exp(-i\Omega t) + \chi_{\alpha\beta}(-\Omega) h^{*\beta}_{\Omega} \exp(i\Omega t) \right\}$ (1.5) is written down. These equations are now more closely investigated. Assuming that the radio-frequency field is in the xy plane, equations (2.3) are derived for $\chi_{xx}(\Omega)$, $\chi_{xy}(\Omega)$, $\chi_{yx}(\Omega)$, and $\chi_{yy}(\Omega)$. Herefrom one obtains: $X_a(\Omega) = 2\nu G^r_{12}(\Omega)$; $g_a(\Omega) = 0$ (2.12), where $X_a(\Omega) = \nu \left\{ G^r_{12}(\Omega) + G^r_{21}(\Omega) \right\}$; $g_a(\Omega) = \nu \left\{ -G^r_{12}(\Omega) + G^r_{21}(\Omega) \right\}$. For the behavior of χ in the resonance region one obtains: $X_a(\Omega) \sim -C(K+K_1)R_r(\Omega)$; and $g_a(\Omega) \sim C(K-K_1)R_r(\Omega)$ (3.15). Here, $K = \Phi(E_R)/F(-E_R)$; $K_1 = \Phi_1(E_R)/F(-E_R)$; $C = 2\pi i \mu^2 F(-E_R)/2E_R A(E_R)$ (3.8), (F, Φ, Φ_1 are matrix functions). The author further describes the absorption of energy by the spin system and the attenuation in the latter. For this purpose, the functions

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The Theory of Ferromagnetic Resonance. II (General Relations)

$F_r(\Omega) = ia(\Omega_o + \Omega)$; $\Phi_r(\Omega) = ia\Omega_1$ (5.2) are written down, and for the G^r functions he derives the following relations: $G^r_{11}(\Omega) = -\overset{*}{G}{}^r_{22}(-\Omega) = (i/a)(\Omega_o - \Omega)/(\Omega^2 - \Omega_R^2)$; $G^r_{21}(\Omega) = -\overset{*}{G}{}^r_{12}(-\Omega) = -(i/a)\Omega_1/(\Omega^2 - \Omega_R^2)$; $\Omega_R = \sqrt{\Omega_o^2 - \Omega_1^2}$ (5.3). In appendix I, the Green functions are defined by means of Heisenberg operators, and in appendix II, the complex matrices G(E) and $F = G^{-1}$ are defined. The author thanks Academician N. N. Bogolyubov for his advice, as well as Pu Fu-cho and Ye. N. Yakovlev for discussions. There are 13 references: 9 Soviet, 2 US, and 1 Japanese.

ASSOCIATION: Matematicheskiy institut im. V. A. Steklova AN SSSR, Moskva (Institute of Mathematics imeni V. A. Steklov of the AS USSR, Moscow)

SUBMITTED: February 5, 1960

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86428

S/181/60/002/011/012/042
B006/B056

24.2200 (1144,1138,1162)

AUTHORS: Potapkov, N. A. and Tyablikov, S. V.

TITLE: Theory of the s-d Model

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 11, pp. 2733-2742

TEXT: In the theory of ferromagnetic metals, taking account of the effect of the interaction between conduction electrons (s-electrons) and d-electrons, which are responsible for the magnetic properties, upon the material characteristics is of interest. The authors deal with this problem from the point of view of the s-d model by S. V. Vonsovskiy (Refs. 1, 2). The effect of this interaction upon the magnetization, electrical conductivity, resonance, etc. has been investigated by Vonsovskiy et al. A number of these results are subjected to a renewed theoretical investigation, and several formulas are derived, which hold within a wide temperature interval; for this purpose the authors use the two - time temperature (advanced and retarded) Green functions. Among other things, energy spectrum and magnetization are calculated in third approximation with respect to the coupling constant. It is shown that s-d interaction causes a gap in the

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Theory of the s-d Model

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spectrum of the elementary excitations of the spin-wave type. Due to this interaction, the spin-induced degeneracy of s-electrons is partly reduced, and the s-electrons are magnetized. The entire magnetization of the system is composed of the magnetization of s-electrons and that of d-electrons. Formulas are also given for the entire magnetization (spontaneous magnetization), taking s-d interaction into account. These formulas correspond to those obtained by Vonsovskiy et al. and have been published in an implicit form in Ref. 11. There are 11 Soviet references.

ASSOCIATION: Magnitnaya laboratoriya AN SSSR (Magnetic Laboratory AS USSR). Matematicheskiy institut im. V. A. Steklova AN SSSR (Institute of Mathematics imeni V. A. Steklov AS USSR)

SUBMITTED: June 3, 1960

Card 2/2

PU FU-CHOUCH; TYABLIKOV, S.V.; SIKLOS, T.

Retarded and advanced green functions in the quantum theory of isotropic ferromagnetics. Acta phys Hung 11 no.4:323-331 '60.
(EEAI 10:2)

1. Matematicheskiy Institut im. V.A.Steklova AN SSSR, Moskva, (for Pu Fu-chouch and Tiyablikov). 2. Ob"yeinennyy Institut yadrenykh issledovaniy, Dubna, SSSR (for Siklos)
(Quantum theory) (Magnetism)

TYABLIKOV, S.V.; SIKLOS, T.

Quantum theory of uniaxial anisotropic ferromagnetic crystals. Acta phys Hung 12 no.1:35-46 '60. (EEAI 10:2)

1. Matematicheskiy institut im. V.A.Steklova AN SSSR, Moskva, (for Tyablikov). 2. Ob"yedinennyy institut yadernykh issledovaniy, Dubna, SSSR (for Siklos). Predstavleno K.F.Novobatski
(Quantum theory) (Crystals) (Magnetism)

BONCH-BRUYEVICH, Viktor Leopol'dovich; TYABLIKOV, S.V.; GUSEV, A.A., red.; BRUDNO, K.F., tekhn. red.

