GINZBURG, V.L.; LEVANYUK, A.P.

Roman scattering of light near phase transition points of the second kind. Zhur. eksp. i teor. fiz. 39 no. 1:192-196 Jl '60. (MIRA 13:12)

1. Fizicheskiy institut imeni P.N. Lebedeva AN SSSR. (Light--Scattering)

86905

S/056/60/039/005/022/051
B006/B077

24.7900 (1035,1144,1160)

AUTHORS: Ginzburg, V. L., Fayn, V. M.

TITLE: Theory of Ferro- and Antiferromagnetism

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 5(11), pp. 1323-1338

TEXT: A simple approximate method is developed which permits determining the magnetization of the lattice or sublattice and also other quantities of ferro- and antiferromagnetics practically throughout the complete temperature range as functions of the dimensions and shape of the magnetic system. By way of introduction the authors point out the importance of the magnetic methods in the investigation of fine disperse substances, polymers and macromolecules. This paper concentrates on the examination of the anomalous magnetic properties of some nucleic acids and synthetic polymers. The nature of these effects is still unclear, and even if they are not related to the antiferromagnetism (as is assumed by the authors, cf.Ref.2), an analysis of the properties of "polymer-type" ferro- and antiferromagnetics is still of significance. The approximate method used to determine

Card 1/2

86905

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B006/B077

Theory of Ferro- and Antiferromagnetism

the magnetic quantities in relation to size and shape of the specimens (small particles, films, polymer chains, etc.) is based on a self-consistent generalization of the spin wave theory using the usual model of localized spins with exchange interaction. Although this model is far from representing the real conditions the results obtained are essentially of general validity, that is, independent of the model and can be regarded as semi-phenomenological. The problem is also examined as to when and to what extent the assumption of small particles and polymer chains forming a "paramagnetic fluid" is valid. The magnetic properties of such a fluid are studied. M. I. Kaganov, N. N. Bogolyubov, S. V. Tyablikov, Pu Fu-cho, and L. A. Blyumenfel'd are mentioned. There are 30 references: 9 Soviet, 15 US, 2 German, and 4 British.

ASSOCIATION: Radiofizicheskiy institut Gor'kovskogo gosudarstvennogo universiteta (Institute of Radio Physics of the Gor'kiy State University)

SUBMITTED: May 26, 1960

Card 2/2

68696

24.2120

S/053/60/070/02/004/016
B006/B007

AUTHORS: Ginzburg, V. L., Gurevich, A. V.

TITLE: Nonlinear Phenomena in a Plasma Which Is Located in a Variable Electromagnetic Field

PERIODICAL: Uspekhi fizicheskikh nauk, 1960, Vol 70, Nr 2, pp 201-246 (USSR)

ABSTRACT: The present paper is the first part of a very detailed survey of the theory of nonlinear phenomena in an ionized gas. This article will be published simultaneously in the periodical "Fortschritte der Physik" of Eastern Germany. The nonlinearities occurring partly because of the relatively great electron free path and partly because of the considerable difference between electron mass and atomic- and molecular masses already at comparatively low field strengths (e.g. if the polarization and the conduction current are not proportional to the field E, the propagation of electromagnetic waves must be described by a nonlinear theory, as the superposition principle, for example, no longer holds), are systematically dealt with with reference to voluminous publications. In the first two paragraphs of the present article, the influence exerted by a homogeneous electric field

Card 1/4

68696

Nonlinear Phenomena in a Plasma Which Is Located in a Variable Electromagnetic Field

S/053/60/070/02/004/016
B006/B007

$\vec{E} = \vec{E}_0 e^{i\omega t}$ upon a non-relativistic and non-degenerate (classical) plasma which may be located in a homogeneous and constant (external) magnetic field $\vec{H}_0$ is investigated. Macroscopic (hydrodynamic) motions in the plasma are not dealt with. The influence of the field upon the plasma in this case leads to a change in the velocity-distribution function of the plasma electrons, which is set up as a function of $\omega$, $\vec{E}_0$, $\vec{H}_0$ and of the plasma parameters. The distribution function of the heavy particles may in this case be considered to be a Maxwell temperature function, which is justifiable in the steady case under investigation. If the electron velocity distribution is known, their kinetic energy (their temperature $T_e$) and the total current density $\vec{j}_t$ may be determined. In weak fields electron temperature is equal to that of the heavy particles, and $\vec{j}_t$ is proportional to $\vec{E}$. Paragraph 1 deals with the elementary theory of the plasma in a homogeneous electric field (electron current; dielectric constant and plasma conductivity; electron temperature). In paragraph 2 the kinetic theory of a

Card 2/4

68696

Nonlinear Phenomena in a Plasma Which Is Located in a Variable Electromagnetic Field

S/053/60/070/02/004/016
B006/B007

plasma in a homogeneous electric field, i.e. the description of the electron gas by means of distribution functions $f(\vec{v},\vec{r},t)$ is dealt with. Individual sections deal with the following: The kinetic equation; the transformation of the collision integral; elastic collisions with neutral particles (molecules); inelastic collisions with neutral particles; collisions with ions; collisions of electrons with one another; the solution of the equation of motion for a highly ionized plasma; the (Maxwellian) distribution function; the effective number of collisions; the relative portion of transferred energy $\delta_{eff}$ (table 1 gives the $\delta_{eff}$-values for electron temperatures of between 500 and 15000° for helium, hydrogen, oxygen, nitrogen, and air; $\delta_{eff}$ equals $\delta_{elast}$ up to electron temperatures of $\sim$1 ev, after which it increases exponentially with $T_e$.); electron current, dielectric constant and conductivity of the plasma; electron temperature; the weakly ionized plasma; elastic collisions; the molecular plasma; inert gases; the electron current and the mean energy of the electrons; the elementary theory

Card 3/4

68696

Nonlinear Phenomena in a Plasma Which Is Located in a Variable Electromagnetic Field

S/053/60/070/02/004/016
B006/B007

for an arbitrary degree of ionization; transition from the highly- to the weakly ionized plasma; and the conditions for the applicability of the elementary theory (by comparison with the kinetic theory these conditions are mathematically formulated for highly and weakly ionized plasma). There are 8 figures, 2 tables, and 68 references, 35 of which are Soviet.

Card 4/4

S/053/60/070/03/001/007
B006/B014

AUTHORS: Ginzburg, V. L., Gurevich, A. V.

TITLE: Nonlinear Phenomena in a Plasma Located in a Variable Electromagnetic Field

PERIODICAL: Uspekhi fizicheskikh nauk, 1960, Vol 70, Nr 3, pp 393-428 (USSR)

ABSTRACT: This article is continued from a survey published in "Uspekhi fizicheskikh nauk", 1960, Vol 70, p 202. Paragraph 3 deals with the nonlinear effects occurring in the propagation of radio waves in a plasma (ionosphere, solar corona), perturbation of the principle of superposition, influence of the wave field on the plasma, Maxwell equations. Section 3.1 deals with the propagation of radio waves in a plasma in consideration of nonlinearity (self-action of the radio waves). In this case, the field at the plasma boundary (z=0 plane) is assumed to be $\vec{E}_0(0)\cos\omega t$, and the wave propagation is described by $\Delta\vec{E} - \text{grad div}\,\vec{E} + \frac{\omega^2}{c^2}\varepsilon'(\vec{r},\omega,E_0)\vec{E} = 0$; $\varepsilon' = \varepsilon - \frac{4\pi\sigma i}{\omega}$.
The amplitude and the self-action factor are studied, and the modulation of waves is discussed in detail. Section 3.2



APPROVED FOR RELEASE: Thursday, July 27, 2000 CIA-RDP86-00513R00051673(

Nonlinear Phenomena in a Plasma Located in a Variable Electromagnetic Field

S/053/60/070/03/001/007
B006/B014

describes the influence of self-action on the propagation of radio waves in the ionosphere. This self-action depends on the wavelength, and is separately studied for short waves, medium waves (Table 4), and long waves. The resonance of self-modulation near the gyromagnetic frequency, which amounts to $(6 - 8) \cdot 10^6$ in the ionosphere, is also investigated. The specific features and the causes of this greatly nonlinear effect are discussed separately. Section 3.3 is devoted to an investigation of the interaction between modulated radio waves (cross modulation). A theoretical study of cross modulation in an isotropic plasma is followed by an investigation of the influence of a constant magnetic field and of the resonance effects occurring near the gyromagnetic frequency. Section 3.4 describes the results of experiments on cross modulation in the ionosphere (absolute cross-modulation depth, dependence of the depth $\mu_\Omega$ and the phase of cross modulation on the depth $\mu_0$ and the frequency $\Omega$, dependence of $\mu_\Omega$ on the intensity and frequencies of the disturbing waves, and cross-modulation

Card 2/3

Nonlinear Phenomena in a Plasma Located in a Variable Electromagnetic Field

S/053/60/070/03/001/007
B006/B014

resonance). In section 3.5 the authors study the nonlinear interaction of nonmodulated radio waves. At first, the variations of propagation conditions for a nonmodulated wave are investigated, then so-called lateral waves, viz. waves with combined frequencies, and finally the nonlinear effects connected with the variation in electron concentration. This article is concluded with a few notes about future studies in this field. There are 11 figures, 2 tables, and 65 references, 21 of which are Soviet.

Card 3/3

81677
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3.1900

AUTHORS: Ginzburg, V. L., Syrovatskiy, S. I.

TITLE: The Present Stage of the Problem of the Origin of Cosmic Rays

PERIODICAL: Uspekhi fizicheskikh nauk, 1960, Vol. 71, No. 3, pp. 411-469

TEXT: The International Conference on Cosmic Radiation took place in Moscow in July, 1959. This review article contains a compilation and discussion of all known results, with special regard to the data obtained after this conference. The authors proceed from concepts based on radio-astronomical data, according to which cosmic radiation mainly originates from Galaxies, and is due to eruptions of Supernovae and possibly other variable stars. § 1 is devoted to primary cosmic radiation on the Earth, its chemical composition being described first. Table 1 lists data on Z, $\bar{A}$, flux, number of nucleons, flux- and particle number ratios. The energy spectrum is described next. In general, $I_A(>\varepsilon) = K_A\varepsilon^{-\gamma+1}$ holds, where $I_A(>\varepsilon)$ is the nuclear flux of group A with

Card 1/3

81677

The Present Stage of the Problem of the Origin of Cosmic Rays

S/053/60/071/03/02/008
B006/B063

a total energy (per nucleon) greater than $\mathcal{E}$. The values for $K_A$ and $\gamma$ are given in Table 2. Within the limits of error $\gamma = 2.5 \pm 0.2$. The differential spectrum exhibits a maximum with a steep decline, so that one may speak of a "cutoff". The origin of this "cutoff" and the fact that its energy is independent of the nuclear charge are discussed. The spectrum of the total energy per particle may be expressed by $I_A(>E) = K_A(E/A)^{-\gamma+1} = (K_A A^{\gamma-1})/E^{\gamma-1}$ (cf. Table 3). For $\simeq 10^{15}$ ev the spectrum has a singularity whose nature and cause are discussed in the following. § 2 gives a survey of radioastronomical data referring to synchrotron radiation, results and interpretation of some observations on the structure of the Galaxy and its sources of discrete radiation (galactic "halo" or "corona", "radio-disk" of the Galaxy (Figs. 1 and 2), and its "central radio range" (Figs. 3 and 4)). Data on power, energy, and magnetic field strength are given in Table 4 for numerous sources of galactic radiation. § 3 gives details on the lifetime of cosmic rays and their motion in the Galaxy and metagalaxy (the part played by cosmic rays formed in the early developmental stages of the Galaxy; the motion of cosmic particles in galactic magnetic fields,

Card 2/3

81677

The Present Stage of the Problem of the Origin of Cosmic Rays

S/053/60/071/03/02/008
B006/B063

the radiation yield from the Galaxy; cosmic radiation of metagalactic origin; the origin of the electronic component of cosmic radiation in the interstellar space or in the envelopes of Supernovae). § 4 deals with the sources of cosmic radiation, mechanism of particle acceleration and chemical composition (radiation sources, mechanism of acceleration, energy spectrum, and the possibility of preferential acceleration of heavy nuclei; changes in the chemical composition of cosmic radiation in the interstellar space; chemical composition and distribution of elements in the radiation. The article is concluded with three additional remarks in the proof correction of this paper. Mention is made of G. A. Shayn, I. S. Shklovskiy, G. G. Getmantsev, V. A. Razin, and I. M. Gordon. There are 6 figures, 8 tables, and 144 references: 67 Soviet, 22 American, 1 Japanese, 2 German, 7 British, 14 Italian, 1 Belgian, 5 Australian, 1 French, 2 Dutch.

