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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 ω , \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 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

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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 δ_{eff} (table 1 gives the δ_{eff} -values for electron temperatures of between 500 and 15000° for helium, hydrogen, oxygen, nitrogen, and air; δ_{eff} equals δ_{elast} up to electron temperatures of ~ 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

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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. ✓

AUTHORS: Ginzburg, V. L., Gurevich, A. V. S/053/60/070/03/001/007
B006/B014

TITLE: Nonlinear Phenomena in a Plasma Located in a Variable Electro-
magnetic 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), per-
turbation 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 considera-
tion 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 describ-
ed by $\Delta \vec{E} - \text{grad div } \vec{E} + \frac{\omega^2}{c^2} \epsilon'(\vec{r}, \omega, E_0) \vec{E} = 0$; $\epsilon' = \epsilon - \frac{4\pi d_i}{c}$.

The amplitude and the self-action factor are studied, and the
modulation of waves is discussed in detail. Section 3.2

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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 μ_{Ω} and the phase of cross modulation on the depth μ_0 and the frequency Ω , dependence of μ_{Ω} on the intensity and frequencies of the disturbing waves, and cross-modulation

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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.



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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, A, flux, number of nucleons, flux- and particle number ratios. The energy spectrum is described next. In general,

$I_A(>\epsilon) = K_A \epsilon^{-\gamma+1}$ holds, where $I_A(>\epsilon)$ is the nuclear flux of group A with

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a total energy (per nucleon) greater than ϵ . The values for K_A and γ 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 $\approx 10^{15}$ 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,

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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.

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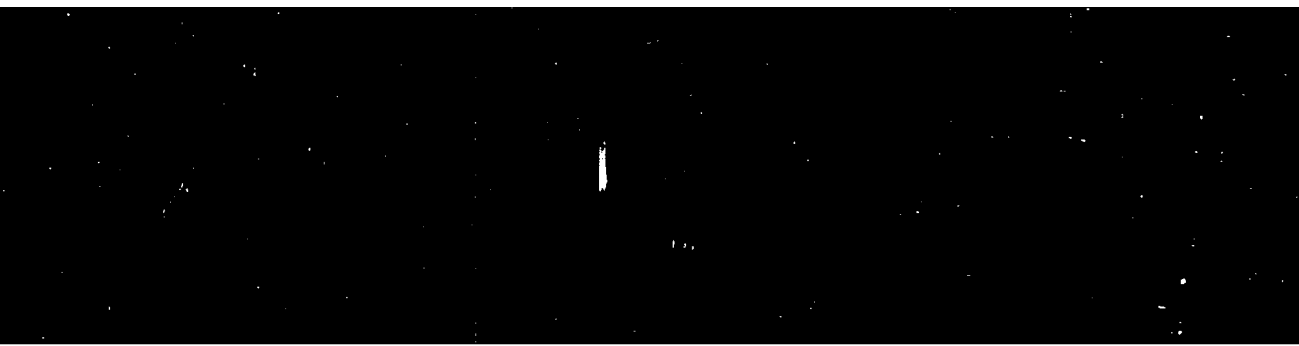
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AUTHORS: Gingburg, V. L., Corresponding Member, S/020/60/131/04/019/073
AS USSR, Fayul, V. M. B013/B007

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



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at a certain frequency ν 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

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"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

AUTHORS Bienediktow, J. A., Gittmancew, G. G., Ginzburg, W. I.

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 extra-terrestrial signals can be received above 20-40 m and below 1 cm. Measurements of the microwave spectrum 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.

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AUTHORS: G. S. Ginzburg, Ye. A., Getmantsev, G. I., 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. S. Ginzburg, V. L. Ginzburg, I. S. Shklovskiy, *UFN*, 66, 197, 1958) some of the possible applications of artificial Earth satellites to radio astronomy were discussed. The present paper extends this discussion and pays particular attention to fundamental problems. The paper is divided into the following sections: 1) the theory of radio astronomy measurements of sporadic radio emission from the Earth, 2) cosmic radio emission and the radio emission of the Sun and other sources, 3) radio emission in the radio range from the planets and the planets, 4) studies of the ionosphere and the interplanetary medium. The first part of this paper is devoted to the study of $\lambda < 1-3$ cm. The high-frequency radio emission from the Earth is discussed 3/10