[Method of Green's functions in statistical mechanics] Metod funktsii Grina v statisticheskoi mekhanike. S predisl. N.N.Bogoliubova. Moskva, Gos. izd-vo fiziko-matem. lit-ry, 1961. 312 p. (MIRA 14:10)

(Potential, Theory of) (Mechanics)

S/181/61/003/001/016/042
B006/B056

24.7900 (1147, 1158, 1160)

AUTHORS: Tyablikov, S. V. and Pu Fu-cho

TITLE: Higher approximations in the theory of ferromagnetic resonance

PERIODICAL: Fizika tverdogo tela, v. 3, no. 1, 1961, 142-145

TEXT: The present paper deals with a method of calculating the Kubo expansions (J. Phys. Japan, Vol. 12, p. 570); the method is based upon the use of the many-time temperature retarded Green functions. The reaction of a system with a time-independent Hamiltonian $\mathcal{H}_0$ to an external perturbation $\mathcal{H}'(t)$ is investigated. If the perturbation vanishes at $t=-\infty$, the density matrix has the following form: $\rho_0 = e^{\mathcal{H}_0/\theta}$. In an adiabatically occurring perturbation, the density matrix changes and becomes equal to

$$\rho(t) = \rho_0 + \sum_{n=1}^{\infty} (-i)^n \int_{-\infty}^{t} d\tau_1 \int_{-\infty}^{\tau_1} d\tau_2 \ldots \int_{-\infty}^{\tau_{n-1}} d\tau_n \times$$

$$\times e^{-i\mathcal{H}_0 t} [\mathcal{H}'(\tau_1), \ldots [\mathcal{H}'(\tau_{n-1}), [\mathcal{H}'(\tau_n), \rho_0] \ldots] e^{i\mathcal{H}_0 t}, \quad (1)$$

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where $\tilde{\mathcal{H}}'(\tau) = e^{i\mathcal{H}_0\tau}\mathcal{H}'(\tau)e^{-i\mathcal{H}_0\tau}$. The perturbed mean value of any non-explicitly time-dependent variable A is given by

$$A(t) = Q^{-1}\,\mathrm{sp}\,A\rho = \langle A\rangle + \sum_{n=1}^{\infty}\overline{\delta^{(n)}}A(t), \qquad (2)$$

$$\overline{\delta^{(n)}}A(t) = (-i)^n \int_{-\infty}^{t} d\tau_1 \int_{-\infty}^{\tau_1} d\tau_2 \dots \int_{-\infty}^{\tau_{n-1}} d\tau_n \langle[\dots[A(t), \tilde{\mathcal{H}}'(\tau_1)], \tilde{\mathcal{H}}'(\tau_2)], \dots \tilde{\mathcal{H}}'(\tau_n)]\rangle, \qquad (3)$$

where $A(t) = e^{i\mathcal{H}_0 t}Ae^{-i\mathcal{H}_0 t}$, $\langle\check{A}\rangle = Q^{-1}\mathrm{sp}\check{A}\rho_0$, $Q = \mathrm{sp}\,P_0$. If the function $\theta(t-\tau_1)\theta(\tau_1-\tau_2)\dots\theta(\tau_{n-1}-\tau_n)$ is introduced, (3) may be written in the form

$$\overline{\delta^{(n)}}A(t) = (-i)^n \int_{-\infty}^{\infty} \dots \int_{-\infty}^{\infty} d\tau_1 \dots d\tau_n \theta(t-\tau_1)\theta(\tau_1-\tau_2)\dots\theta(\tau_{n-1}-\tau_n) \times$$
$$\times \langle[\dots[A(t), \tilde{\mathcal{H}}'(\tau_1)], \tilde{\mathcal{H}}'(\tau_2)], \dots \tilde{\mathcal{H}}'(\tau_n)]\rangle. \qquad (4)$$

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Higher approximations in the...

In the following, a periodic perturbation $\mathcal{H}'(t) = \sum_{\Omega} V_{\Omega} \exp(-i\Omega t + \varepsilon t)$ is studied, where V_{Ω} does not explicitly depend on time, and $V_{\Omega}^{+} = V_{-\Omega}$. Thus, (4) may be replaced by

$$\overline{\delta^{(n)} A}(t) = \sum_{\Omega_1, \dots \Omega_n} (-i)^n \int_{-\infty}^{\infty} \dots \int_{-\infty}^{\infty} d\tau_1 \dots d\tau_n \theta(t-\tau_1)\theta(\tau_1-\tau_2)\dots\theta(\tau_{n-1}-\tau_n) \times$$
$$\times \langle [\dots [A(t), V_{\Omega_1}(\tau_1)], V_{\Omega_2}(\tau_2)], \dots V_{\Omega_n}(\tau_n)] \rangle e^{-i\Omega_1\tau_1 \dots i\Omega_n\tau_n + \varepsilon(\tau_1 + \dots \tau_n)}. \quad (5)$$