Card 3/3

AUTHORS: Ginzburg, V. L., Corresponding Member, AS USSR, Fayn, V. M.

S/020/60/131/04/019/073
B013/B007

TITLE: Possible Anomalies of the Magnetic Properties of Macromolecules

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol 131, Nr 4, pp 785-788 (USSR)

TEXT: Strong lines of electron paramagnetic resonance and anomalous magnetic properties have recently been detected in a number of macromolecules (polymers). In this connection it is essential that the initial links of the chain and the short chains (monomers) are diamagnetic or ferromagnetic. Consequently, this means a transition (with elongation of the chain) from a diamagnetic state into a paramagnetic or ferromagnetic one. The authors give an explanation of this hitherto unexplained effect. They assume that the finite, but not too short and not too long chain of monomers is antiferromagnetic. The electrons under consideration then form two antiparallel sublattices. The antiferromagnetic level is the lowest level of the whole system. It is further assumed that the antiferromagnetic level is the lowest level in a chain of monovalent atoms with the exchange interaction $H_{ex} = -\frac{1}{2}\sum_{lm} 2 J_{lm}\vec{S}_l\vec{S}_m$ at $J_{lm}$. Here, $\vec{S}_l$ denotes the spin operator in $\hbar$ units. When the chain is stretched, antiferromagnetism may

Card 1/3

Possible Anomalies of the Magnetic Properties of Macromolecules

S/020/60/131/04/019/073
B013/B007

at a certain frequency $\nu$ not only with a certain value of H but in a wide frequency range. The lateral links which "cement" the chains into the three-dimensional body, play a stabilizing part. Of special importance is the determination of the temperature dependence of the magnetic moment of the samples. It is possible that the spin waves play an important part also in biological processes. The authors thank L. A. Blyumenfel'd and V. A. Benderskiy for experimental data and a discussion. There are 1 figure and 16 references, 7 of which are Soviet.

ASSOCIATION: Fizicheskiy institut im. P. N. Lebedeva Akademii nauk SSSR (Physics Institute imeni P. N. Lebedev of the Academy of Sciences of the USSR) Nauchno-issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom gosudarstvennom universitete imeni N. I. Lobachevskogo (Radiophysical Scientific Research Institute of Gor'kiy State University imeni N. I. Lobachevskiy)

SUBMITTED: January 3, 1960

Card 3/3

GINZBURG, V. L., KURNOSOVA, L. V., ROSORENOV, L. A., FRADKIN, M. I.

"The results of measurements of nuclear component of cosmic rays of solar origin with Sputniks and Lunniks."

report to be submitted for the IAU Symposium on the Corona, Cloudcroft, New Mexico, 28-30 Aug 1961.

P/048/61/000/003/001/004
1004/1204

V. L.,

AUTHORS Bieniediktow, J. A., Gittmancew, G. G., Ginzburg, W. L.

TITLE: Radioastronomical investigations with the aid of artificial satellites and cosmic rockets

PERIODICAL Astronautyka no. 3, 1961, 5-8

TEXT: Radioastronomical observations by satellites can expand the range of wave lengths at which extraterrestrial signals can be received above 20-40 m and below 1 cm. Measurements of the microwave sepctrum of the sun may reveal that the drop in its effective temperature is caused by the fact that the radiation passes through an inverse layer whose temperature is probably lower than that of the photosphere. Radiation of the moon in the millimeter range and below may furnish information about the structure and electric and thermal properties of the moon's soil. Rockets which will pass in the vicinity of Mars, Venus, and other planets may carry out measurements of electromagnetic radiation from these planets over a wide frequency range Sporadic eruptions of the sun which are closely related to magnetic storms, ionospheric disturbances affecting short wave radio communication, and other phenomena can be observed more clearly from satellites. Investigation of the sporadic eruptions of Jupiter below 14 Mc may reveal their cause.

Card 1/1

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E032/E114

AUTHORS: Benediktov, Ye.A., Getmantsev, G.G., and Ginzburg, V.L.

TITLE: Radio-astronomical studies using artificial earth satellites and space rockets

PERIODICAL: Akademiya nauk SSSR. Iskusstvennyye sputniki Zemli, No.7, Moscow, 1961, pp. 3-22

TEXT: In a previous paper (Ref.1: G.G. Getmantsev, V.L. Ginzburg, I.S. Shklovskiy, UFN, 66, 157, 1958) some of the possible applications of artificial Earth satellites ... were discussed. The present paper extends this discussion and pays particular attention to fundamental problems ... discussions of specific forms of apparatus. The paper is divided into the following sections: 1) high-frequency ... 2) measurements of sporadic radio emission of the ... 3) cosmic radio emission and the radio emission ... sources; 4) radio emission in the radiation belts of the Earth and the planets; 5) studies of the ionosphere and the ... medium. The first part of this paper is concerned with ... range $\lambda < 1$-$3$ cm. The high-frequency radio emission of the ... the

Card 1/ 10

moon can be investigated with the aid of low orbit satellites, while the observation of this emission on millimetre and sub-millimetre wavelengths is of great interest since these waves are strongly absorbed in the troposphere. Solar and lunar radio emission on these wavelengths should be of thermal nature and the effective temperature of the sun should be of the order of [illegible] deg. while that of the moon should be ~ [illegible] °K. This region may also include the synchrotron emission due to relativistic electrons circulating in solar magnetic fields. By measuring the millimetre spectrum of the sun it may be possible to determine the reduction in the effective temperature on wavelengths corresponding to the passage of the radiation through the reversing layer whose temperature is apparently lower than that of the photosphere. The apparatus which should be set up on artificial earth satellites in order to measure the high-frequency solar and lunar radio emission need not differ to any great extent from ordinary "surface" apparatus. The linear dimensions of the antennae (mirrors) need not be very large since the angular dimensions of the moon and the sun are of the order of 30'. For example, for $\lambda = 0.1$ cm the mirror diameter turns out to be about 11 cm.

Card 2/10

26657

Radio-astronomical studies using.... S/560/61/000/007/001/010
E032/E114

The flux of solar and lunar radio emission can only be measured with antennas having high directivity which would require "oriented" satellites. In the case of space rockets launched so that they reach the neighbourhood of Mars, Venus and other planets in the solar system, the radio measurements can be carried out in a wide frequency range. C.H. Mayer, T.P. McCullough and R.M. Sloanaker (Ref.5: Proc. IRE, V.46, 260, 1958) and L.E. Alsop, Y.A. Giorgmaine, C.H. Mayer and C.H. Townes (Ref.7: Paris Symposium on Radio Astronomy, Stanford, California, 1959) have already measured the radio emission of Venus and Mars on centimetre waves using a radio telescope with a parabolic mirror 15 m in diameter. On $\lambda$ = 3.15 cm the effective temperature of Mars was found to be 220 ± 75 °K, while for Venus the corresponding figure is 600 °K. These measurements represent the present limit of radio astronomical apparatus. On the other hand attempts to extend these measurements to longer decimetre waves, or even metre waves, will meet with serious difficulties. In fact, since the emission of Mars and Venus in this range is of thermal character its intensity should be proportional to $\lambda^{-2}$, and hence in order to achieve the same power at the output of the antenna as in the case

Card 3/10

26657



of the shorter wavelengths the area of the antenna must be increased in proportion to $\lambda^2$. A mirror having a diameter of about 150 m is already necessary at $\lambda \approx 1$ m. In the case of a space rocket, on the other hand, the antenna dimensions can be reduced very considerably, e.g. down to $L \sim \lambda$. The sporadic solar radio emission has been extensively studied in a wide wavelength range beginning at a few cm right up to $\lambda \sim 10$ m. It has been established that the slowly varying (in time) component is associated with sunspots. The other component of the sporadic radio emission takes the form of short bursts. These are due to the radio emission which is largely associated with solar corpuscular streams and also solar cosmic rays emitted from chromospheric flares. The study of the spectral characteristics of these bursts, and also the time dependence of the intensity, is of major importance to any detailed theory of the sporadic radio emission of the sun. The sporadic solar radio emission is also of great interest from the geophysical point of view. The corpuscular streams which are responsible for these bursts are also responsible for geomagnetic disturbances, radio fadeout on short waves, ionospheric disturbances, etc. A consideration of the experimental

26657

Radio-astronomical studies using .... S/560/61/000/007/001/010
E032/E114

material available so far shows that in the case of $\lambda \gtrsim 40-50$ m; the study of solar radio bursts can only be carried out with the aid of artificial Earth satellites with orbits lying above the F layer maximum. Satellites will also be useful for $\lambda \gtrsim 20$ m. Presently available data (C.W. Allen, Astrophysical Quantities, London, Athlone Press, 1955, Ref.15, and D.E. Blackwell, Monthly Not. Roy. Astr. Soc., V.116, 56, 1956, Ref.16) suggest that the radio bursts on $\lambda \lesssim 40$ m should be generated at relatively low heights in the corona, namely $R/R_{\odot} \lesssim 2.1$. On the other hand the regular solar corona is known to extend at least up to $R/R_{\odot} \sim 10-20$ and possibly to even greater distances. It may therefore be expected that the burst component of the sporadic solar radio emission should be observable up to $\lambda \sim 300-400$ m. Thus any information on bursts on wavelength in excess of 20 m would be of considerable interest from the point of view of the physics of the outer solar corona. Satellite apparatus designed to record solar bursts could also be used to detect the bursts due to Jupiter. Particularly interesting information about the latter bursts would correspond to the wavelength range below 20 m. As regards the cosmic radio emission and the radio emission of discrete sources,

Card 5/10

26657

Radio-astronomical studies using ... S/560/61/000/007/001/010
E032/E114

it is pointed out that presently available data suggest that measurements of the spectrum of the non-thermal cosmic radio emission on $\lambda \gtrsim 30$ m obtained with the aid of artificial earth satellites should lead to more accurate information on the gas concentrations in inter-planetary space for known magnetic fields H. Conversely, these measurements should lead to more accurate values for H if the gas concentration can be determined independently. Accurate satellite measurements of the spectrum of the primary cosmic radio emission should be carried out from high orbits so as to minimise ionospheric effects. Recent rocket and satellite measurements show that the electron concentration above the F-layer decreases with altitude rather slowly (Ya.L. Al'pert, F.F. Dobryakova, E.F. Chudesenko, B.S. Shapiro, UFN, V.65, 161, 1958, Ref.27). It is estimated that in order to minimise ionospheric effects, the measurements of extra-terrestrial radio emission on wavelengths greater than 1 m should be carried out from satellites having an apogee in excess of 1000 km. Inter-planetary absorption of radio waves may become important in satellite measurements. Table 2 gives the estimated absorption in inter-planetary space for 100, 1, and 0.01 electron/
Card 6/10

cm$^3$ where $\ell$ is the path length in cm. The optical thickness $\tau$ given in Table 2 was calculated from a formula given by V.P. Ginzburg (Ref.28: "Propagation of Electromagnetic Waves in Plasma", Fizmatgiz, 1960). This formula reads:

$$\tau = \frac{10^{-2} \cdot N}{Te^{3/2} \cdot f^2} \left[ 17.7 + \ln \frac{T_e^{3/2}}{f} \right] \cdot \ell \qquad (1)$$

and holds for rarefied plasma for which $(n - 1) \ll 1$. The values given in Table 2 are very approximate but nevertheless it is to be expected that the absorption should become appreciable beginning with $\lambda \sim 500$-$1000$ m. Another interfering effect in the range $\lambda \gtrsim 200$-$300$ m may be due to corpuscular streams. A consideration of available satellite and rocket data (Ref.1: as above. Ref.2: F.T. Haddock, Amer. Rocket Soc. No.794, 1959. Ref.3: A.C.B. Lovell, Proc. Roy.Soc. A253, 494, 1959. Ref.4: J.P.I. Tyas, C.A.Franklin, A.R. Molozzi, Nature, 184, 785, 1959) suggest that the satellite antennas should be of a simple form. It is estimated that there should be no intensity difficulties and antenna dimensions of the order of a few metres should be sufficient. As regards the radio

26657

Radio-astronomical studies using .... S/560/61/000/007/001/010
E032/E114

emission of discrete sources the wavelength range 20-50 m is of particular interest since it is inaccessible to terrestrial measurements. Here antennas having linear dimensions of the order of the wavelength are estimated to be adequate. In order to achieve angular localization of discrete sources and to determine the details in the distribution of non-thermal cosmic radio emission, one could use the diffraction of extra-terrestrial radio emission by the moon and the earth. Estimates of the radio emission of terrestrial and planetary radiation belts are more difficult. Nevertheless, very rough calculations indicate that the intensities involved should be detectable from artificial earth satellites, and it is precisely because these estimates are difficult that the satellite experiments should be carried out. Finally, satellite and rocket measurements can produce information about the radio emission of the terrestrial and planetary atmospheres and also about the inter-planetary medium. It is suggested that the most promising method of measuring the electron concentration in the ionosphere and in inter-planetary space is the method involving the measurement of the group delay time of audio-frequency modulated signals transmitted from artificial earth

26657

Radio-astronomical studies using .... S/560/61/000/007/001/010
E032/E114

satellites (E.Ye. Gershman, N.A. Mityakov and V.O. Rapoport, Ref.37: Izv. vuz, Radiofizika, Vol.3, 949, 1960). It is suggested that a review of available information indicates that the above radio-astronomical observations can be carried out with relatively simple apparatus (this refers to the radio apparatus and the antennas). The authors therefore expect that satellite and rocket radio-astronomical observations will attract considerable attention in the near future.