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moon can be investigated with the aid of ... while the observation of this emission ... millimeter wavelengths is of great interest ... strongly absorbed in the troposphere ... Solar ... emission on these wavelengths should ... effective temperature of the sun should ... while that of the moon should be ... include the synchrotron emission due ... circulating in solar magnetic fields ... spectrum of the sun it may be possible ... the effective temperature on wavelengths ... passage of the radiation through the ... temperature is apparently lower than that of the photosphere. The apparatus which should be set up on artificial earth ... in order to measure the high-frequency solar and lunar radiation emission need not differ to any great extent from ordinary "surface" apparatus. The linear dimensions of the antennas (mirrors) need not be very large since the angular dimensions of the moon and the sun are of the order of 30'. For example, if $\lambda = 0.1$ cm the mirror diameter turns out to be about 11 m.

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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.J. McCullough and R.N. Sloanaker (Ref.5: Proc. IRE, V.46, 260, 1958) and L.E. Alsop, Y.A. Glorjmaine, 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 λ^{-2} , and hence in order to achieve the same power at the output of the antenna as in the case

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of the shorter wavelengths the area of the antenna must be increased in proportion to λ^2 . A mirror having a diameter of about 150 m is already necessary at $\lambda = 1$ 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

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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 $\lambda \sim 200-400$ 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, para 5/10

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it is pointed out that presently available data suggest that measurements of the spectrum of the non-thermal cosmic radio emission on $\lambda \approx 30$ m obtained with the aid of artificial earth satellites should lead to more accurate information on the gas concentration 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, E.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

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cm³ where ℓ is the path length in cm. The optical thickness τ 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:

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

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 $\lambda \approx 200-300$ 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
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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

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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.

PHASE I BOOK EXPLOITATION

SOI/5705

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

Kosmicheskiye luchy 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 K, 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.

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Cosmic Rays at the Earth (Cont.)

SOV/5705

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

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2420(1482, 2806, 1049)

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D299/D302

17 2400

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

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 $+65^{\circ}$ 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

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the global intensity J_{g1} 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

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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

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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

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is assumed (as a working model) that the inner radiation belt is 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 ρ can be expressed by the values:

$h, \text{ km}$	100	150	200	300	400	500
$\rho, \text{ gm} \cdot \text{cm}^{-3}$	10^{-9}	10^{-11}	10^{-12}	10^{-13}	2×10^{-14}	2×10^{-15}
$h, \text{ km}$	600	700	800	900	1000	
$\rho, \text{ gm} \cdot \text{cm}^{-3}$	6×10^{-16}	2×10^{-16}	6×10^{-17}	3×10^{-17}	10^{-17}	

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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 $J \sim p^{-1}$ 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-

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

torial region) of $E_p \geq 60$ 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

X

Card 7/7

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

Origin of cosmic rays. Geomag. i aer. 1 no.4:479-482 J1-Ag '61.
(MIRA 14:12)

1. Fizicheskii institut imeni P.N. Levedeva AN SSSR.
(Cosmic rays)

24,7710 (1137, 1138, 1160, 1462)

2492

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 $\epsilon_{ij}(\omega, \mathbf{k})$, 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:

$$\text{curl } \vec{B} = \frac{1}{c} \frac{\partial \vec{D}'}{\partial t} + \frac{4\pi}{c} \vec{j}_0; \text{div } \vec{D}' = 4\pi q_0; \text{curl } \vec{E} = -\frac{1}{c} \frac{\partial \vec{B}}{\partial t}; \text{div } \vec{B} = 0; \vec{F} = e \left(\vec{E} + \frac{1}{c} [\vec{v} \vec{B}] \right),$$

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:

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$$D_i(\mathbf{k}, \omega) = \epsilon_{ij}(\omega, \mathbf{k}) E_j(\mathbf{k}, \omega); \quad E_i(\mathbf{k}, \omega) = \epsilon_{ij}^{-1}(\omega, \mathbf{k}) D_j(\omega, \mathbf{k}), \quad (1, 6)$$

$$\epsilon_{ij}(\omega, \mathbf{k}) = \int_0^{\infty} d\tau \int dR e^{i(\mathbf{k}\mathbf{R} - \omega\tau)} \epsilon_{ij}(\tau, \mathbf{R}). \quad (1, 7)$$