From the cyclic invariance of the trace it follows that the mean values under the sign of integration depend only on the differences $t-\tau_1$, $\tau_1-\tau_2, \dots \tau_{n-1}-\tau_n$; it is therefore possible to generalize the two-time retarded Green functions to (n-1)-time functions:

$$G^{(n)}_{\Omega_1 \dots \Omega_n}(t-\tau_1, \tau_1-\tau_2, \dots \tau_{n-1}-\tau_n) \equiv \theta(t-\tau_1)\theta(\tau_1-\tau_2)\dots\theta(\tau_{n-1}-\tau_n) \times$$
$$\times \langle [\dots [A(t), V_{\Omega_1}(\tau_1)], V_{\Omega_2}(\tau_2)], \dots V_{\Omega_n}(\tau_n)] \rangle. \quad (6)$$

or in Fourier representation:

$$G^{(n)}_{\Omega_1 \dots \Omega_n}(t-\tau_1, \tau_1-\tau_2, \dots \tau_{n-1}-\tau_n) =$$
$$= \int_{-\infty}^{\infty} \dots \int_{-\infty}^{\infty} dE_1 \dots dE_n G^{(n)}_{\Omega_1 \dots \Omega_n}(E_1, \dots E_n) \times e^{-iE_1(t-\tau_1) \dots -iE_n(\tau_{n-1}-\tau_n)}. \quad (7)$$

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Higher approximations in the...

From (5)-(7) it follows that

$$\delta^{(n)} A(t) = \sum_{\Omega_1, \dots \Omega_n} (-2\pi i)^n G^{(n)}_{\Omega_1, \dots \Omega_n}(\Omega_1 + \Omega_2 + \dots \Omega_n + ni\varepsilon,$$

$$\Omega_2 + \dots \Omega_n + (n-1) i\varepsilon, \dots, \Omega_{n-1} + \Omega_n + 2i\varepsilon, \Omega_n + i\varepsilon) e^{-i(\Omega_1+\Omega_2+\dots \Omega_n)t}, \quad (8)$$

The Fourier form of the retarded Green function for real arguments must be considered to be their limit in transition from the complex plane to the real axis. Time enters into (8) only exponentially; if the exterior perturbation contains one harmonic of the frequency, the frequency in $\delta^{(2)}A(t)$ is doubled (2Ω), in the third correction it is tripled (3Ω) etc. Using a method described in an earlier paper it is possible for the (n+1)-time Green function $G^{(n)}_{\Omega_1 \dots \Omega_n}(t-\tau_1, \tau_1-\tau_2, \dots \tau_{n-1}-\tau_n)$ to obtain a closed set of equations. With $\Omega \longrightarrow 0$ (8) may be considered to be a time-independent perturbation-theoretical expansion. As an example, (8) is now applied to the theory of a linear uniform oscillation in the case of ferromagnetic resonance. By means of the Hamiltonian

$$\mathcal{H} = -\frac{1}{2}\sum I(f_1, f_2) S^{\alpha}_{f_1} S^{\alpha}_{f_2} - \mu H S^z - \cos\Omega t h \mu S^x, \quad (S^{\alpha} = \sum_f S^{\alpha}_f)$$

describing the system, one obtains

$$\delta^{(2)} S^z(t) = -N\sigma\mu h^2 \left\{ \frac{\Omega^2+\omega_0^2}{(\Omega^2-\omega_0^2)^2} - \frac{\cos 2\Omega t}{\Omega^2-\omega_0^2} + \frac{\pi}{2} \frac{\delta(\Omega-\omega_0)}{\omega_0} \sin 2\Omega t \right\},$$

which

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apart from the δ-term agrees with the corresponding classical result. $\omega_0 = 2\mu H$ is the resonance frequency; $\sigma = \langle S_f^z \rangle$. There are 6 references: 5 Soviet-bloc and 1 non-Soviet-bloc.

ASSOCIATION: Matematicheskiy institut im. V. A. Steklova AN SSSR Moskva (Institute of Mathematics imeni V. A. Steklov, AS USSR, Moscow)

SUBMITTED: May 25, 1960

S/181/61/003/011/031/056
B125/B138

AUTHOR: Tyablikov, S. V.

TITLE: The method of Green's function in the theory of adiabatic approximation

PERIODICAL: Fizika tverdogo tela, v. 3, no. 11, 1961, 3445-3460

TEXT: The interaction of a particle (or a system of particles) with a quantum field is investigated in adiabatic approximation with the method of the two-time Green's functions. The resulting generalization holds for temperatures other than zero. The system under consideration consists of N electrons which interact with phonons within the volume V; direct interactions between electrons are not taken into account. This system has the Hamiltonian

$$\mathcal{H} = \sum_{(k,\sigma)} T_k \overset{+}{a}_{k,\sigma} a_{k,\sigma} + \varepsilon \sum_{(q)} A_q (\rho_q b_q + \overset{+}{b}_{-q} \overset{+}{\rho}_{-q}) + \varepsilon^2 \sum_{(q)} \omega_q \overset{+}{b}_q b_q, \qquad (2,1)$$

where

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$$\left.\begin{aligned}\rho_q &= \sum_{(k,\sigma)} \dot{a}_{k,\sigma} a_{k-q,\sigma},\\ \dot{\rho}_q &= \rho_{-q};\ \rho_q\rho_{q'} = \rho_{q'}\rho_q;\end{aligned}\right\} \quad (2,2)$$

$$A_q = g(q)\sqrt{\frac{\omega_q}{2V}}\ (g(q)\underset{q\to\infty}{\longrightarrow} 0). \quad (2,3)$$