There are 1 figure, 2 tables and 39 references: 19 Soviet and 20 English. The four most recent English language references read:

Ref.3: as above.
Ref.10: A.R. Tompson, A. Maxwell, Nature, 185, 89, 1960.
Ref.31: J. Van Allen, Nature, 183, 430, 1959.
Ref.39: A.G. Smith, T.D. Carr, H. Bollhagen, N. Chatterton and F. Six. Nature, 187, 568, 1960.

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Card 9/10

PHASE I BOOK EXPLOITATION SOV/5705

Ginzburg, Vitaliy Lazarevich, Corresponding Member, Academy of Sciences USSR

Kosmicheskiye luchi u Zemli i vo vselennoy (Cosmic Rays at the Earth and in the Universe) Moscow, Izd-vo "Znaniye," 1961. 46 p. (Series: Vsesoyuznoye obshchestvo po rasprostraneniyu politicheskikh i nauchnykh znaniy. Seriya IX, 1961: Fizika i khimiya, no. 11) 26,000 copies printed.

Ed.: I. B. Faynboym; Tech. Ed.: Ye. V. Savchenko.

PURPOSE: This booklet is intended for readers interested in the phenomenon of cosmic rays.

COVERAGE: The booklet discusses briefly the origin, nature, and properties of cosmic rays. The theory of the phenomenon of cosmic rays is examined, and methods of investigating such rays are described. Included are a discussion of our and other galaxies as the source and origin of cosmic rays, an analysis of their chemical composition and energy spectrum and balance, and an investigation of the mechanism of particle acceleration.

Card 1/2

The principles of radioastronomy as the most important tools of investigating cosmic rays are discussed. No personalities are mentioned. There are 8 references, all Soviet.

TABLE OF CONTENTS:



AVAILABLE: Library of Congress

Card 2/2

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3.2420(1482,2806,1049)
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33305
S/560/61/000/010/003/016
D299/D302

AUTHORS: Ginzburg, V. L., Kurnosova, L. V., Logachev, V. I., Razorenov, L. A., Sirotkin, I. A., and Fradkin, M. I.

TITLE: Study of charged-particle intensity during the flight of the 2nd and 3rd Sputniks

SOURCE: Akademiya nauk SSSR. Iskusstvennyye sputniki Zemli. no. 10. Moscow, 1961, 22-33

X

TEXT: During the flight of the 2nd and 3rd Sputniks, the flow of charged particles at altitudes between 187 and 339 km and latitudes of -65 to +65° was recorded by means of a telescope consisting of 2 rows of gas-discharge counters; the telescope was part of measuring equipment for cosmic rays. As a result of the measurements, the intensity of the charged particles and its latitude dependence were determined. The counting rate $N_c$ and

Card (1/7)

33305
S/560/61/000/010/003/016
D299/D302

Study of charged-particles...

the global intensity $J_{gl}$ at various latitudes are listed in a table. It was found that at all latitudes the recorded intensity was several times higher than the intensity of cosmic rays recorded in the stratosphere and in free space beyond the earth's magnetic field. This difference is particularly noticeable in the region of the geomagnetic equator, where the measured intensity was six times that of cosmic rays. Several regional anomalies of intensity were observed, apparently related to the anomalies of the earth's magnetic field. For the entire track of the space-ships, detailed graphs were made of the time dependence of the intensity and hence of its dependence on geographical coordinates and altitude of the space-ship. From these graphs, maps were made of the intensity distribution on the earth's surface. It is noted that, with repeated passage of the space-ship above the same terrestrial point and almost same altitude, the recorded intensity differed sometimes from that on the first passage; in some cases, the intensity was almost double. This difference

Card 2/7

33305

Study of charged-particles... S/560/61/000/010/003/016
D299/D302

was particularly noticeable at high latitudes. As the orientation of the apparatus changes during the second passage, this difference in intensity may not be real. The obtained equi-intensity lines for the south-Atlantic and southern anomalies constitute a slight refinement to the earlier obtained data (in the references); the maximum number of counts in the southern anomaly was 60 per second, and in the south-Atlantic anomaly it was 70 per second. The anomalies are particularly great in the Southern Hemisphere. The intensity distributions in the anomaly regions, recorded at altitudes of 306 - 339 km and at altitudes of 187 - 265 km during the two flights, differ from each other. This difference is apparently due to the different flight-altitudes. The connection between the anomalous structure of the radiation belts and the anomalies of the earth's magnetic field is evident; it would be premature, however, to assume that the regional anomalies of the magnetic field on the earth's surface have a substantial influence on charged-particle flow up to altitudes of 200 - 300 km. The many anomalies in the South- and

Card 3/7

33305

Study of charged-particles... S/560/61/000/010/003/016
D299/D302

North-Pole regions, their disposition and variation, suggest that these anomalies are the edges of the outer radiation belt of the earth. The latitude dependence of the intensity is shown in a graph (for the Northern Hemisphere); it is noted that, at high latitudes, the increase in intensity ceases. The obtained data on the intensity distribution give evidence of the edge effects of the radiation belts at 200 - 300 km altitude and of certain peculiar features not observed previously. In particular, the great temporal anomalies are noted; thus, the "northern anomaly" recorded on August 20, 1960, at 7 hr. 40 min. (world time) and the south-polar anomaly recorded on December 1, 1960, at 14 hr. 22 min. These anomalies are apparently due to solar activity. The line of least intensity (the "radiation equator") is shown in a figure. With regard to the composition of the radiation, it is likely that the increase in the counting rate (as compared to that from primary cosmic rays) is due to protons with $E_p >$ 60 Mev; although no definite conclusion is possible as yet, it

X

Card 4/7

33305

S/560/61/000/010/003/016
D299/D302

Study of charged-particles...

is assumed (as a working model) that the inner radiation belt if formed by protons and that the number of electrons of energies higher than ~2 Mev is small. The above results confirm the existence of a high-intensity region down to 200 km altitude (from 1000 km). On the other hand, the radiation at 50 - 150 km is practically independent of altitude. The altitude dependence of the intensity (for 200 - 2000 km) is shown in a figure. Tentatively, the altitude h and the atmospheric density $\rho$ can be expressed by the values:

| | | | | | | |
|---|---|---|---|---|---|---|
| h, km | 100 | 150 | 200 | 300 | 400 | 500 |
| $\rho$, gm · cm$^{-3}$ | $10^{-9}$ | $10^{-11}$ | $10^{-12}$ | $10^{-13}$ | $2 \times 10^{-14}$ | $2 \times 10^{-15}$ |

| | | | | | |
|---|---|---|---|---|---|
| h, km | 600 | 700 | 800 | 900 | 1000 |
| $\rho$, gm · cm$^{-3}$ | $6 \times 10^{-16}$ | $2 \times 10^{-16}$ | $6 \times 10^{-17}$ | $3 \times 10^{-17}$ | $10^{-17}$ |

X

Card 5/7

33305
S/560/61/000/010/003/016
D299/D302

Study of charged-particles...

On the basis of the incomplete data available, the internal radiation-belt in the equatorial region for altitudes above 400 - 600 km can be approximated by a very simple model, where only ionization losses are taken into account. At higher latitudes, the pattern is more complicated; it becomes necessary to render more precise the composition, spectrum and altitude-variation of the charged particles. At altitudes below 400 - 600 km, considerable deviations from the formula $J \sim \rho^{-1}$ occur. This is due to diffusion of the particles in a direction transverse to the magnetic field; this diffusion mechanism is related to collisions between particles. A second diffusion mechanism exists, related to the presence of electric fields E which cause particle-drift. The diffusion processes require further investigation. Finally, the radiation dose is estimated beneath a layer of matter of the order of 4 $gm/cm^{-2}$ at an altitude of 200 - 300 km. Assuming recorded proton energies (in the equa-

Card 6/7

33305
S/560/61/000/010/003/016
D299/D302

Study of charged-particles...

torial region) of $E_p \gtrsim 60$ Mev, the daily radiation dose constitutes approximately 30% of the permissible dose. In the region of the south-Atlantic anomaly at 300 km altitude, the radiation dose is by an order of magnitude higher than at the equator. There are 10 figures, 1 table and 10 references: 7 Soviet-bloc and 3 non-Soviet-bloc (including 2 translations). The reference to the English-language publication reads as follows: S. Yoshida, G. H. Ludwig, J. A. Van Allen, J. Geophys. Res., 65, 807, 1960.

SUBMITTED: May 15, 1961

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Card 7/7

GINZBURG, V.L.; SYROVATSKIY, S.I.

Origin of cosmic rays. Geomag. i aer. 1 no.4:479-482 Jl-Ag '61.
(MIRA 14:12)

1. Fizicheskiy institut imeni P.N. Lebedeva AN SSSR.
(Cosmic rays)

24.7710 (1137, 1138, 1160, 1482) 24927

S/181/61/003/006/024/031
B102/B214

AUTHORS: Ginzburg, V. L., Rukhadze, A. A., and Silin, V. P.

TITLE: Electrodynamics of crystals and the exciton theory

PERIODICAL: Fizika tverdogo tela, v. 3, no. 6, 1961, 1835 - 1850

TEXT: The present paper gives a detailed theoretical treatment of the general problem of the application of the electrodynamics of matter with spatial dispersion to crystals. The authors confine themselves particularly to the investigation of the approximations one obtains when one works with $\varepsilon_{ij}(\omega,\vec{k})$, the tensor of the complex dielectric constant. First the fundamental equations of the electrodynamics of matter with spatial dispersion are written down. They are in the usual notations: $\mathrm{curl}\vec{B} = \frac{1}{c}\frac{\partial \vec{D}'}{\partial t} + \frac{4\pi}{c}\vec{j}_0$; $\mathrm{div}\vec{D}' = 4\pi\varrho_0$; $\mathrm{curl}\vec{E} = -\frac{1}{c}\frac{\partial \vec{B}}{\partial t}$; $\mathrm{div}\vec{B} = 0$; $\vec{F} = e(\vec{E} + \frac{1}{c}[\vec{v}\vec{B}])$, the force acting on a point charge moving with velocity $\vec{v}$; for the electric induction $\vec{D}'$ one has $\partial\vec{D}'/\partial t = \partial\vec{E}/\partial t + 4\pi\vec{j}$. For plane monochromatic waves, $\vec{D}'$ and $\vec{E}$ are interrelated by:

Card 1/7

APPROVED FOR RELEASE: Thursday, July 27, 2000 CIA-RDP86-00513R00051673(

$$D'_i(\mathbf{k},\ \omega)=\varepsilon_{ij}(\omega,\ \mathbf{k})E_j(\mathbf{k},\ \omega);\quad E_i(\mathbf{k},\ \omega)=\varepsilon^{-1}_{ij}(\omega,\ \mathbf{k})D'_j(\omega,\ \mathbf{k}),\qquad (1,6)$$

$$\varepsilon_{ij}(\omega,\ \mathbf{k})=\int_0^\infty d\tau\int d\mathbf{R}e^{i(\mathbf{kR}-\omega\tau)}\hat{\varepsilon}_{ij}(\tau,\mathbf{R}).\qquad (1,7)$$