For crystals one has

$$\left. \begin{aligned} D_i(\mathbf{r}, \omega) &= \int d\mathbf{r}' \epsilon_{ij}(\omega, \mathbf{r}, \mathbf{r}') E_j(\mathbf{r}', \omega), \\ D_i(\mathbf{k}, \omega) &= \int d\mathbf{k}' \epsilon_{ij}(\omega, \mathbf{k}, \mathbf{k}') E_j(\mathbf{k}', \omega). \end{aligned} \right\} \quad (1, 8)$$

It is shown that in crystals in the optical region the tensor $\epsilon_{ij}(\omega, \vec{k}, \vec{k}')$ can be reduced to the tensor $\epsilon_{ik}(\omega, \vec{k})$ in the usual way. If the normal electromagnetic waves have the form $\vec{E}_1 = \vec{E}_{0,1} e^{i(\vec{k}\vec{r} - \omega t)}$, $\vec{B}_1 = \vec{B}_{0,1} e^{i(\vec{k}\vec{r} - \omega t)}$, $\vec{E}_{0,1} = \text{constant}$, $\vec{B}_{0,1} = \text{constant}$ (spatially homogeneous medium) one has for $j_0 = 0$,
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$$\left. \begin{aligned} D' &= -\frac{c}{\omega} [kB], & B &= \frac{c}{\omega} [kE], \\ D' &= \frac{c^2}{\omega^2} (k^2 E - k(kE)), \\ \frac{\omega^2}{c^2} \epsilon_{ij} E_j - k^2 E_i + k_i k_j E_j &= 0. \end{aligned} \right\} \quad (1, 13)$$

or, in the determinantal representation $\Delta_1(\omega, \vec{k}) = \left| \frac{\omega^2}{c^2} \epsilon_{ij}(\omega, \vec{k}) - k^2 \delta_{ij} + k_i k_j \right| = 0$, or $\Delta_2(\omega, \vec{k}) = \left| \frac{\omega^2}{c^2} \delta_{ij} - k^2 \epsilon_{ij}^{-1}(\omega, \vec{k}) + k_i k_j \epsilon_{ij}^{-1}(\omega, \vec{k}) \right| = 1$ (Δ or ϵ 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 $\epsilon_{ij}(\omega, \vec{k})$ 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 $\epsilon_{ij}(\omega, \vec{k}, \vec{k}') = \sum_{\vec{b}} \delta(\vec{k}' - \vec{k} - 2\pi\vec{b}) \vec{b}_{ij}(\omega, \vec{k})$, where $\vec{b} = \sum_{i=1}^3 n_i \vec{b}_i$ is an arbitrary vector of the reciprocal lattice. The relation between
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\vec{D} and \vec{E} is given by

$$k_i k_j E_j(\omega, \vec{k}) - k^2 E_i(\omega, \vec{k}) + \frac{\omega^2}{c^2} \sum_j \epsilon_{ij}(\omega, \vec{k}) E_j(\vec{k} + 2\pi\vec{b}, \omega) = 0. \quad (2, 3)$$

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): $k_i (kE) - k^2 E_i + (\omega^2/c^2) \epsilon_{ij}(\omega, \vec{k}) E_j = 0$. Here $\epsilon_{ij}(\omega, \vec{k})$ differs from $\epsilon_{ij}^{b=0}(\omega, \vec{k})$ 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 $a/\lambda_0 = an/\lambda_0 \ll 1$ (a -lattice constant, λ_0 -vacuum wavelength). This is done in the following, i. e., the spatial dispersion is assumed to be small. One may then expand $\epsilon_{ij}(\omega, \vec{k})$ in series of powers of \vec{k} and neglect terms of higher order than the second. Near the absorption lines where some components of $\epsilon_{ij}(\omega)$ become very large one must expand analogously the reciprocal tensor of (1.6): $\epsilon_{ij}^{-1}(\omega, \vec{k}) = \epsilon_{ij}^{-1}(\omega) + i g_{ijlc} \frac{k_l}{c} \tilde{n}_{s1} + \beta_{ijlm} (\omega/c)^2 \tilde{n}_{sm}^2$.