$a_{k,\sigma}$ and b_q denote the Fermi and Bose operators, respectively; k,q - the wave vectors; σ - the spin variable; T_k and ω_q - the proper energies of the free electrons and phonons; ε ($\varepsilon \ll 1$) a formal small parameter; g - a function of q the form of which depends on the peculiarities of the problem. The electron subsystem is described by anticommutating Green's functions

$$E\langle\langle a_{k,\sigma}|\dot{a}_{f,s}\rangle\rangle = \frac{i}{2\pi}\Delta(k-f)\delta_{\sigma,s} + T_k\langle\langle a_{k,\sigma}|\dot{a}_{f,s}\rangle\rangle +$$
$$+\sum_{\substack{(q,k'')\\(k-k''-q=0)}} A_q(c_q + \dot{c}_{-q})\langle\langle a_{k'',\sigma}|\dot{a}_{f,s}\rangle\rangle +$$
$$+\varepsilon\sum_{\substack{(q,k'')\\(k-k''-q=0)}} A_q\langle\langle(\beta_q + \dot{\beta}_{-q})\,a_{k'',\sigma}|\dot{a}_{f,s}\rangle\rangle; \quad (3,1)$$

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$$E\langle\langle(\beta_q+\overset{+}{\beta}_{-q})a_{k'',s}|\overset{+}{a}_{f,s}\rangle\rangle=T_{k''}\langle\langle(\beta_q+\overset{+}{\beta}_{-q})a_{k'',s}|\overset{+}{a}_{f,s}\rangle\rangle+$$
$$+\sum_{\substack{(q',k')\\(k'-k''+q=0)}}A_{q'}(c_{q'}+\overset{+}{c}_{-q'})\langle\langle(\beta_q+\overset{+}{\beta}_{-q})a_{k',s}|\overset{+}{a}_{f,s}\rangle\rangle+$$
$$+\varepsilon\sum_{\substack{(q',k')\\(k'-k''+q=0)}}A_{q'}\langle\langle(\beta_q+\overset{+}{\beta}_{-q})(\beta_{q'}+\overset{+}{\beta}_{-q'})a_{k',s}|\overset{+}{a}_{f,s}\rangle\rangle+$$
$$+\varepsilon^2\omega_q\langle\langle(\beta_q-\overset{+}{\beta}_{-q})a_{k'',s}|\overset{+}{a}_{f,s}\rangle\rangle-\varepsilon^2(v,\ q)\langle\langle(\beta_q+\overset{+}{\beta}_{-q})a_{k'',s}|\overset{+}{a}_{f,s}\rangle\rangle\ldots \quad (3,2)$$

Then the auxiliary system of functions $u_{f,\nu}$ is introduced; it is defined as the system of eigenfunctions of the equation

$$\overline{T}_k u_{k,\nu}+\sum_{\substack{(q,k'')\\(k-k''-q=0)}}A_q(c_q+\overset{*}{c}_{-q})u_{k'',\nu}=E_\nu u_{k,\nu} \quad (3.3)$$

and called "equivalent wave equation". The functions c_q are assumed as given. In the first approximation up to and including terms of the order of ε,

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$$E\langle\langle a_{k,\sigma}|\dot{a}_{f,s}\rangle\rangle=\frac{i}{2\pi}\Delta(k-f)\delta_{\sigma,s}+T_k\langle\langle a_{k,\sigma}|\dot{a}_{f,s}\rangle\rangle+ \\ +\sum_{\substack{(q,k'')\\(k-k''-q=0)}}A_q(c_q+\dot{c}_{-q})\langle\langle a_{k'',\sigma}|\dot{a}_{f,s}\rangle\rangle. \quad (3,6)$$

is derived by cutting off the infinite series contained in (3.1) (3.2). In this approximation, the electron subsystem is separated from the phonon system. The approximated equation for the second and third Green's functions read as

$$E\langle\langle(\beta_q+\dot{\beta}_{-q})a_{k'',\sigma}|\dot{a}_{f,s}\rangle\rangle=T_{k''}\langle\langle(\beta_q+\dot{\beta}_{-q})a_{k'',\sigma}|\dot{a}_{f,s}\rangle\rangle+ \\ +\sum_{\substack{(q',k')\\(k'-k''+q=0)}}A_{q'}(c_{q'}+\dot{c}_{-q'})\langle\langle(\beta_q+\dot{\beta}_{-q})a_{k',\sigma}|\dot{a}_{f,s}\rangle\rangle+ \\ +\varepsilon\sum_{\substack{(q',k')\\(k'-k''+q=0)}}A_{q'}\langle(\beta_q+\dot{\beta}_{-q})(\beta_{q'}+\dot{\beta}_{-q'})\rangle\langle\langle a_{k',\sigma}|\dot{a}_{f,s}\rangle\rangle. \quad (3,17)$$

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and

$$E\langle\langle a_{k,\sigma}|\overset{+}{a}_{f,\sigma}\rangle\rangle = \frac{i}{2\pi}\Delta(k-f)\delta_{\sigma,\sigma} + T_k\langle\langle a_{k,\sigma}|\overset{+}{a}_{f,\sigma}\rangle\rangle + \sum_{\substack{(q,k'')\\(k-k''-q=0)}} A_q(c_q+\overset{+}{c}_{-q})\langle\langle a_{k'',\sigma}|\overset{+}{a}_{f,\sigma}\rangle\rangle + \varepsilon^2\sum_{(k')} M(k,k')\langle\langle a_{k',\sigma}|\overset{+}{a}_{f,\sigma}\rangle\rangle, \quad (3,20)$$

the latter taking account up to including terms of the order ε^2. $M(k,k')$ denotes the mass operator. For the mean energy,

$$W_0 = \mu v^2 + 2\sum_{(k,\nu)}\bar{T}_k\bar{n}_\nu|u_{k,\nu}|^2 - 4\sum_{(q)}(A_q^2\omega_q/(\omega_q^2-(v,q)^2)\Big|\sum_{(k,\nu)}\bar{n}_\nu\overset{*}{u}_{k,\nu}u_{k-q,\nu}\Big|^2 \quad (4.8)$$