For crystals one has

$$\left.\begin{aligned} D'_i(\mathbf{r},\ \omega)&=\int d\mathbf{r}'\varepsilon_{ij}(\omega,\ \mathbf{r},\ \mathbf{r}')E_j(\mathbf{r}',\ \omega),\\ D'_i(\mathbf{k},\ \omega)&=\int d\mathbf{k}'\varepsilon_{ij}(\omega,\ \mathbf{k},\ \mathbf{k}')E_j(\mathbf{k}',\omega).\end{aligned}\right\}\qquad (1,8)$$

It is shown that in crystals in the optical region the tensor $\varepsilon_{ij}(\omega,\vec{k},\vec{k}')$ can be reduced to the tensor $\varepsilon_{ik}(\omega,\vec{k})$ in the usual way. If the normal electromagnetic waves have the form $\vec{E}_l = \vec{E}_{ol}e^{i(\vec{k}\vec{r}-\omega t)}$, $\vec{B}_l = \vec{B}_{o,l}e^{i(\vec{k}\vec{r}-\omega t)}$, $\vec{E}_{o,l}$ = constant, $\vec{B}_{ol}$ = constant (spatially homogeneous medium) one has for $j_o = 0$,

$$\left.\begin{aligned} D' = -\frac{c}{\omega}[kB], \quad B = \frac{c}{\omega}[kE], \\ D' = \frac{c^2}{\omega^2}\{k^2E - k(kE)\}, \\ \frac{\omega^2}{c^2}\varepsilon_{ij}E_j - k^2E_i + k_ik_jE_j = 0. \end{aligned}\right\} \qquad (1,13)$$

or, in the determinantal representation $\Delta_1(\omega,\vec{k}) = \left|\frac{\omega^2}{c^2}\varepsilon_{ij}(\omega,\vec{k}) - k^2\delta_{ij} + k_ik_j\right| = 0$, or $\Delta_2(\omega,\vec{k}) = \left|\frac{\omega^2}{c^2}\delta_{ij} - k^2\varepsilon^{-1}_{ij}(\omega,\vec{k}) + k_ik_l\varepsilon^{-1}_{ij}(\omega,\vec{k})\right| = 1$ ($\Delta$ or $||$ denote the determinants of the system of linear homogeneous equations). Starting from these equations the authors investigate in the following the properties of the tensor $\varepsilon_{ij}(\omega,\vec{k})$ in crystals, as well as the possibility of calculating this tensor quantum-mechanically. First, the effect of taking into consideration the space inhomogeneity is investigated. (1.8) may be written in the form $\varepsilon_{ij}(\omega,\vec{k},\vec{k}') = \sum_{\vec{b}}\delta(\vec{k}'-\vec{k}-2\pi\vec{b})\varepsilon^{\vec{b}}_{ij}(\omega,\vec{k})$, where $\vec{b} = \sum_{i=1}^{3} n_i\vec{b}_i$ is an arbitrary vector of the reciprocal lattice. The relation between
Card 3/7

$\vec{D}'$ and $\vec{E}$ is given by

$$k_i k_j E_j(\omega, \mathbf{k}) - k^2 E_i(\omega, \mathbf{k}) + \frac{\omega^2}{c^2} \sum_b \varepsilon^b_{ij}(\omega, \mathbf{k}) E_j(\mathbf{k} + 2\pi \mathbf{b}, \omega) = 0. \quad (2, 3)$$

whose determinant leads to the dispersion equation $\Delta(\omega,\vec{k}) = 0$ with roots $\omega = \omega_1(\vec{k})$. If all terms with $b \neq 0$ are eliminated from (2.3) (which is justified for the region with $k \ll b \sim 1/a$; $\omega \ll cb \sim c/a$), considered here one obtains for $\vec{E}(\omega,\vec{k})$ analogous to (1.13): $k_i(\vec{k}\vec{E}) - k^2 E_i + (\omega^2/c^2)\varepsilon_{ij}(\omega,\vec{k})E_j = 0$. Here $\varepsilon_{ij}(\omega,\vec{k})$ differs from $\varepsilon_{ij}^{b=0}(\omega,\vec{k})$ only by terms of the order of $(a/\lambda_0)^2$. In optics, not only is $(a/\lambda_0)^2 \ll 1$, but it can also be assumed that $a/\lambda = an/\lambda_0 \ll 1$ (a-lattice constant, $\lambda_0$-vacuum wavelength). This is done in the following, i. e., the spatial dispersion is assumed to be small. One may then expand $\varepsilon_{ij}(\omega,\vec{k})$ in series of powers of $\vec{k}$ and neglect terms of higher order than the second. Near the absorption lines where some components of $\varepsilon_{ij}(\omega)$ become very large one must expand analogously the reciprocal tensor of (1.6): $\varepsilon^{-1}_{ij}(\omega,\vec{k}) = \varepsilon^{-1}_{ij}(\omega) + ig_{ijl}\frac{\omega}{c}\tilde{n}s_l + \beta_{ijlm}(\omega/c)^2\tilde{n}^2 s_l s_m$, where $\vec{k} = \frac{\omega}{c}\tilde{n}\vec{s}$, $\tilde{n} = n'+in'' \equiv n+i\varkappa$. These expansions are not justified in all the cases (e. g. for absorption lines caused by a quadrupole transition). In the following the longitudinal waves and "mechanical excitons" are studied. Besides the longitudinal wave solution $|\varepsilon_{ij}(\omega,\vec{k})| = 0$ there exist other solutions of the field equations corresponding to "fictitive" longitudinal waves. It is, however, sufficient to observe in the domain of classical crystal optics that waves with $\vec{D}' = 0$ become longitudinal when $n^2 \to \infty$. Eq. (1.13) is investigated in this case in the form $\vec{D}' = \tilde{n}^2\{\vec{E} - \vec{s}(\vec{s}\vec{E})\}$, $\vec{k} = (\omega/c)\tilde{n}(\omega)\vec{s}$ $(k\to\infty)$, and the relation $\varepsilon_{ij}(\omega,\vec{k})s_i s_j = 0$ obtained. Only in this case, $\vec{D}'$ and $\vec{E}$ are different from zero. If $\vec{E} = 0$ and $\vec{D}' \neq 0$, the condition $|\varepsilon^{-1}_{ij}(\omega,\vec{k})| = 0$ must be satisfied. The last case is that of "polarization waves". All three, the longitudinal, the fictitive longitudinal, and the polarization waves satisfy the condition div $\vec{D}' = 0$. Finally the authors discuss some problems of the quantum theory of the dispersion of light in crystals during which the choice of the method of quantum-mechanically calculating the tensor $\varepsilon_{ij}(\omega,\vec{k})$ is also discussed. Taking into consideration the translational symmetry of the crystal a result is obtained for the current density in the approximation of the perturbation theory. This result is:

$$j_i^{(n)}(\mathbf{k}, \omega) = \sum_{\mathbf{b}} \sigma_{ij}^{(n),\mathbf{b}}(\omega, \mathbf{k}) E_j(\mathbf{k} + 2\pi\mathbf{b}, \omega), \qquad (4,4)$$

where

$$\sigma_{ij}^{(n)}(\omega, \mathbf{k}) = \sigma_{ij}^{(n),\mathbf{b}=0}(\omega, \mathbf{k}) = \sum_{a} \frac{ie_a^2}{m_a\omega}\delta_{ij} -$$

$$- \sum_{a,\beta,m} \frac{ie_a e_\beta}{4m_a m_\beta \hbar\omega} \left\{ \frac{(p_i^a e^{-i\mathbf{k}\mathbf{r}_a} + e^{-i\mathbf{k}\mathbf{r}_a} p_i^a)_{mn} (p_j^\beta e^{i\mathbf{k}\mathbf{r}_\beta} + e^{i\mathbf{k}\mathbf{r}_\beta} p_j^\beta)_{nm}}{\omega - \omega_m + \omega_n} - \right.$$

$$\left. - \frac{(p_i^a e^{-i\mathbf{k}\mathbf{r}_a} + e^{-i\mathbf{k}\mathbf{r}_a} p_i^a)_{nm} (p_j^\beta e^{i\mathbf{k}\mathbf{r}_\beta} + e^{i\mathbf{k}\mathbf{r}_\beta} p_j^\beta)_{mn}}{\omega - \omega_m + \omega_n} \right\}. \qquad (4,5)$$

It may be assumed that the value of $\varepsilon_{ij}(\omega,\vec{k})$ is determined by exciton transitions, i. e., the frequencies $\omega_m$ and $\omega_n$ in (4.5) are the frequencies of "mechanical excitons" in the crystal. The exciton states are quasi-stationary, i. e. the $\omega_m$ are complex. One can expand (4.5) or the tensor $\sigma_{ij}^{-1}$ into a series of powers of $\vec{k}$ and thus obtains formulas analogous to

(2.9); in the neighborhood of the absorption line (4.8) holds. The investigations showed that the tensor $\varepsilon_{ij}(\omega \vec{k})$ determines all properties of the "normal" electromagnetic waves in a crystal if $(a/\lambda_0)^2$ is sufficiently small. These waves are identical with the long wave excitations in the crystals, namely those which are treated by considering the electromagnetic interaction in the exciton theory. Therefore, crystal optics contains a part of general exciton theory if the spatial dispersion is taken into account. S. I. Pekar is mentioned. There are 30 references: 22 Soviet-bloc and 8 non-Soviet-bloc. The three most important references to English-language publications read as follows: T. Muto. Progr. Theor. Phys. Suppl., no. 12, 3, 1959; U. Fano. Phys. Rev. 103, 1202, 1956; J. J. Hopfield. Phys. Rev. 112, 1555, 1958.

ASSOCIATION: Fizicheskiy institut im. P. N. Lebedeva AN SSSR Moskva (Institute of Physics imeni P. N. Lebedev AS USSR, Moscow)

SUBMITTED: January 23, 1961

Card 7/7

GINZBURG, V.L.; RUKHADZE, A.A.; SILIN, V.P.

Correction to the article "Electrodynamics of crystals and exciton theory." Fiz. tver. tela 3 no.9:2890 S '61. (MIRA 14:9)
(Crystals--Electric properties)
(Excitons)

9.9845

25947
S/141/61/004/001/007/022
E133/E435

AUTHOR: Ginzburg, V.L.

TITLE: On the law of energy conservation and the expression for the energy density in the electrodynamics of an absorbing and dispersive medium

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1961, Vol.4, No.1, pp.74-89

TEXT: There seems to be some doubt, from the macroscopic viewpoint, as to what constitutes the energy density of a medium when absorption is present. On the other hand, a physically comprehensible expression for the energy density can be formulated in the microscopic approach. The author first considers the macroscopic approach in the form of electromagnetic waves passing through a non-magnetic, isotropic medium. It is known from plasma theory that the following equations hold:

$$\varepsilon' = 1 - \frac{\Omega^2}{\omega(\omega - i\nu)}; \quad \varepsilon = 1 - \frac{\Omega^2}{\omega^2 + \nu^2}; \quad \sigma = \frac{\Omega^2 \nu}{4\pi(\omega^2 + \nu^2)}; \quad \Omega^2 = \frac{4\pi e^2 N}{m}. \qquad (5)$$