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where $\vec{k} = \frac{\omega}{c} \vec{n}$, $\vec{n} = n' + in''$. 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 $\epsilon_{ij}^{-1}(\omega, \vec{k})_{ij} = 0$

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 $n^2 \rightarrow \infty$. Eq. (1.13) is investigated in this case in the form $\vec{D}' = n^2(\vec{E}' - \vec{E}(\vec{E}'))$, $\vec{k} = (\omega/c)n(\vec{e})^*$ ($k \rightarrow \infty$), and the relation $\epsilon_{ij}^{-1}(\omega, \vec{k})_{ij} = 0$ obtained. Only in this case, \vec{E}' and \vec{E} are different from zero. If $\vec{E} = 0$ and $\vec{D}' \neq 0$, the condition $\epsilon_{ij}^{-1}(\omega, \vec{k})_{ij} = 0$ 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 $\text{div } \vec{D}' = 0$. 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 $\epsilon_{ij}^{-1}(\omega, \vec{k})$ is also discussed. Taking into consideration the trans-

lational symmetry of the crystal a result is obtained for the current
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 B102/2214

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density in the approximation of the perturbation theory. This result is:

$$j_{ij}^{(1)}(k, \omega) = \sum_b \sigma_{ij}^{(1) b}(\omega, k) E_j(k + 2\pi b, \omega), \quad (4.4)$$

where

$$\sigma_{ij}^{(1)}(\omega, k) = \sigma_{ij}^{(1) b=0}(\omega, k) = \sum_m \frac{ie^2}{m_m \omega} \gamma_{ij} -$$

$$- \sum_{n, \beta, m} \frac{ie^2 \gamma_{ij}}{4m_n m_\beta \hbar \omega} \left\{ \frac{(\rho_i^* e^{-ikr_a} + e^{-ikr_a} \rho_i^*)_{nm} (\rho_j^\beta e^{ikr_\beta} + e^{ikr_\beta} \rho_j^\beta)_{mn}}{\omega - \omega_m + \omega_n} - \frac{(\rho_i^* e^{-ikr_a} + e^{-ikr_a} \rho_i^*)_{nm} (\rho_j^\beta e^{ikr_\beta} + e^{ikr_\beta} \rho_j^\beta)_{mn}}{\omega - \omega_m + \omega_n} \right\}. \quad (4.5)$$

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

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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)

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

9.9845

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:

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

(where N - electron concentration and ν is the number of
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collisions of electrons with other particles). It can be seen that two simplifications are possible: if $\omega^2 \ll v^2$ the dispersion can be neglected, whereas in the opposite case absorption can be neglected. If dispersion is absent

$$W^{(0)} = W_E^{(0)} + \frac{H^2}{8\pi} = \frac{1}{8\pi} E^2 + \frac{H^2}{8\pi} \quad (9)$$

holds. $W^{(0)}$ is sometimes referred to as the energy density in the medium. A similar expression can be derived from

$$\frac{1}{4\pi} E \frac{\partial D}{\partial t} = \frac{\partial \bar{W}_E}{\partial t}; \quad \bar{W}_E = \frac{1}{8\pi} \frac{d(\omega t)}{d\omega} E^2 = \frac{1}{16\pi} \frac{d(\omega t)}{dt} E_0 E_0^* \quad (10)$$
$$\bar{W} = \bar{W}_E + H^2/8\pi.$$

If absorption is absent, the entropy is constant and $W^{(0)}$ (or \bar{W}) represents the internal energy (in the thermodynamic sense). This is untrue if absorption is present (\bar{W}_E , for example, can even become negative). This does not contradict the necessity for entropy to
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On the law of energy ...

increase, since $w(0)$ does not now represent the internal energy. The author next takes the microscopic approach and considers a plasma with the equation of motion:

$$m \frac{\partial u}{\partial t} = eE - mvu \quad (14)$$

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

$$E(t) = \frac{1}{2} \{ E_0(t)e^{i\omega t} + E_0^*(t)e^{-i\omega t} \}$$
$$H(t) = \frac{1}{2} \{ H_0(t)e^{i\omega t} + H_0^*(t)e^{-i\omega t} \}, \quad (15)$$