is found. For terms of the order of magnitude of v^2 inclusively,

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$$W_0 = \frac{\mu v^2}{2} + 2\sum_{(k,\nu)} T_k n_\nu |u_{k,\nu}|^2 - \sum_{(q)} \frac{A_q^2}{\omega_q} |\langle \rho_{-q} \rangle|^2 =$$

$$= \frac{\mu v^2}{2} + 2\sum_{(k,\nu)} T_k n_\nu |u_{k,\nu}|^2 -$$

$$-4\sum_{(q)} \frac{A_q^2}{\omega_q} \left| \sum_{(k,\nu)} n_\nu \hat{u}_{k,\nu} u_{k-q,\nu} \right|^2 . \qquad (4,14)$$

is found. In $W_0(v) = W_0(0) + \mu v^2/2$ (4.15) W_0 is mean energy at $v = 0$, and $\mu v^2/2$ is the kinetic energy of motion of the electrons with mean velocity v and effective mass μ. In the coordinate representation,

$$W_0 = \mu v^2 + 2\sum_{(\nu)} n_\nu \int \overset{*}{\psi}_\nu (x)\, T(-i\nabla_x)\, \psi_\nu (x)\, dx -$$

$$-\frac{1}{2} \iint V(x-y)\, \rho(x)\, \rho(y)\, dx dy, \qquad (4,25)$$

holds for W_0 and

$$W_0 = \frac{\mu v^2}{2} + 2 \sum_{(\nu)} n_\nu \int \overset{+}{\psi}{}_\nu^{(0)}(x)\, T(-i\nabla_x)\, \psi_\nu^{(0)}(x)\, dx - \frac{1}{2} \iint V^{(0)}(x-y)\, \rho^{(0)}(x)\, \rho^{(0)}(y)\, dx dy, \qquad (4,26)$$

for low v. At non-zero temperatures, local states are only to be taken into account where particle density is not too small or volume per particle is not macroscopically great. For a phonon subsystem, the equations

$$\{[E + \varepsilon^2(v,\ q)]^2 - \varepsilon^4\omega_q^2\}\, \Gamma(q,\ p) = \frac{i}{2\pi}\, \Delta(q-p)\, \frac{E + \varepsilon^2(v,\ q) + \varepsilon^2\omega_q}{\sqrt{\omega_q}} - \varepsilon^4 \sum_{(q')} 4A_q A_{q'} \mathcal{K}(q,\ q')\, \Gamma(q',\ p); \qquad (6,12)$$

$$\varepsilon^2\omega_q \Gamma'(q,\ p) = E\Gamma(q,\ p) - \frac{i}{2\pi}\, \frac{1}{\sqrt{\omega_q}}\, \Delta(q-p). \qquad (6,13)$$

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with

$$\left.\begin{aligned}\Gamma(q, p) &= \frac{1}{\sqrt{\omega_q}}\left(\langle\langle\beta_q|\overset{+}{\beta}_p\rangle\rangle + \langle\langle\overset{+}{\beta}_{-q}|\overset{+}{\beta}_p\rangle\rangle\right);\\ \Gamma'(q, p) &= \frac{1}{\sqrt{\omega_q}}\left(\langle\langle\beta_q|\overset{+}{\beta}_p\rangle\rangle - \langle\langle\overset{+}{\beta}_{-q}|\overset{+}{\beta}_p\rangle\rangle\right).\end{aligned}\right\} \quad (6,11)$$

hold for the two first Green's functions. Finally, the behaviour of the phonon subsystem is calculated for $v = 0$. In the second approximation of the adiabatic theory, several quantities can be calculated from the phonon operators. The average value of the energy operator of electron-phonon interaction and the operators of the proper energy of the phonons read as

$$\langle\mathcal{H}_1\rangle = 2\sum_{(q)} A_q \langle\beta_q\beta_q\rangle = \cdot\sum_{(q,\alpha)} |a_{q,\alpha}|^2 \frac{\Omega_\alpha^2 - \omega_q^2}{2\omega_q\Omega_\alpha}[\omega_q(2\bar{N}_\alpha + 1) + \Omega_\alpha] \quad (7.10)$$

and

$$\langle\mathcal{H}_2\rangle = \sum_{(q)} \omega_q \langle\overset{+}{\beta}_q\beta_q\rangle = -\frac{1}{2}\sum_{(q)}\omega_q + \sum_{(q,\alpha)} |a_{q,\alpha}|^2 \frac{\Omega_\alpha^2 + \omega_q^2}{4\Omega_\alpha}(2\bar{N}_\alpha + 1). \quad (7,11)$$

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S/181/61/003/011/031/056
B125/B138

The method of Green's function in the...

respectively. There are four Soviet references.

ASSOCIATION: Matematicheskiy institut im. V. A. Steklova AN SSSR Moskva (Institute of Mathematics imeni V. A. Steklov of the AS USSR Moscow)

SUBMITTED: June 17, 1961

Card 9/9

S/058/62/000/010/079/093
A061/A101

AUTHORS: Siklós, Tivadar, Tyablikov, Sz. V.

TITLE: Formulas describing ferromagnetic resonance in uniaxial ferromagnetic materials

PERIODICAL: Referativnyy zhurnal, Fizika, no. 10, 1962, 79, abstract 10E599 ("Magyar tud. akad. Közp. fiz. kutató int. közl." 1961, v. 9, no. 4, 193 - 196, III, IX, Hungarian; summaries in Russian and English)

TEXT: The temperature-time Green functions are used to derive formulas describing the ferromagnetic resonance absorption in uniaxial ferromagnetic materials. Specimen shape and respective demagnetizing factors are not taken into account in the calculation.