(where N - electron concentration and $\nu$ is the number of

Card 1/6

25947
S/141/61/004/001/007/022
E133/E435



collisions of electrons with other particles). It can be seen that two simplifications are possible: if $\omega^2 \ll \nu^2$ the dispersion can be neglected, whereas in the opposite case absorption can be neglected. If dispersion is absent

$$W^{(0)} = W_E^{(0)} + \frac{H^2}{8\pi} = \frac{\varepsilon E^2}{8\pi} + \frac{H^2}{8\pi} \quad (9)$$

holds. $W^{(o)}$ is sometimes referred to as the energy density in the medium. A similar expression can be derived from

$$\overline{\frac{1}{4\pi} E \frac{\partial D}{\partial t}} = \frac{\partial \overline{W}_E}{\partial t}; \qquad \overline{W}_E = \frac{1}{8\pi} \frac{d(\omega\varepsilon)}{d\omega} \overline{E^2} = \frac{1}{16\pi} \frac{d(\omega\varepsilon)}{dt} E_0 E_0^*;$$

$$\overline{W} = \overline{W}_E + H^2/8\pi. \quad (10)$$

If absorption is absent, the entropy is constant and $W^{(o)}$ (or $\overline{W}$) represents the internal energy (in the thermodynamic sense). This is untrue if absorption is present ($\overline{W}_E$, for example, can even become negative). This does not contradict the necessity for entropy to
Card 2/6

increase, since $W^{(o)}$ does not now represent the internal energy. The author next takes the microscopic approach and considers a plasma with the equation of motion:

$$m\frac{\partial u}{\partial t} = eE - m\nu u \qquad (14)$$

This gives the first equation above for ε'. The field in the medium is supposed to be quasi-monochromatic

$$E(t) = \frac{1}{2}\left[E_0(t)e^{i\omega t} + E_0^*(t)e^{-i\omega t}\right]$$

$$H(t) = \frac{1}{2}\left[H_0(t)e^{i\omega t} + H_0^*(t)e^{-i\omega t}\right], \qquad (15)$$

where $E_0(t)$ and $H_0(t)$ are slowly varying functions of time. Next, an equation for $\overline{W'}_E$ - the sum of the kinetic energies of all the particles and the energy of the field in the absence of particles - is derived:

$$\overline{W'_E} = N\overline{K} + \frac{\overline{E^2}}{8\pi} = \left\{1 + \frac{4\pi e^2 N}{m(\omega_0^2 + \nu^2)}\right\} \frac{E_0 E_0^*}{16\pi} \quad (17)$$

If absorption is absent ( $\nu = 0$), $\overline{W'_E} = \overline{W}_E$. When $\nu \neq 0$, $\overline{W'_E}$ is always positive. It therefore seems reasonable to consider $\overline{W'_E}$ as being the average energy density of the medium. It is pointed out that the equation

$$\frac{\partial}{\partial t}\left(\overline{NK + \frac{E^2}{8\pi} + \frac{H^2}{8\pi}}\right) = \frac{\partial}{\partial t}\left\{\left(1 + \frac{4\pi e^2 N}{m(\omega_0^2 + \nu^2)}\right)\frac{E_0 E_0^*}{16\pi} + \frac{H_0 H_0^*}{16\pi}\right\} = -\frac{c}{16\pi}\operatorname{div}\left\{[E_0 H_0^*] + [E_0^* H_0]\right\} - mN\nu\overline{u^2}. \quad (24)$$

derived from plasma theory and the expression

$$\frac{\partial}{\partial t}\left\{\left(1 + \frac{4\pi e^2 N(\omega_0^2 - \nu^2)}{m(\omega_0^2 + \nu^2)^2}\right)\frac{E_0 E_0^*}{16\pi} + \frac{H_0 H_0^*}{16\pi}\right\} + \frac{e^2 N \nu}{2m(\omega_0^2 + \nu^2)} E_0 E_0^* +$$

$$+\frac{ie^2 N\omega_0\nu}{2m(\omega_0^2+\nu^2)^2}\left(\frac{\partial E_0}{\partial t}E_0^* - E_0\frac{\partial E_0^*}{\partial t}\right) = -\frac{c}{16\pi}\operatorname{div}\{[E_0H_0^*]+[E_0^*H_0]\};$$

$$1+\frac{4\pi e^2 N(\omega_0^2-\nu^2)}{m(\omega_0^2+\nu^2)^2} = \left(\frac{d(\omega\varepsilon)}{d\omega}\right)_{\omega_0}; \quad \frac{e^2N\nu}{m(\omega_0^2+\nu^2)} = \sigma; \quad -\frac{2e^2N\omega_0\nu}{m(\omega_0^2+\nu^2)^2} = \left(\frac{d\sigma}{d\omega}\right)_{\omega_0}. \qquad (25)$$

derived from the phenomenological equations both represent the same model and, hence, may be equated. This indicates that the terms on the left hand side of the latter equation cannot be defined exactly as representing certain types of energy (e.g. as due to change in the internal energy etc). The expression for the energy in the plasma is next considered in more detail (in terms of an electron distribution function and collision integral). An equation representing the law of conservation of energy is thus obtained:

$$\frac{\partial}{\partial t}\left(\frac{E^2+H^2}{8\pi}+K_t\right) = -\frac{c}{4\pi}\operatorname{div}[EH] - \int\frac{mv^2}{2}S\,dv. \qquad (34)$$

Here, the last term on the right represents the energy transferred to the heavier particles by the electrons. This is small and can usually be neglected. It is shown that the equation given above for $\overline{W'_E}$ does not always hold. The author finally considers the velocity of propagation of a quasi-monochromatic signal in an absorbing medium. From the expression for $\overline{W'_E}$ he obtains

$$v_{\text{эн}} = \frac{2c \operatorname{Re} \sqrt{\varepsilon'}}{|\varepsilon'| - \varepsilon + 2} = \frac{cn}{1 + \varkappa^2}, \quad (44)$$

for this velocity. It is noted that the use of this expression for $\overline{W'_E}$ (which is not always true) might be justified by the fact that this gives a minimum. An appendix gives a formal discussion of Poynting's theorem for the general case of a quasi-harmonic field. There are 1 figure and 7 references: 6 Soviet-bloc and 1 non-Soviet-bloc.

ASSOCIATIONS: Fizicheskiy institut AN SSSR (Physics Institute AS USSR) Nauchno-issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete (Scientific Research Institute on Radiophysics, Gorkiy University)

SUBMITTED: October 21, 1960

LEONTOVICH, M.A., akademik; GINZBURG, V.L.

Some problems in journal publishing in the field of physics. Vest. AN SSSR 31 no.5:131-134 My '61. (MIRA 14:6)

1. Chlen-korrespondent AN SSSR (for Ginzbhurg).
(Physics—Periodicals)

89318

S/033/61/038/001/001/019
E032/E514

3,1720(1041,1126,1127)

AUTHORS: Ginzburg, V.L. and Zheleznyakov, V.V.

TITLE: Noncoherent Mechanisms of Sporadic Solar Radio Emission in the Case of a Magnetoactive Coronal Plasma

PERIODICAL: Astronomicheskiy zhurnal, 1961, Vol. 38, No. 1, pp. 3 - 20

TEXT: Noncoherent mechanisms of sporadic solar radio emission are reviewed, taking into account the influence of the magnetic field. The emission is conventionally described as noncoherent when it is possible to sum the emission intensities due to separate particles (taking re-absorption into account) but the intensification of the waves in the system itself can be ignored (for example, in a stream of particles). It is shown that noncoherent mechanisms can be responsible for the intensified radio emission above sunspots and for bursts of types IV and V. Bursts of types I, II and III cannot be connected with noncoherent radio emission of either the bremsstrahlung or the Cherenkov type. It is also shown that types II and III bursts cannot be connected with noncoherent emission of plasma waves in isotropic plasma.

Card 1/2

89318

S/033/61/038/001/001/019
E032/E514

Noncoherent Mechanisms of Sporadic Solar Radio Emission in the Case of a Magnetoactive Coronal Plasma

There are 47 references: 20 Soviet and 27 non-Soviet.

ASSOCIATION: Radiofizicheskiy in-t Gor'kovskogo gos. universiteta im. N.I. Lobachevskogo (Radiophysical Institute, Gor'kiy State University imeni N.I. Lobachevskiy)

SUBMITTED: July 21, 1960

Card 2/2

20887

S/033/61/038/002/011/011
E032/E414

3.1570 (1062, 1172, 1182)

AUTHOR: Ginzburg, V.L.

TITLE: On the Nature of Radio Galaxies

PERIODICAL: Astronomicheskiy zhurnal, 1961, Vol.38, No.2, pp.380-382

TEXT: V.A.Ambartsumyan (Ref.1), B.A.Vorontsov-Vel'yaminov (Ref.2), G.R.Burbidge (Ref.3) and I.S.Shklovskiy (Ref.4) have put forward arguments in favour of the hypothesis that radio galaxies of the Cygnus A type are not colliding galaxies. On the basis of these papers (and particularly Ref.4) and of the available observational data, one may suppose that strong radio galaxies belong to a type of galaxies which at a certain state in their evolution rapidly eject cosmic rays and turbulent gas which "carries" a magnetic field. I.S.Shklovskiy (Ref.4) relates the rapid ejection of cosmic rays in radio galaxies to a corresponding increase in the number of supernova explosions. The assumption that the number of these explosions rapidly increases can be reduced to the assumption that a sudden process of star formation occurred in the radio galaxy (characteristic time $T_0 \sim 10^7$ years). However,

Card 1/4

taking this as the starting point, the present author considers that it is possible, at least in principle, to avoid the introduction of the supernova mechanism. In fact, the efficiency of the acceleration process is very dependent on the presence of strong turbulence or compression of the medium. This appears to be the reason why the explosions of supernovae lead to the generation of cosmic rays. The gravitational compression of the galaxy (or its central part) which is accompanied by the appearance of motions and irregularities in the gas (instability) with subsequent star formation should also lead to the generation of cosmic rays. It can be shown that the necessary energy (up to $10^{61}$ erg in the case of Cygnus A) may be of gravitational origin. In fact, when a cloud of mass M is compressed into N regions (protostars) with masses m and radii r, the gravitational energy is reduced by a quantity of the order of $\varkappa m^2 N/r = \varkappa mM/r$. When $M \sim 10^{12} M_{\odot}$, the energy $\sim 10^{61}$ erg corresponds to $m/r \sim 10^{23}$ and hence $r \sim 10 r_{\odot}$ when $m \sim 100\ M_{\odot}$. Thus, there are no energetic difficulties and the basic problem is the rate of acceleration. The total energy E of a particle (rest mass = $\mu$) is given by

$$\frac{dE}{dt} = (\alpha_1 + \alpha_2) E, \quad \alpha_1 \sim \frac{u^2 v}{c^2 l}, \quad \alpha_2 \sim \frac{V}{R} \cdot \frac{v^2}{c^2}, \qquad (1)$$

where only acceleration is taken into account, and u is the velocity of random motions, V is the systematic rate of compression of a medium having a characteristic linear dimension R, $l$ is the characteristic linear dimension of irregularities in the velocity and the magnetic field, and $v \sim c \sim 10^{10}$ is the velocity of a fast particle along the line of force. Assuming in a rough approximation that $\alpha_1$ and $\alpha_2$ are constant and that the acceleration from $E_0 = \mu c^2$ to $E \sim 10\ \mu c^2$ occurs in a time $T_0$ we have

$$E \sim \mu c^2 e^{(\alpha_1 + \alpha_2) T_0} \sim 10 \mu c^2, \quad \alpha_1 + \alpha_2 \sim \frac{3}{T_0} \sim 10^{-14}. \qquad (2)$$

According to the above two equations, we have the following special cases

$$\text{a)}\ \alpha_1 = 0, \quad \frac{V}{R} \sim 10^{-13}; \qquad \text{б)}\ \alpha_2 = 0, \quad \frac{u^2}{l} \sim 10^{-3}. \qquad (3)$$

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E032/E414

On the Nature of ...

Systematic acceleration in separate protostars is even more effective; for example, when $R \sim 10^{13}$ and $V \sim 10^5$; only 10 years are necessary for $\alpha_2$ to reach $10^{-8}$ and the energy to reach $\sim 10\ \mu c^2$. These estimates are said to be not unreasonable although it is emphasized that a more detailed analysis, taking into account kinetic energy dissipation of other effects would show whether the above mechanism can in fact be justified.
The present paper was reported, November 28, 1960, at the full assembly of Komissiya po radioastronomii Astrosoveta AN SSSR (Commission for Radioastronomy of the Astronomical Council AS USSR).
There are 9 references: 8 Soviet and 1 non-Soviet.

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

SUBMITTED: December 15, 1960

Card 4/4

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)

28757 S/056/61/041/003/010/020
B125/B102

24,2140 (1072, 1164, 1482)

AUTHOR: Ginzburg, V. L.