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

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

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

derived from plasma theory and the expression

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

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$$\begin{aligned}
 & + \frac{ie^2 N \omega_0 \nu}{2m(\omega_0^2 + \nu^2)^2} \left(\frac{\partial E_0}{\partial t} E_0 - E_0 \frac{\partial E_0}{\partial t} \right) = - \frac{c}{16\pi} \operatorname{div} (|E_0 H_0| + |E_0' H_0'|); \\
 & 1 + \frac{4\pi e^2 N (\omega_0^2 - \nu^2)}{m(\omega_0^2 + \nu^2)^2} = \left(\frac{d(\omega \epsilon)}{d\omega} \right)_{\omega_0}; \quad \frac{e^2 N \nu}{m(\omega_0^2 + \nu^2)} = \nu; \quad - \frac{2e^2 N \omega_0 \nu}{m(\omega_0^2 + \nu^2)^2} = \left(\frac{d\sigma}{d\omega} \right)_{\omega_0}. \quad (25)
 \end{aligned}$$

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:

$$\frac{\partial}{\partial t} \left(\frac{E^2 + H^2}{8\pi} + K_r \right) = - \frac{c}{4\pi} \operatorname{div} |EH| - \int \frac{m v^3}{2} S dv. \quad (34)$$

Here, the last term on the right represents the energy transferred.
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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

$$v_{gr} = \frac{2c \operatorname{Re} \epsilon''}{|\epsilon'| - \epsilon'' + 2} = \frac{cn}{1 + \epsilon''} \quad (44)$$

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

SUBMITTED: October 21, 1960
Card 6/6

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 Ginzburg).
(Physics--Periodicals)

89318

S/033/61/036/001/001/019
E032/E514

3,1720(1041,1126,1127)

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

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

PERIODICAL: Astronomicheskij zhurnal, 1961, Vol. 36, 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 type 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.

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9318
S/033/61/030/001/001/019
E032/E514

Incoherent 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

20887

S/O33/61/038/002/011/011
E032/E414

3.1570 (1062, 1172, 1182)

AUTHOR: Ginzburg, V.L.

TITLE: On the Nature of Radio Galaxies

PERIODICAL: Astronomicheskii 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,

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EO32/E414

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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 $\mu m^2 N / r = \mu m M / r$. 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 = μ) is given by

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

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 α_1 and α_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

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

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

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

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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 a_2 to reach 10^{-8} and the energy to reach $\sim 10 \mu\text{c}^2$. 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: Fizicheskii 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 (1079, 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 super-
conductive 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

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 B125/B102

Second sound, convective heat...

$$\begin{aligned} \frac{\partial \rho}{\partial t} + \nabla \rho \cdot \mathbf{v} + \frac{\partial \rho}{\partial t} + \nabla \rho \cdot \mathbf{v} &= -\nabla \rho \cdot \mathbf{v} + \frac{\partial \rho}{\partial t} + \nabla \rho \cdot \mathbf{v} \\ \frac{\partial \rho}{\partial t} + \nabla \rho \cdot \mathbf{v} + \frac{\partial \rho}{\partial t} + \nabla \rho \cdot \mathbf{v} &= -\nabla \rho \cdot \mathbf{v} + \frac{\partial \rho}{\partial t} + \nabla \rho \cdot \mathbf{v} \\ \frac{\partial \rho}{\partial t} + \nabla \rho \cdot \mathbf{v} + \frac{\partial \rho}{\partial t} + \nabla \rho \cdot \mathbf{v} &= -\nabla \rho \cdot \mathbf{v} + \frac{\partial \rho}{\partial t} + \nabla \rho \cdot \mathbf{v} \end{aligned} \quad (1)$$



follow immediately in linear approximation. The index 0 refers to the unperturbed values and is neglected henceforward. Since the plasma frequency ω_0 is extremely high, the relation

$$k^2 = \omega^2 \left(1 - i \frac{\rho_s}{\rho} \frac{v}{\omega} \right) \frac{\rho_n \rho \left[(\partial S / \partial T)_\rho (\partial \rho / \partial p)_T - (\partial S / \partial p)_T (\partial \rho / \partial T)_\rho \right]}{\rho_s S^2 (\partial \rho / \partial p)_T} \quad (2)$$

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

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Second sound, convective heat...