[Abstracter's note: Complete translation]

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24.7700

35970
S/517/61/064/000/006/006
D299/D301

AUTHORS: Tyablikov, S. V. and Moskalenko, V. A.

TITLE: The method of Green's quantum functions in the theory of multi-phonon transitions

SOURCE: Akademiya nauk SSSR. Matematicheskiy institut. Trudy. v. 64, 1961, 267-283

TEXT: A method is proposed for calculating the characteristic function of phonon transitions; the method involves the use of Green's quantum functions. The multi-phonon transition-probability is determined (to within a factor of proportionality), by the quantity

$$J(\nu) = \sum_{(m,n)} W_m \left|(bn|M_{ba}(q)|am)\right|^2 \delta(E_{bn} - E_{am} - h\nu) \qquad (3)$$

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where ν denotes either the frequency of electromagnetic radiation (in radiative transitions), or it equals zero (in non-radiative transitions); W is a weighting factor; E_{am} and E_{bm} denote the total initial and final energy of the system. Expression (3) was calculated by M. Lax (Ref. 4: The Franck-Condon principle and its application to crystals. Journ. Chem. Phys., 20, N 1, 1725-1760, 1952) by means of the Fourier transform

$$I(t) = \int_{-\infty}^{\infty} J(\nu) e^{-2\pi i \nu t} d\nu$$

$$J(\nu) = \int_{-\infty}^{\infty} I(t) e^{2\pi i \nu t} dt \qquad (5)$$

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By virtue of formulas (3) - (5), one obtains

$$I(t) = \frac{1}{Sp\left[e^{-\beta H_a}\right]} Sp\left[\overset{+}{M}_{ba}(q) e^{-\frac{i}{\hbar}H_b t} M_{ba}(q) e^{\frac{i}{\hbar}H_a t} e^{-\beta H_a}\right] \qquad (6)$$

where M_{ba} is the matrix element of the quantum transition. If M_{ba} is a c-number (the Condon approximation), then the characteristic function is

$$I(t) = |M_{ba}|^2 S(t) \qquad (11)$$

where

$$S(t) = \langle U(t) \rangle;$$

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$$U(t) = e^{\frac{i}{\hbar}H_a t} e^{-\frac{i}{\hbar} H_b t} \qquad (12)$$

If M_{ba} is a linear form:

$$M_{ba} = \sum_{(\mu)} (M_\mu b_\mu + \overset{*}{N}_\mu \overset{+}{b}_\mu) \qquad (16)$$

then the characteristic function is

$$I(t) = \sum_{(\mu_1,\mu_2)} \Big[\overset{*}{M}_{\mu_1} M_{\mu_2} G_1(\mu_1,\mu_2|t) + \overset{*}{M}_{\mu_1} \overset{*}{N}_{\mu_2} F_2(\mu_1,\mu_2|t) +$$

$$+ N_{\mu_1} M_{\mu_2} F_2(\mu_1, \mu_2 | t) + \overset{+}{N}_{\mu_2} N_{\mu_1} G_2(\mu_1, \mu_2 | t)\Big] \qquad (17)$$

(where G_1, G_2, F_1 and F_2 are given by expressions involving $\overset{+}{b}_\mu$ and $U(t)$). The proposed method involves calculating (11) and (17) by means of Green's quantum functions. The method can be also extended to more complex M_{ba}. Three temperature-time Green's functions are introduced; the first of them is

$$D(\mu_1, \tau_1 | \mu_2, \tau_2) = \frac{\left\langle P\left[b_{\mu_1}(\tau_1)\overset{+}{b}_{\mu_2}(\tau_2)U'_\alpha(t)\right]\right\rangle}{S'_\alpha(t)} \qquad (22)$$

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D299/D301

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These functions differ from the ordinarily used functions; they have no time-homogeneity. In addition to the functions (22), the functions

$$\varphi(\mu, \tau|) = \frac{\langle P[b_\mu(\tau) U'_\alpha(t)]\rangle}{S'_\alpha(t)};$$

$$\varphi(|\mu, \tau) = \frac{\langle P[\dot{b}_\mu(\tau) U'_\alpha(t)]\rangle}{S'_\alpha(t)}. \qquad (26)$$

are introduced. Calculation of S'(t) reduces to determining the functions (22) and (26), followed by addition and integration. The functions D are sought in the form of sums of φ and Δ (where the new functions Δ satisfy a system of equations). Thus, a closed finite system of equations is obtained for the Green functions. With small t, the functions φ and Δ are calculated by an approximate me-

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thod (iteration). The obtained approximate formulas determine I(t) in the Condon approximation. The spectral moments of the optical bands can be exactly calculated, i.e. the formulas for the first moments of J(ν) take into account the displacement of the oscillators from the equilibrium position, as well as the change in phonon frequency during the electronic transitions. The obtained formulas for the moments are in agreement with the results of Ref. 4 (Op. cit.). Taking into account the change in phonon frequencies, leads to an increase in the half-width of the spectral curve; the half-width of the absorption and emission curves may differ (which is not the case if the frequency effect is neglected). By setting ν = 0 in Eqs. (3) and (5), one obtains the function J(0) which determines the probability of non-radiative transitions. After calculations, an approximate expression is obtained for J(0). The above results are extended to more complex M_{ba}. The formulas thereby obtained can be interpreted by the Fock-Hartree method. There are 8 references: 5 Soviet-bloc and 3 non-Soviet-bloc. The references to the English-language publications read as follows: Kun

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S/517/61/064/000/006/006
D299/D301

The method of Green's ...