TITLE: Second sound, convective heat conduction, and exciton excitations in superconductors

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 41, no. 3(9), 1961, 828-833

TEXT: This article deals with the possibility of observing the heat convection and the second sound in superconductors. The fact that superconductive and normal currents with the densities $\vec{j}_s$ and $\vec{j}_n$, respectively, may occur simultaneously, is bound to cause a convective heat transfer in an unevenly heated metal. Within the framework of the hydrodynamical theory of two liquids, the equations

Card 1/5

$$\partial \frac{m}{e} j/\partial t = -\nabla p - \rho_n \nu v_n + \frac{e}{m}\rho_0 E, \quad \frac{\partial \rho}{\partial t} + \mathrm{div}\frac{m}{e} j = 0,$$
$$\frac{\partial v_s}{\partial t} = -\nabla \mu + \frac{e}{m}E, \quad \frac{\partial S}{\partial t} + S_0 \,\mathrm{div}\, v_n = 0,$$
$$\mathrm{div}\, E = \frac{4\pi e}{m}(\rho - \rho_0), \quad dp = S_0\, dT + \rho_0\, d\mu,$$
$$\frac{m}{e} j = \rho_s v_s + \rho_n v_n, \quad j_s = \frac{e}{m}\rho_s v_s, \quad j_n = \frac{e}{m}\rho_n v_n \qquad (1)$$

follow immediately in linear approximation. The index 0 refers to the unperturbed values and is neglected henceforward. Since the plasma frequency $\omega_0$ is extremely high, the relation

$$k^2 = \omega^2 \left(1 - i\frac{\rho_s}{\rho}\frac{\nu}{\omega}\right)\frac{\rho_n \rho\,[(\partial S/\partial T)_p (\partial \rho/\partial p)_T - (\partial S/\partial p)_T (\partial \rho/\partial T)_p]}{\rho_s S^2 (\partial \rho/\partial p)_T}. \qquad (2)$$

follows from (1) for the propagation of low-frequency waves. No low-frequency sound propagates, if for normal motion in the superconductors $\nu$ is of the same order of magnitude as in the non-superconductive state. The attenuation in (2) is weak for $\nu \sim v_0/l_r \ll \omega$, where $v_0 \sim 10^8$ is the velocity on the Fermi boundary, $l_r$ is the mean free path on scattering from impurities. Then $l_r \gg v_0/\omega \sim 10^8/\omega$ is valid, and even for $\omega \sim 10^8$ the rigorous condition $l_r \gg 1$ cm must be satisfied. However, even this

Card 2/5

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condition is not sufficient. Nevertheless, the possible existence of second sound is to be taken into account. I. M. Khalatnikov pointed out the very strong attenuation of second sound in superconductors. Spectrum and character of excitations in the superconductive state differ essentially from the corresponding quantities in the normal state. In the simplest case, the number of collisions is proportional to v, whereas in the superconductive state $\nu^{(s)} = \nu^{(n)} v/v_0$. If the Fermi surfaces have a complex structure and if there is a sufficiently large number of excitations, $\nu^{(s)}$ may be much smaller in the superconductive state than $\nu^{(n)}$ in the normal state. The situation may be more favorable with transverse collective excitations (excitons), since collective excitations are weakly scattered in the case of long waves. The scattering of phonons and long-wave excitons (photons) in non-conductors is an example. Both the character of excitations and the law of their scattering in the important long-wave range are insufficiently explained for excitons in superconductors. For the predominating excitons with a sufficiently large wave vector q, the impurity scattering cross section may largely decrease since the excitons are very large. The transport cross section for the elastic

Card 3/5

scattering of a pair from impurities in Born approximation reads

$$\sigma_{tr} = \frac{32\pi M^2 A^2}{\hbar^4} \int_0^{\pi} \left\{ \int_0^{\infty} \frac{\sin (qr \sin (\Theta/2)) |\varphi(r)|^2}{q \sin (\Theta/2)} r\,dr \right\}^2 (1 - \cos\Theta) \sin\Theta\, d\Theta,$$

and if $qa \ll 1$ one finds $\sigma_{tr} = 4M^2A^2/\pi\hbar^4$. $\sigma_{tr}$ is very small if $qa \gg 1$. A considerable number of pairs is probably weakly scattered from impurities. It is very probable though not yet proved that in the case of exciton excitations, $\nu^{(s)}$ is many orders of magnitude smaller than $\nu^{(n)}$. The author believes that there is a group of excitations, which occurs rather than the excitons with low friction. These excitations might contribute substantially to the transfer phenomena and allow for the propagation of second sound with the velocity $u_{2ex} = \sqrt{\varrho_s S^2_{ex} T/\varrho \varrho_{n ex} C_{ex}}$. $S_{ex}$, $C_{ex}$, and $\varrho_{n\,ex}$ are the contributions of the excitations under consideration to S, C, and $\varrho_n$. $\varrho_{n\,ex}$, $S_{ex}$, and $C_{ex}$ change considerably from one metal to another. These quantities are relatively large only in Pb and Hg. If there is any group of excitations with a sufficiently low friction, propagation of second sound is, in principle, possible even at very small values of $\rho_{n\,ex}$ and $S_{ex}$. In the case of Pb and Hg, a substantial contribution of exciton excitations may be expected. A. A. Abrikosov and L. P. Gor'kov (ZhETF, 39, 480, 1960) doubted the existence of a Knight shift of frequencies in superconductors. The Knight shift can possibly be explained by the effect of a strong magnetic field on the exciton levels. The diamagnetic effect is insignificant for small particles. The author thanks G. P. Motulevich for discussions, and L. P. Gor'kov for hints. There are 26 references: 10 Soviet and 17 non-Soviet. The three most recent references to English-language publications read as follows: A. Bardasis, J. Schrieffer. Phys. Rev., 121, 1050, 1961; P. B. Miller. Phys. Rev., 121, 435, 1961; G. M. Androes, W. D. Knight. Phys. Rev., 121, 779, 1961.

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

25020 S/053/61/074/003/002/002
B102/B209

3,2410

AUTHOR: Ginzburg, V. L.

TITLE: Cosmic rays on the Earth and in the Universe

PERIODICAL: Uspekhi fizicheskikh nauk, v. 74, no. 3, 1961, 521-552

TEXT: The present article is a synopsis on the origin, the chemical composition, and the properties of the cosmic radiation and the radio emission, of the primary radiation, and on problems in radio astronomy. In an introductory note, the author gives a short historical review and points out some particulars of this radiation (as, for instance, its energy- the highest energy recorded was $10^{19}$ev) which make it especially suited to physical examinations. Although in such examinations the secondary radiation is the chief phenomenon to work with, this paper is devoted to problems of the primary radiation only. The investigation of the primary radiation chiefly utilized sounding balloons, and lately also rockets, stratosphere air planes, and satellites. The chemical composition was determined with the help of photoemulsions and Cherenkov counters. The energy spectrum is

Card 1/4

25020 S/053/61/074/003/002/002
B102/B209

Cosmic rays on the Earth ...

determined from the width dependence of the cosmic-particle flux (in a range up to 15 Bev for protons and up to 7.5 Bev/nucleon for nuclei) or from the particle number in emulsions as depending on energy (at higher energies of up to $10^4$ Bev); high energy studies are almost exclusively carried out via extensive air showers. In many countries, the primary radiation is investigated as to composition, energy and spatial distribution, but in spite of the quick progress it is not yet possible to draw final conclusions. The most important and so far doubtless results are given in the following. First, the chemical composition of the radiation and of the interstellar gas is discussed, using the conventional groups L, M, H, and VH (light, medium, heavy, and very heavy). The most important results are listed in Table 1. After this, the energy spectrum and the isotropy of the cosmic rays are discussed; the conclusions deduced from the absence of low-energy particles in the primary radiation are discussed and the influence of the sunspot activity is pointed out. The energy spectrum may be approximated by $F_A(>\varepsilon) = K_A/\varepsilon^{\gamma-1}$, when the particle flux is given by $F_A(>\varepsilon)$ (A - atomic weight of the particles, $>\varepsilon$ - total energy). With

Card 2/6

25020 S/053/61/074/003/002/002
B102/B209

Cosmic rays on the Earth ...

K=5000 and $\gamma$ = 2.5 and $t \to E$, for the three energy classes the following is obtained: $F(E > 10^6 Bev) = 5 \cdot 10^{-6}$, $F(E > 10^8 Bev) = 5 \cdot 10^{-9}$, $F(E > 10^{10} Bev) = 5 \cdot 10^{-12}$ particles/$m^2$·steradian·sec. These considerations are followed by radioastronomic problems. The particular discussions concern the nature of the cosmic radio emission and of the cosmic rays (division into three components: Thermal radiation with continuous spectrum, thermal radiation of neutral hydrogen with $\lambda \approx 21$ cm, and non-thermal cosmic radio emission; the first component is the bremsstrahlung of the electrons in interstellar matter). The third component which incides upon the Earth from all places in the Galaxy, from single nebulae, and from other galactic systems is discussed in detail. Data and photographs of the best-known sources of radio emission are given. The origin of the cosmic radiation is discussed in the last section of the paper; the characteristic parameters of the groups of nuclei are given in Table 2. Particular attention is paid to the accelerating mechanism to which the cosmic particles are subjected. Finally, the following aims are mentioned to be the most important ones in future research work: Flux measurements of $e^-$, $e^+$, and $\gamma$; determination of the chemical composition at high and at very high ($> 10^{16}$ ev) energies;

Card 3/6

25020 S/053/61/074/003/002/002
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Cosmic rays on the Earth ...

more accurate energy measurements in the range of $E > 10^{14} - 10^{15}$ ev and measurement of the coefficient of anisotropy. There are 18 figures, 2 tables, and 10 Soviet-bloc references.

Card 4/6

GINZBURG, V.L.

On the threshold of the sixth year of space era. Nauka i zhizn' 29 no.10:3-9 O '62. (MIRA 15:12)

1. Chlen redaktsionnoy kollegii zhurnala "Nauka i zhizn'"; chlen-korrespondent AN SSSR.
(Space sciences)

GINZBURG, V.L.; EYDMAN, V.Ya.

Radiation reaction in the case of media with negative absorption. Zhur. eksp. i teor. fiz. 43 no.5:1865-1871 N '62. (MIRA 15:12)

1. Radiofizicheskiy institut Gor'kovskogo gosudarstvennogo universiteta.

(Masers)
(Quantum theory)

S/141/62/005/001/004/024
E032/E314

9,9000

AUTHORS: Gershman, B.N. and Ginzburg, V.L.

TITLE: Some remarks on the propagation of electromagnetic waves in an anisotropic dispersive medium

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, v.5, no. 1, 1962, 31 - 46

TEXT: This paper is concerned with the general theory of propagation of waves in an arbitrary anisotropic medium which is uniform in space and constant in time. Spatial dispersion is taken into account. A simple method is used to derive various relations between expressions involving quadratic forms of the wave amplitudes, i.e. expressions involving terms of the form $\underline{E}_o \cdot \underline{B}_o$, $\underline{E}_o^* \cdot \underline{B}_o^*$ and so on. Formulae are derived for the derivatives of the components of the real part of the dielectric-constant tensor with respect to the frequency. It is shown that in the absence of spatial dispersion the group-velocity vector always forms an acute angle with the wave vector, and the square of the complex refractive index is always real.in the absence of

1/2

Card 1/2

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E032/E314

Some remarks on ....

absorption. The paper is concluded with a discussion of cases where the above results may not hold in the presence of spatial dispersion. The paper is entirely theoretical. No numerical computations are reported.

ASSOCIATION: Nauchno-issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete (Scientific Research Radiophysics Institute of Gor'kiy University)

SUBMITTED: November 1, 1961

Card 2/2

GINZBURG, V. L.

"Motion of Charged Particles in Magnetic Fields and Applications"
"Planetary Atmospheres"

Reports to be presented at the Varenna Summer School, Varenna, Italy, 9 and 15 June 1962

APPROVED FOR RELEASE: Thursday, July 27, 2000 CIA-RDP86-00513R00051673(

GINZBURG, V.L.

Study of the operation of a magnetic thermonuclear reactor. Trudy Fiz.inst. 18:55-104 '62. (MIRA 15:12)
(Thermonuclear reactions)

42126

3.2410
3.2420

S/203/62/002/002/001/017
I046/I246

AUTHORS: Ginzburg, V. L., Kurnosova, L. V., Razorenov, L. A., and Fradkin, M. I.

TITLE: Some investigations of the cosmic ray nuclear component and of the radiation belts of the earth on Soviet satellites and rockets. Review.