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 $v^{(s)} = v^{(n)}v/v_0$. If the Fermi surfaces have a complex structure and if there is a sufficiently large number of excitations, $v^{(s)}$ may be much smaller in the superconductive state than $v^{(n)}$ 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

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Second sound, convective heat...

scattering of a pair from impurities in Born approximation reads

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

and if $qa \ll 1$ one finds $\sigma_{tr} = 4M^2 A^2 / \pi \hbar^4$. σ_{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, $v^{(s)}$ is many orders of magnitude smaller than $v^{(n)}$. 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 $u_{2ex} = \sqrt{\rho_{s ex}^2 T / (\rho_{n ex} C_{ex} S_{ex} C_{ex} \text{ and } \rho_{n ex})}$ are the contributions of the excitations under consideration to S, C, and ρ_n . $\rho_{n ex}$, 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

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Second sound, convective heat...

second sound is, in principle, possible even at very small values of $Q_{n\text{ex}}$ 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)

Card 5/8

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

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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 $F_A(>\epsilon) = K_A/\epsilon^{\gamma-1}$ when the particle flux is given by $F_A(>\epsilon)$ (A - atomic weight of the particles, ϵ - total energy). With

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B102/B209

Cosmic rays on the Earth ...

$Z=5000$ and $\gamma = 2.5$ and $\epsilon \rightarrow E$, for the three energy classes the following is obtained: $F(E > 10^6 \text{ Bev}) = 5 \cdot 10^{-6}$, $F(E > 10^8 \text{ Bev}) = 5 \cdot 10^{-9}$, $F(E > 10^{10} \text{ Bev}) = 5 \cdot 10^{-12}$ particles/ $m^2 \cdot \text{steradian} \cdot \text{sec}$. 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 γ ; determination of the chemical composition at high and at very high ($> 10^{16}$ ev) energies;

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B102/B209

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.

GINZBURG, V.L.

On the threshold of the sixth year of space era. Nauka i zhizn'
29 no.10:3-9 0 '62. (MIRA 15:12)

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

GINZBURG, V.L.; EYMAN, 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
EO52/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 $\underline{E}_0 \cdot \underline{B}_0$, $\underline{E}_0^* \cdot \underline{B}_0^*$ 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

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S/141/62/005/001/004/024
E052/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. ✓
B

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

SUBMITTED: November 1, 1961

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

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

S/203/62/002/002/001/017
I046/1246

3,2410
3,2470

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 $Z \geq 2$, $Z \geq 5$, $Z \geq 12$ to 14, $Z \geq 15$, $Z \geq 28$ 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 $Z \geq 28$ to $Z > 30$. 2) The nuclear-component intensity increases in correlation with the solar activity; at energies $E \cdot 10^9$ eV, some selective acceleration mechanism on the sun accelerates preferably the heavier nuclei. 3) Measurements of the latitudinal effect show that, at energies between ~ 1.8 and 7.5 BeV/nucleon, the energy spectra are identical for groups of nuclei with $Z \geq 2$, $Z \geq 5$, $Z \geq 12$ 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 $Z \geq 6$ 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).

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Some investigations of the cosmic ray...

S/203/62/002/002/001/017
1046/1246

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.

X

GINZBURG, V.L.

Law of the conservation of energy in the electrodynamics of media with
spatial dispersion. Izv. vyz. 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
EO32/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
1957 by S.A. Borovik and T.F. Borovik-Romanova (Ref. 1 - DAN
SSSR, 20, 555, 1957) and D. Webb (Ref. 2 - Nature, 159, 248,
1957). The theoretical explanation was supplied by
S.L. Mandel'shtam (Ref. 3 - DAN SSSR, 18, 559, 1958;
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

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S/051/62/012/003/003/016
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

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E032/E314

Dependence of

the point of view adopted by Semenov (Ref. 8 - Izv. vyssh. uchebn. zav. 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 (2655 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, V.L.
USSR

no title given

no affiliation given

Crakow, Posteny 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

13501

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

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
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Notes on the article by ...

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E039/E120

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

Card 2/2 [Abstractor's note: Abridged translation]

GHINZBURG, V. I. [Ginzburg, V.I.]


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

32420

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 $Z \geq 5$ and more than 30,000 of
 $Z \geq 2$ 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° 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

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Temporary increases in the ...