Huang and A. Rhys. Theory of light absorption and non-radiative transitions in F-centres. Proc. Roy. Soc., A204, 406-423, 1950; M. Lax. The Franck-Condon principle and its application to crystals. Journ. Chem. Phys., 20, N 1, 1752-1760, 1952; R. Kubo and Y. Toyozawa. Application of the method of generating function to radiative and non-radiative transitions of a trapped electron in a crystal. Progr. Theor. Phys., 13, N 2, 160-182, 1955.

Card 8/8

TYABLIKOV, S.V.; MOSKALENKO, V.A.

Method of quantum Green functions in the theory of optical bands in crystals. Dokl. AN SSSR 139 no. 4:851-854 Ag '61. (MIRA 14:7)

1. Matematicheskiy institut im. V.A. Stekova AN SSSR i Laboratoriya teoreticheskoy fiziki Moldavskogo filiala AN SSSR. Predstavleno akademikom N.N. Bogolyubovym.
(Potential, Theory of) (Crystal lattices)

36093
S/185/62/007/003/003/015
D299/D301

24.2110

AUTHORS: Tyablikov, S.V. and Hlauberman, A.Yu.

TITLE: To the many-electron theory of liquid semiconductors

PERIODICAL: Ukrayins'kyy fizychnyy zhurnal, v. 7, no. 3, 1962, 256 - 259

TEXT: This study is related to an article by A.Yu. Hlauberman and O.M. Muzychuk, in which the theory of liquid atomic semiconductors was developed by way of extending the polar model to liquids (Ref. 1: Ukr. fizych. zh., 5, 597, 1960). In Ref.1 (Op. cit) a model Hamiltonian of quasiparticles was considered, obtained by taking the statistical average of the Hamiltonian for an arbitrarily fixed configuration of atoms, over all possible configurations. The Hamiltonian of the system can be written in the form:

$$H = H_{bachgr.} + H_{exc.} = H_g + H_e + H_{int.} \quad (1)$$

where the exact Hamiltonian $H_{backgr.} = H_g$ represents the kinetic energy

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of the atoms of the liquid and the interaction between these atoms, and $H_{exc.} = H_o + H_{int.}$ represents the kinetic energy of the excitations, the energy of interaction of excitations with the atoms, and the excitation-interaction energy. $H_{int.}$ is not simply the sum of terms, each of which depends only on the position of a single atom, but the sum of complex terms, depending on the position of several atoms. The notations

$$H_o = H_e + H_g, \quad (2)$$

$$\overline{H}_{int.} = \frac{1}{Q} \underset{(g)}{Sp} \{ H_{int.} e^{-\beta H_g} \}, \qquad Q = \underset{(g)}{Sp} \{ e^{-\beta H_g} \}, \qquad \beta = \frac{1}{kT}, \quad (3)$$

are introduced, where $\underset{(g)}{Sp}$ denotes taking the average over the atomic variables. With the further notations

$$\overline{H}_o = H_e + \overline{H}_{int.} + H_g = \overline{H}_e + H_g, \quad (4)$$

$$V_i = H_{int.} - \overline{H}_{int.} \quad (5)$$

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To the many-electron theory ...

one can express the exact Hamiltonian for the natural configuration of atoms of the liquid, in the form:

$$H = \overline{H}_e + H_g + V_i = \overline{H}_o + V_i. \quad (6)$$

By neglecting the terms of order V_1^2 and higher order, one obtains:

$$\underset{(g)}{Sp}\{e^{-\beta H}\} = Q\, e^{-\beta \overline{H}_e}. \quad (12)$$

In the same approximation, it is possible to replace H by the averaged Hamiltonian $\overline{H}_e$, when calculating the mean values of quantities, whose operators act only on the excitation variables. Analogously, an approximate equation is derived for Green's function; this equation contains $\overline{H}e$ (instead of H). There are 3 Soviet-bloc references.

ASSOCIATION: L'vivs'kyy derzhuniversytet im. Iv. Franka (L'viv

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S/185/62/007/003/003/015
D299/D301

To the many-electron theory ...

State University im. Iv. Franko)

SUBMITTED: June 8, 1961

Card 4/4

TYABLIKOV, C.V.; SHIKLOSH, T. [Siklos, T.]

Resonance formulas for uniaxial ferromagnetic substances. Acta phys Hung 14 no.4:331-334 '62.

1. Matematicheskiy institut im. V.A. Steklova A.N. SSSR, Moskva, SSSR (for Tyablikov). 2. TSentral'nyy institut fizicheskikh issledovaniy, Budapesht.

S/020/62/144/002/007/028
B104/B102

AUTHORS: Tyablikov, S. V., and Yakovlev, Ye. N.

TITLE: A generalization of the spin-wave method

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 144, no. 2, 1962, 303-306

TEXT: If the Hamiltonian of the spin system of an isotropic ferromagnetic takes account of the interaction among closest neighbors only, it takes the form

$$\mathcal{H} = -\mu\mathcal{H}\sum_{(f)} S_f - I \sum_{(f,\delta)} S_f^{\alpha} S_{f+\delta}^{\alpha},$$

where f is the vector of the lattice point, δ is the vector linking a given lattice point with its closest neighbor, I is the exchange integral, μ is the magnetic moment of a lattice point, and S_f^{α} is the component of the spin operator. Where $S \gg 1$ (T. Oguchi, Phys. Rev., 117, 117 (1960)), (1) can be expanded according to powers of S^{-1}. The Hamiltonian is then