PERIODICAL: Geomagnetizm i aeronomiya, v. 2, no. 2, 1962, 193-232

TEXT: 1) Measurements on groups of nuclei with $Z \geqq 2$, $Z \geqq 5$, $Z \geqq 12$ to 14, $Z \geqq 15$, $Z \gtrsim 28$ to 30, and estimates of the relative intensity of the stream of very heavy nuclei ($Z > 30$) indicate that the nuclear component of cosmic rays drops very sharply in intensity from $Z \gtrsim 28$ to $Z > 30$. 2) The nuclear-component intensity increases in correlation with the solar activity; at energies $E$ $10^9$ eV, some selective acceleration mechanism on the sun accelerates preferably the heavier nuclei. 3) Measurements of the latitudinal effect show that, at energies between $\sim$ 1.8 and 7.5 BeV/nucleon, the energy spectra are identical for groups of nuclei with $Z \geq 2$, $Z \geqq 5$, $Z \gtrsim 12$ to 14 (differences in spectral indices do not exceed 10 to 20%). 4) The charge spectra of nuclei indicate that the ratio of the Li, Be, B nuclear group to the $Z \geqq 6$ group is $53 \pm 15\%$. 5) The intensity maximum of the outer radiation belt shifted $10^4$km towards the surface of the earth during the time interval between the launchings of orbital spaceships I and II (from January to September, 1959).

Card 1/2

Some investigations of the cosmic ray...

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I046/I246

6) At altitudes of 200 to 300 km in the 65N to 65S belt the radiation count is in excess of what could have been expected from primary cosmic rays; on the equator, the global radiation intensity is 6 to 7 times as high as the cosmic ray intensity. This phenomenon remains still unexplained 7) Two radiation-intensity anomalies were discovered, viz., the South-Atlantic anomaly at an altitude of 340 km and the Southern anomaly at 194 to 340 km above the Antarctic coast, both being closely associated with the geomagnetic anomalies. In August and December 1960, the lower boundary of the South-Atlantic anomaly was mapped at an altitude of 265 to 306 km. There are 15 figures, 7 tables and 70 references.

Card 2/2

GINZBURG, V.L.

Law of the conservation of energy in the electrodynamics of media with spatial dispersion. Izv. vys. ucheb. zav; radiofiz. 5 no.3:473-477 '62. (MIRA 15:7)

1. Nauchno-issledovatel'skiy radiofizicheskiy institut pri Gor'kovskom universitete.
(Electrodynamics) (Field theory)

S/051/62/012/003/003/016
E032/E314

AUTHORS: Ginzburg, V.L. and Glukhovetskaya, N.P.

TITLE: Dependence of the intensity of spectral lines on the effective ionization potential of an arc

PERIODICAL: Optika i spektroskopiya, v. 12, no. 3, 1962, 344 - 349

TEXT: The authors report an experimental study of the dependence of the intensity of the spectral lines of various elements on the amount of alkali metals introduced into an arc discharge. The existence of this dependence was discovered in 1937 by S.A. Borovik and T.F. Borovik-Romanova (Ref. 1 - DAN SSSR, 20, 535, 1937) and D. Webb (Ref. 2 - Nature, 139, 248, 1937). The theoretical explanation was supplied by S.L. Mandel'shtam (Ref. 3 - DAN SSSR, 18, 559, 1938; Ref. 4 - Zavodsk. laboratoriya, 6, 597, 1948; Ref. 5 - Vvedeniye v spektral'nyy analiz ( Introduction to Spectral Analyses)) and others. However, it is stated that a complete quantitative study of this phenomenon has not so far

Card 1/3

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E032/E314

Dependence of ....

been available. In the present work the alkali elements were introduced into a carbon dust in small amounts ($10^{-4}$ - $10^{-2}$%) and the mixture was inserted into a recess in the lower electrode. The alkali elements were usually in the form of oxides or chlorides. In each case the effective ionization potential was computed using a formula reported by O.P. Semenov (Izv. AN SSSR, ser. fiz., 9, 715, 1945 - Ref. 9) and A.K. Rusanov (Spectral analysis of ores and minerals - Gosgeolizdat, 1946 - Ref. 10). Plots are reproduced giving the intensity of various lines as a function of the effective ionization potential of a carbon arc. It is found that both for spectral lines of neutral and singly-ionized atoms the intensity plotted as a function of temperature exhibits a well-defined maximum which occurs at a temperature lower than that of the carbon arc, whose ionization potential is of the order of 11.3 eV. The position of the maxima and the general form of the curves are very similar to the curves computed theoretically by Mandel'shtam (Ref. 3). It is concluded that

Card 2/3

Dependence of ....

S/051/62/012/003/003/016
E032/E314

the point of view adopted by Semenov (Ref. 8 - Izv. vyssh..uchebn. zaved. MVO, fizika, no. 2, 103, 1959) is erroneous. The present experimental results also show that lines with close excitation potentials belonging to elements with different ionization potentials have different intensity-versus-temperature curves, i.e. they are not homologous. For example, Pb and Zn lines (2833 and 3075 Å) are found to exhibit this behaviour. It is pointed out that two lines are homologous if both the excitation and ionization potentials are the same. Acknowledgments are expressed to V.G. Koritskiy, S.M. Rayskiy and V.A. Fabrikant for advice and interest. Acknowledgments are also expressed to N.N. Danilova and L.A. Lerner, who took part in the experiments.
There are 6 figures and 1 table.

SUBMITTED: February 27, 1961

Card 3/3

V. L.

GINZBURG, W.L.

USSR

no title given

no affiliation given

Crakow, Postepy Fizyki, Vol XIII, No 5, 1962, pp 507-48.

"Cosmic Radiation approximating the Earth and in the Cosmos".

Translated by:

Michal MASSALSKI, no title or affiliation given

43504

S/051/62/013/006/026/027
E039/E120

24.6710

AUTHORS: Ginzburg, V.L., and Glukhovetskaya, N.P.

TITLE: Notes on the article by O.P. Semenova and M.A. Levchenko. ("Dependence of the effective ionisation potential on the concentration of easily ionised impurities in the arc discharge")

PERIODICAL: Optika i spektroskopiya, v.13, no.6, 1962, 881-882

TEXT: In previous work on the intensity of the spectral lines of many elements present in arcs of elements with low $v_i$, the calculation of $v_{i\ eff}$ of the arc plasma is made on the assumption that the degree of ionisation of easily ionised elements is far from 1. Observations show that this is more correct than the proposals of O.P. Semenova and M.A. Levchenko (Opt. i spektr., v.13, 1962, 610). Comparison of the spectrum of a high purity carbon arc with that from an arc containing 0.003-0.005% metal impurity shows that in the former the spark lines C II 2837.602 and C II 2836.71 are clearly seen while in the latter these lines are absent. This shows that the arc temperature is lowered by the presence of the impurities. The substitution of Na, Ca or Li
Card 1/2

results in equal changes in intensity of the spectral lines of the elements if the quantities of these elements correspond with their $v_i$ and atomic weights. This dependence of the intensity of spectral lines on the content of Na (Ca etc) shows that there is no threshold and is in agreement with the theoretical work of S.L. Mandel'shtam (DAN SSSR, v.18, 1938, 559). Quantitative calculations on arc processes are only approximate and the arc temperatures are taken to be average values. Our estimate of the range of values for $v_{i\ eff}$ at 7 - 9 eV for the majority of spectral lines of the elements is confirmed not only by the theoretical work of Mandel'shtam but also by direct observation. For example in the determination of impurities in selenium $v_{i\ eff}$ is practically equal to $v_i$ selenium, i.e. 9.75 eV. When Na is added to the upper electrode there is an increase in intensity of spectral lines of a series of elements. The intensity passes through a maximum and decreases again at large concentrations of Na. This increase in sensitivity enables many impurities in selenium to be determined. Similar results are reported by other authors.

SUBMITTED: July 3, 1962

 [Abstractor's note: Abridged translation]

GHINZBURG, V. L. [Ginzburg, V.L.]

Cosmic rays around the earth and in the universe. Analele mat 16 no.1:130-170 Ja- Mr '62.

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S/048/62/026/006/014/020
B125/B102

AUTHORS: Ginzburg, V. L., Kurnosova, L. V., Logachev, V. I., Razorenov, L. A., and Fradkin, M. I.

TITLE: Temporary increases in the intensity of the nuclear cosmic-ray component induced by solar activity and investigation of the radiation intensity at altitudes from 200 to 300 km

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 26, no. 6, 1962, 782-798

TEXT: During the flight of the second Soviet space rocket more than 100 nuclei of $Z \geq 15$, more than 3000 of $Z \geqslant 5$ and more than 30,000 of $Z \geqslant 2$ were measured by means of two Cherenkov counters working independently. On the second and third Soviet space ships a current of charged particles was measured by a telescope consisting of gas-discharge counters at altitudes between 187 and 339 km, in latitudes ranging from $-65^{\circ}$ to $+65^{\circ}$. Variation in number of heavy nuclei with $Z > 15$ was considerable but that of α-particles was smaller. At altitudes from 187 to 339 km the counting rate of the telescope was several times greater than otherwise by reason

Card 1/2

of the solar activity. On the equator, at an altitude from 306 to 339 km, the global intensity is 1.36 and in higher latitudes 3.3 particles. $cm^{-2}$ $sec^{-1}$. The charged-particle flux intensity of the anomalies in the southern part of the Atlantic Ocean exceeds that in the corresponding geomagnetic latitudes by two orders of magnitude. In 330 km an area of smaller intensity separates the South Atlantic Anomaly (a "sleeve" of the inner radiation belt) from the Southern Anomaly connected with the outer radiation belt. The particles recorded in the equatorial area are protons of at least 60 Mev or electrons of at least 8 Mev. There are obviously very many particles of smaller energy in the anomalies. The line of the smallest radiation intensity lies in an altitude from 187 to 339 km and on the western hemisphere farther south than the geometrical equator. In higher latitudes, owing to solar activity, the intensity of particle currents is subject to considerable temporal variations. The actual mechanism of acceleration and ejection of heavy particles on the sun is not known hitherto. There are 12 figures and 2 tables.

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

Card 2/2

34012

24.2200 (1144,1147,1164)

S/056/62/042/001/030/048
B102/B108

AUTHORS: Ginzburg, V. L., Fayn, V. M.

TITLE: Magnetic properties of paramagnetic "fluids" of the type of molecular chains

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 1, 1962, 183 - 190

TEXT: Continuing their own studies (DAN SSSR, 131, 785, 1960; ZhETF, 39, 1523, 1960) the authors investigate the dependence of magnetic susceptibility $\chi$ on the length of a certain type of polymer chains. It is shown that a chain of spins may be regarded as forming a paramagnetic fluid with an abnormally low or zero Curie temperature. A polymer is considered which consists of N monomeric links, each link having an even number of outer electrons with a singlet ground state (energy $E_1$). In the simplest case the first excited state is a triplet with $E_3$, $E_3 - E \sim J_0$, $J_0$ being the exchange interaction energy of the monomer. For $J_0 \gg kT$, the monomer will be diamagnetic. If the system is in the antiferromagnetic

IX

Card 1/4

state, and if the chain is not too long, $\chi \sim (\mu^2/kT)\exp(-\xi J/kTN)$, $\xi \sim 1$. It is further assumed that $\Delta E_{min} \sim J/N$, $\Delta E_{min}$ being the distance between the ground state and the lowest excited state of the system. For a chain of 4, 6, 8, or 10 spins $\Delta E_{min}$ = const·J/N for J > 0 and for spins 0 or 1. If the exchange Hamiltonian reads $\mathcal{H}_{ex} = 2J \sum_{l=1}^{N} (\vec{s}_l \vec{s}_{l+1} - \frac{1}{4})$, $s_{lz} = \pm \frac{1}{2}$; the mean magnetic moment in a field H ∥ z is given by

$$M_z = \frac{\sum_{n, S_z} \mu S_z \exp\{-(E(n, S_z) - \mu S_z H)/kT\}}{\sum_{n, S_z} \exp\{-(E(n, S_z) - \mu S_z H)/kT\}}, \qquad \mu = \frac{e\hbar}{mc}. \qquad (6)$$

and for H→0,

$$\chi = \frac{dM_z}{dH} = \frac{\mu^2}{kT} \sum_{S_z} S_z^2 g_{S_z} \Big/ \sum_{S_z} g_{S_z}, \qquad g_{S_z} = \sum_n \exp\{-E(n, S_z)/kT\}. \qquad (7)$$

Card 2/4

$S_z = \sum s_{1z}$; $s_1$ is the spin operator in terms of ħ. $\chi(T)/\chi_0 = 2J\chi(T)/\mu^2N$ was calculated numerically and the curves were drawn for several N, α = 0 and α = 1 (Ising model). It can be seen that for $N \ll J/kT$, χ is very small and increases exponentially with N, reaching $\sim \mu^2N/J$ when $N \sim J/kT$. The calculations were carried out at the NIRFI GGU under the supervision of G. M. Zhislin. For $N \to \infty$ and α = 1, $\chi(T,H=0)=(\mu^2N/4kT)\exp(-J/kT)$. In this case $\chi \sim \mu^2N/J$ only at $\sim kT$. In the following the relations between the properties of simple spin chains and the behavior of real molecular chains are discussed and some approximate results for large N (infinite chains) are given. For $\alpha \ll 1$,

$$\chi(0) = (\mu^2N/18J)(1-\tfrac{1}{8}\alpha), \quad \chi(T \gg J/k) = \mu^2N/4kT. \qquad (11)$$

for $(1-\alpha) \ll 1$,

$$\chi(0) = \mu^2(1-\alpha)^2 N/4J, \quad \chi(T \gg J/k) = \mu^2N/4kT. \qquad (12)$$

It is shown that for a chaintype paramagnetic fluid with antiferromagnetic interaction $\chi \neq 0$ at T = 0; with ferromagnetic interaction and α = 1, J < 0; $\chi(0) = \infty$. G. A. Semenov is thanked for help. There are 5 figures

Magnetic properties of paramagnetic... S/056/62/042/001/030/048
B102/B108

and 13 references: 6 Soviet and 7 non-Soviet. The four most recent references to English-language publications read as follows: T. W. Ruijgrok. S. Rodriguez. Phys. Rev. 119, 596, 1960; C. Domb. Adv. Phys. 9, 149, 1960; D. Paul Phys. Rev. 118, 92, 1960; 120, 463, 1960; L. F. Mattheiss. Phys. Rev. 123, 1209, 1961.