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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 $\text{cm}^{-2} \text{sec}^{-1}$. 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)

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34012

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

24.2200 (1144, 1147, 1164)

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

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, 151, 785, 1960; ZhETF, 32,
1325, 1960) the authors investigate the dependence of magnetic
susceptibility χ 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 , $E_3 - E_1 \ll J_0$, J_0
being the exchange interaction energy of the monomer. For $J_0 \ll kT$, the
monomer will be diamagnetic. If the system is in the antiferromagnetic
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X

3/050/62/042/001/050/049
 B102/3108

Magnetic properties of paramagnetic...

state, and if the chain is not too long, $\chi \sim (\mu^2/kT) \exp(-J/kT)$, $J \ll kT$.
 It is further assumed that $\Delta E_{\min} \sim J/N$, ΔE_{\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 $\Delta E_{\min} = \text{const} \cdot J/N$ for $J \ll 0$ and for spins 0 or 1.

If the exchange Hamiltonian reads $\mathcal{H}_{\text{ex}} = 2J \sum_{l=1}^N (\vec{S}_l \cdot \vec{S}_{l+1} - \frac{1}{4})$, $g_{1z} = \pm \frac{1}{2}$;

the mean magnetic moment in a field $H \parallel z$ is given by

$$M_z = \frac{\sum_{n, S_z} \mu S_z \exp\{-[E(n, S_z) - \mu S_z H]/kT\}}{\sum_{n, S_z} \exp\{-[E(n, S_z) - \mu S_z H]/kT\}}, \quad \mu = \frac{eh}{mc} \quad (6)$$

and for $H \rightarrow 0$,

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

Magnetic properties of paramagnetic...

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B102/B108

$S_z = \sum s_{1z}$; s_1 is the spin operator in terms of \hat{t} . $\chi(T)/\chi_0 = 2J\chi(T)/\mu^2 N$ was calculated numerically and the curves were drawn for several N , $\alpha = 0$ and $\alpha = 1$ (Ising model). It can be seen that for $K \ll J/kT$, χ is very small and increases exponentially with N , reaching $\sim \mu^2 N/J$ when $N \sim J/kT$. The calculations were carried out at the NIRFI GGU under the supervision of G. M. Zhislin. For $N \rightarrow \infty$ and $\alpha = 1$, $\chi(T, H=0) = (\mu^2 N/4kT) \exp(-J/kT)$. In this case $\chi \sim \mu^2 N/J$ 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 $\alpha \ll 1$,

$$\chi(0) = (\mu^2 N/18J) (1 - \frac{1}{3}\alpha), \quad \chi(T \gg J/k) = \mu^2 N/4kT. \quad (11)$$

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

$$\chi(0) = \mu^2 (1-\alpha)^3 N/4J, \quad \chi(T \gg J/k) = \mu^2 N/4kT. \quad (12)$$

It is shown that for a chain type paramagnetic fluid with antiferromagnetic interaction $\chi \neq 0$ at $T = 0$; with ferromagnetic interaction and $\alpha = 1$, $J < 0$; $\chi(0) = \infty$. G. A. Semenov is thanked for help. There are 5 figures
Card 3/4

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. 1, 149, 1960; D. Paul Phys. Rev. 118, 92, 1960; 120, 463, 1960; L. F. Mattheis. Phys. Rev. 123, 1209, 1961. X

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

24,2140 (1072, 1147, 1164)

3:020
3/056/62/042/001/044/048
B102/B108

AUTHOR: Ginzburg, V. I.

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

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

and Ψ_0 and \vec{A} satisfying

$$\left(\nabla + i \frac{e^*}{\hbar c} \mathbf{A} \right)^2 \Psi_0 = \frac{\kappa^4}{\delta_0^2} (1 - |\Psi_0|^2) \Psi_0. \quad (2)$$

Card 1/4 $\text{rot rot } \mathbf{A} = \frac{4\pi}{c} \mathbf{j}_s, \quad \mathbf{j}_s = -\frac{c}{4\pi\delta_0^2} \left\{ -\frac{i\hbar c}{2e^*} (\Psi_0^* \nabla \Psi_0 - \Psi_0 \nabla \Psi_0^* + |\Psi_0|^2 \mathbf{A}) \right\} (3),$

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Magnetic flux quantization for a ...

the magnetic flux is obtained:

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

$\text{div } \vec{A} = 0$. $|\Psi_0| = \text{const}$; H_{KM} - critical field for massive metal, δ_0 - depth of penetration for a weak field; $\kappa = \sqrt{2} e^* H_{KM} \delta_0^2 / Kc$. 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

$$(j_r = j_z = 0; j_\varphi = j(r), \Psi_0 = |\Psi_0(r)| \exp(-i n \varphi))$$

$$A = \frac{hcn}{2\pi\delta_0^2} + A', \quad A' = \delta_0 (a(\xi_1, \xi_2) + bK_1(\xi));$$

$$\begin{aligned} H &= aI_0(\xi) - bK_0(\xi), \quad a = f(\xi_1, \xi_2) [H_2 K_0(\xi_1) - H_1 K_0(\xi_2)]; \\ b &= f(\xi_1, \xi_2) [H_2 I_0(\xi_1) - H_1 I_0(\xi_2)], \quad f(\xi_1, \xi_2) = [I_0(\xi_2) K_0(\xi_1) - \\ &\quad - I_0(\xi_1) K_0(\xi_2)], \quad r = \delta_0 \xi. \end{aligned} \quad (5)$$

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$H_1 \rightarrow H_2$, $\psi_1 \rightarrow \psi_2$. In the case $d = \Delta r / \delta_0 \ll 1$, $\int_1 d \approx r \Delta r / \delta_0^2 \gg 1$,

for $H_2 = 0$, $|\psi_0| = 1$, $j_g = c H_1 / 4 \pi \Delta r$, $\phi = \frac{hcn}{2e} (1 + \frac{\delta_0^2 l}{S \Delta r})^{-1}$ where S is the area and l the perimeter of the cylinder cross section. It is further shown that a state with a given $n \geq 0$ is attained when the flux of the external field through the opening is given by $\phi_2 = \pi r^2 H_2 = \frac{hc}{2e} (n - \frac{1}{2})$.

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. K

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

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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 $\epsilon_{ij}(\omega, \vec{k})$ and normal waves in a medium; properties of $\epsilon_{ij}(\omega, \vec{k})$, 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. $\epsilon_{ij}(\omega, \vec{k})$ in crystals; introduction of ϵ_{ij} ; weak spatial dispersion ($a/\lambda \ll 1$). There are 2 figures and 3 tables.
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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

NOTE: 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 α - β -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 $\epsilon = \epsilon(T)$ near Θ for I. and II.-type transitions, and he presents a theory to account for them. This assumes there is no singularity in the thermo-
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Light scattering near ...

dynamic potential near the transition so that $\Phi(p, T, \eta)$ can be developed in even powers of η , 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 $\Delta \epsilon$ of the dielectric constants, $\Delta \epsilon$ 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 $\epsilon(T)$, and for $\alpha(T)$. 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.

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

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

PERIODICAL: Uspehi 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 $\epsilon_{ij}(\omega, \vec{k})$. a) A quantum-mechanical expression for $\epsilon_{ij}(\omega, \vec{k})$; b) mechanical excitons and the tensor $\epsilon_{ij}(\omega, \vec{k})$ in molecular crystals and
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Crystal optics taking account ...

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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.

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

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)

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

Mechanism of the emission of galaxy 3C 273-B. Astron. tsir.
no.267:1-4 0 '63. (MIRA 17:4)

1. Fizicheskiy institut imeni P.N.Lebedeva AN SSSR.

GINZBURG, V.L.; PISAREVA, V.V.

Polarization of the radio emission from discrete sources, and the
exploration of the metagalactic and galactic spaces and spaces
near the sun. Izv. vys. ucheb. zav.; radiofiz. 6 no.5:877-888
'63. (MIRA 16:12)

1. Nauchno-issledovatel'skiy radiofizicheskiy institut pri
Gor'kovskom universitete.

ADP-005138006/ADP/88D-3 Fe-4
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ACCESSION NR: AP3003293

AUTHORS: Ginsburg, V. L., Sytrovskiy, S. I.

TITLE: Gamma ray and cyclotron radiation X-rays of galactic and metagalactic origin

SOURCE: Zhur. eksper. i teoret. fiz., v. 45, no. 2, 1963, 353-363

TOPIC TAGS: galactic X-ray, galactic gamma ray, metagalactic X-ray, metagalactic gamma ray, cyclotron radiation, pion decay

ABSTRACT: The question of the intensity of gamma and X-rays produced as a result of nuclear interaction of cosmic rays in the galaxy and metagalaxy is discussed, and the intensity of the gamma rays due to the decay of neutral pions produced in such interactions is computed. The intensity of the X-rays due to the cyclotron radiation of the electrons (or positrons) produced by decay of positive and negative pions is calculated for the same conditions. The expected