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transformed according to T. Holstein, H. Primakoff (Phys. Rev. 58, 1098 (1940)) and reduced to

$$\mathcal{H} = A + \sum_{(k)} E_k a_k^+ a_k +$$

$$+ \varepsilon \frac{Iz}{2N} \sum_{(k_1, k_2, k_3, k_4)} \Delta(k_1 + k_2 - k_3 - k_4) \Big[(\gamma_{k_1} + \gamma_{k_2} - 2\gamma_{k_4 - k_2}) +$$

$$+ \frac{\varepsilon}{8S} (\gamma_{k_1} + \gamma_{k_4}) \Big] a_{k_1}^+ a_{k_2}^+ a_{k_3} a_{k_4} + \varepsilon^2 \frac{Iz}{16 SN^2} \sum_{(k_1, \ldots, k_6)} \Delta(k_1 + k_2 + k_3 - k_4 - k_5 - k_6) \times$$

$$\times (\gamma_{k_1} + \gamma_{k_4} - 2\gamma_{k_2 - k_3 - k_6}) a_{k_1}^+ a_{k_2}^+ a_{k_3}^+ a_{k_4} a_{k_5} a_{k_6},$$

Here,

$$A = -\mu HN + 2IzS^2N, \quad E_k = \mu H + 2IzS(1 - \gamma_k),$$

$$\gamma_{k_4} = \frac{1}{z} \sum_{(\delta)} e^{i(k, \delta)}, \quad \Delta(x) = \begin{cases} 1, & x = 0, \\ 0, & x \neq 0, \end{cases}$$

in which N and z are the number of lattice points and of neighbors, respectively. A method due to S. V. Tyablikov (Ukr. matem. zhurn., 11, 287 (1959)) is applied in order to obtain perturbation-theoretical solutions of equations for Green's two-time temperature functions. The solutions are used to calculate energy and attenuation of the spin waves.

ASSOCIATION: Matematicheskiy institut im. V. A. Steklova Akademii nauk SSSR (Institute of Mathematics imeni V. A. Steklov of the Academy of Sciences USSR)
Institut fiziki vysokikh davleniy Akademii nauk SSSR (Institute of High-pressure Physics of the Academy of Sciences USSR)

PRESENTED: December 25, 1961, by N. N. Bogolyubov, Academician

SUBMITTED: December 14, 1961

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S/181/63/005/001/022/064
B102/B186

AUTHORS: Tyablikov, S. V., and Yakovlev, Ye. N.

TITLE: Generalization of the spin-wave method for finite temperatures

PERIODICAL: Fizika tverdogo tela, v. 5, no. 1, 1963, 137-141

TEXT: Bloch's spin wave theory (Z. Phys. 61, 206, 1930) was first generalized by Dyson (Phys. Rev., 102, 1217, 1230, 1956), then applied by Opechocosky (Physica, 25, 476, 1960) and Oguchi (Phys. Rev. 117, 117, 1960). The authors here present a generalization obtained by applying perturbation-theoretical methods to the advanced and retarded Green functions for studying magnetization and the spin-wave energy spectrum at finite temperatures. The problem is reduced to finding the energy spectrum for Dyson's Hamiltonian of ideal spin waves and Oguchi's Hamiltonian: For spin-wave energy ($\tilde{\varepsilon}_k$) and attenuation (Γ_k) in second approximation with respect to ε

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$$\tilde{\varepsilon}_k = \varepsilon_k - \frac{2Iz}{N}\varepsilon \sum_{k_1} (\gamma_0 + \gamma_{k+k_1} - \gamma_{k_1} - \gamma_k)\bar{n}_{k_1} - $$

$$- \frac{Iz}{SN^2}\varepsilon^2 P \sum_{k_2, k_3} \bar{n}_{k_2} \frac{(\gamma_{k_2-k_3} + \gamma_{k_2-k} - \gamma_{k_3} - \gamma_{k+k_2-k_3})^2}{\gamma_k + \gamma_{k_2} - \gamma_{k_3} - \gamma_{k+k_2-k_3}}; \qquad (12)$$

$$\tilde{\gamma}_k = \pi \frac{Iz}{N^2}\varepsilon^2 \sum_{k_2, k_3} \bar{n}_{k_2}(\gamma_{k_2-k_3} + \gamma_{k_2-k} - \gamma_{k_3} - \gamma_{k+k_2-k_3}) \times$$

$$\times \delta(\gamma_k + \gamma_{k_2} - \gamma_{k_3} - \gamma_{k+k_2-k_3}) \qquad (13)$$

is obtained. If H=0, then

$$\tilde{\varepsilon}_k = \varepsilon_k\left(1 - \alpha\left(1 + \frac{0.2}{S}\right)\tau^{5/2}\right), \quad \tau = \frac{kT}{8\pi IS}, \quad \alpha = \frac{\pi}{S}\zeta\left(\frac{5}{2}\right) \qquad (14),(a)$$

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ε_k is Bloch's energy,

$$\left.\begin{aligned} \varepsilon_k &= 2ISz(\gamma_0-\gamma_k)+|\mu|gH, \quad \gamma_k=\frac{1}{z}\sum_{\delta}\exp(i\mathbf{k}\delta),\\ \Gamma^{\lambda}_{\rho\sigma} &= \sum_{\delta}\exp(i\lambda\delta)[1-\exp(-i\rho\delta)][1-\exp(i\sigma\delta)]; \end{aligned}\right\} \quad (3),$$

and $\zeta = \zeta(x)$ is a Rieman function. The resulting expression for the temperature dependence of magnetization is analoguous to that of Dyson. In second approximation Dyson's and Oguchi's Hamiltonians lead to the same results.

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