ASSOCIATION: Fizicheskiy institut im. P. N. Lebedeva Akademii nauk SSSR (Physics Institute imeni P. N. Lebedev of the Academy of Sciences USSR). Radiofizicheskiy institut Gor'kovskogo gosudarstvennogo universiteta (Institute of Radiophysics of Gor'kiy State University)

SUBMITTED: July 4, 1961

Card 4/4

34020
S/056/62/042/001/044/048
B102/B108

24,2140 (1072,1147,1164)

AUTHOR: Ginzburg, V. L.

TITLE: Magnetic flux quantization for a superconducting cylinder

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 1, 1962, 299 - 302

TEXT: A superconducting cylinder of arbitrary thickness, placed in a magnetic field is considered and field, current, magnetic flux and external field with equilibrium flux through the cylinder are determined, using the electrodynamic equations, obtained by the author together with L. D. Landau (ZhETF, 20, 1064, 1950). From the free-energy density in the superconductor

$$F_{sH} = F_s + \frac{H^2}{8\pi} = \frac{H^2_{\kappa M}}{8\pi}\left\{|\Psi_0|^4 - 2|\Psi_0|^2 + \frac{2\delta_0^2}{\kappa^2}\left|\nabla\Psi_0 + i\frac{e^*}{\hbar c}\mathbf{A}\Psi_0\right|^2\right\} + \frac{H^2}{8\pi}, \qquad (1),$$

and $\Psi_0$ and $\vec{A}$ satisfying

$$\left(\nabla + i\frac{e^*}{\hbar c}\mathbf{A}\right)^2\Psi_0 = \frac{\kappa^2}{\delta_0^2}(1 - |\Psi_0|^2)\Psi_0, \qquad (2)$$

Card 1/4

$$\mathrm{rot}\,\mathrm{rot}\,\mathbf{A} = \frac{4\pi}{c}\mathbf{j}_s, \quad \mathbf{j}_s = -\frac{c}{4\pi\delta_0^2}\left\{-\frac{i\hbar c}{2e^*}(\Psi_0^*\nabla\Psi_0 - \Psi_0\nabla\Psi_0^*) + |\Psi_0|^2\mathbf{A}\right\} \qquad (3),$$

APPROVED FOR RELEASE: Thursday, July 27, 2000 CIA-RDP86-00513R00051673(

34020
S/056/62/042/001/044/048
B102/B108

Magnetic flux quantization for a ...

the magnetic flux is obtained:

$$\Phi = \frac{hcn}{e^*} - \frac{4\pi\delta_0^2}{c|\Psi_0|^2}\oint j_s ds, \quad n = 0, \pm 1, \pm 2 \ldots \qquad (4).$$

div $\vec{A} = 0$. $|\Psi_0|$ = const; $H_{KM}$ - critical field for massive metal, $\delta_0$ - depth of penetration for a weak field; $\varkappa = \sqrt{2}\, e^* H_{KM} \delta_0^2/\hbar c$. These relations are used to determine potential, field and flux for a circular cylinder ($r_1$, $r_2 > r_1$) in an axial external field $H_2$. The inner field $H_1 = H(r \leq r_1)$. In the axisymmetric case ($j_r = j_z = 0$; $j_\varphi = j(r)$, $\Psi_0 = |\Psi_0(r)|\exp(-in\varphi)$)

$$A = \frac{hcn}{2e\delta_0\xi} + A', \quad A' = \delta_0(aI_1(\xi) + bK_1(\xi));$$
$$H = aI_0(\xi) - bK_0(\xi), \quad a = f(\xi_2, \xi_1)[H_2K_0(\xi_1) - H_1K_0(\xi_2)]; \qquad (5),$$
$$b = f(\xi_1, \xi_2)[H_2I_0(\xi_1) - H_1I_0(\xi_2)], \quad f(\xi_2, \xi_1) = [I_0(\xi_2)K_0(\xi_1) - I_0(\xi_1)K_0(\xi_2)], \quad r = \delta_0\xi,$$

Card 2/4

34020



S/056/62/042/001/044/048
B102/B108

Magnetic flux quantization for a ...

where $I_n$ and $K_n$ are known cylinder functions. At the inner boundary ($r_1 = \xi_1\delta_0$), $A(\xi_1) = \frac{H_1\delta_0\xi_1}{2}$ and the magnetic flux through a contour of radius $\xi$ equals $\Phi = 2\pi\delta_0\xi A(\xi) = \frac{hcn}{2e} + 2\pi\delta_0\xi A'(\xi)$. The formulas derived are now applied to cases where $\xi_1 \gg r_1/\delta_0 \gg 1$, so that

$$K_n = \sqrt{\pi/2\xi}\, e^{-\xi} \text{ и } I_n = \sqrt{1/2\pi\xi}\, e^{\xi}.$$
$$d = \xi_2 - \xi_1)$$
$$H_1 = \left[\frac{hcn}{e\delta_0^2\xi_1^2} + \frac{2\sqrt{\xi_1\xi_2}H_2}{\xi_1^2 \operatorname{sh} d}\right]\left[1 + \frac{2}{\xi_1}\operatorname{cth} d\right]^{-1}, \qquad (6).$$
$$\Phi(\xi) = \frac{hcn}{2e} + 2\pi\delta_0^2\sqrt{\xi}\,\frac{H_2\sqrt{\xi_2}\operatorname{ch}(\xi - \xi_1) - H_1\sqrt{\xi_1}\operatorname{ch}(\xi_2 - \xi)}{\operatorname{sh} d}.$$

For a thick cylinder ($d \gg 1$), $\Phi(\xi_1) \approx \frac{hcn}{2e}\left(1 - \frac{2\delta_0}{r_1}\right)$, or, with exponential accuracy $\Phi(\xi) = hcn/2e$. For a thin cylinder ($d \ll 1$) and $\xi_1 d \to 0$,

Card 3/4

34020
S/056/62/042/001/044/048
B102/B108

Magnetic flux quantization for a ...

$H_1 \to H_2$, $\phi(\xi_1) \to \pi\delta_0^2\xi_1^2 H_2$. In the case $d = \Delta r/\delta_0 \ll 1$, $\xi_1 d \approx r\Delta r/\delta_0^2 \gg 1$, for $H_2 = 0$, $|\Psi_0| = 1$, $j_s = cH_1/4\pi\Delta r$, $\phi = \frac{hcn}{2e}\left(1 + \frac{\delta_0^2 l}{S\Delta r}\right)^{-1}$ where S is the area and l the perimeter of the cylinder cross section. It is further shown that a state with a given $n \geqslant 0$ is attained when the flux of the external field through the opening is given by $\phi_2 = \pi r_1^2 H_2 = \frac{hc}{2e}(n - \frac{1}{2})$. This result is in agreement with experiments. There are 13 references: 8 Soviet and 7 non-Soviet. The four most recent references to English-language publications read as follows: J. Bardeen. Phys. Rev. Lett., 7, 162, 1961; L. Onsager. Phys. Rev. Lett., 7, 50, 1961; R. Doll, M. Näbauer. Phys. Rev. Lett., 7, 51, 1961; N. Byers, C. N. Yang. Phys. Rev. Lett., 7, 46, 1961.

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

SUBMITTED: September 12, 1961

Card 4/4

GINZBURG, V.

Voices of remote worlds. Av. i kosm. 45 no.9:88-89 '62.
(MIRA 15:10)

1. Chlen-korrespondent AN SSSR.

(Cosmic rays)

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 $\varepsilon_{ij}$; weak spatial dispersion ($a/\lambda \ll 1$). There are 2 figures and 3 tables.

Card 1/1

APPROVED FOR RELEASE: Thursday, July 27, 2000 CIA-RDP86-00513R00051673(

S/053/62/077/004/002/006
B102/B104

AUTHOR: Ginzburg, V. L.

TITLE: Light scattering near phase transition points in solids

PERIODICAL: Uspekhi fizicheskikh nauk, v. 77, no. 4, 1962, 621 - 638

TEXT: The substance of a lecture in memory of G. S. Landsberg is here reproduced, as delivered on February 12, 1962 during a session of the Uchenyy sovet FIAN SSSR (Scientific Council of the FIAN SSSR). Landsberg, partly together with L. I. Mandel'shtam, published fundamental works in the field of molecular light scattering in solids. The discovery of Raman scattering in quartz (1928) is assigned to them. They also pointed out (1929) that the intensity and shape of Raman scattering lines in quartz change at the $\alpha$-$\beta$-transition (846°K). Up to now, the related problems have not been completely solved. The present author surveys these effects and their theory. He describes the geometric change occurring in the structure of quartz $c/a = f(T)$ and the change in the dielectric constant $\mathcal{E} = \mathcal{E}(T)$ near $\Theta$ for I. and II.-type transitions, and he presents a theory to account for them. This assumes there is no singularity in the thermo-

Card 1/2

S/053/62/077/004/002/006
B102/B104



dynamic potential near the transition so that $\Phi(p, T, \eta)$ can be developed in even powers of $\eta$, the latter being equal to c/a-1 or to the amount of spontaneous polarization or to another quantity differentiating the two phases. Light scattering is attendant upon fluctuations $\Delta\varepsilon$ of the dielectric constants, $\Delta\varepsilon$ being equal to a $\Delta\eta^2$ and $\Delta\eta^2 = \Delta(\eta^2 - \eta_0^2)$ near the phase transition points. Formulas are given also for the intensity of scattered light I(T), for the jump in specific heat, for $\varepsilon(T)$, and for n(T). These and others are discussed in relation to quartz. Following them the effect of phase transition points on spectral characteristics is discussed, and among others a formula is given for the frequency dependence of the spectral density $J(\Omega)$, $\Omega = \omega - \omega_0$ (scattered light frequency minus incident light frequency). The importance of investigations into light scattering in ferroelectrics, and of experimental spectral examinations for II-type phase transitions, is especially stressed, and regret expressed that such experiments are "out of fashion". There are 9 figures.

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

Card 1/2

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

Crystal optics taking account ...

in the case of the classical model of oscillators; c) mechanism and calculations of absorption. Concluding remarks. Part II of literature survey. Corrections to part I of the survey. There are 6 figures, 6 tables, and 91 references.

Card 2/2

V. L. GINZBURG, L. V. KURNOSOVA, V. I. LOGACHEV, L. A. RAZORENOV, M. I. FRADKIN

Primary cosmic radiation investigation.

report submitted for the 8th Intl. Conf. on Cosmic Rays (IUPAP), Jaipur India, 2-14 Dec 1963

GINZBURG, Vitaliy Lazarevich; SYROVATSKIY, Sergey Ivanovich;
TOL'SKIY, D.A., red. izd-va; KOSHINA, P.S., tekhn. red.

[Origin of cosmic rays] Proiskhozhdenie kosmicheskikh luchei.
Moskva, Izd-vo Akad. nauk SSSR, 1963. 384 p. (MIRA 16:6)
(Cosmic rays)