S/115/63/000/003/007/010
E192/E382

AUTHOR: Akhiyezer, A.N.

TITLE: Design of wideband waveguide directional couplers

PERIODICAL: Izmeritel'naya tekhnika, no. 3, 1963, 50 - 52

TEXT: The paper was read at the Fourth All-Union Conference of MVSSO, Khar'kov in 1960. The design is considered of directional couplers with identical, equidistantly-spaced, circular coupling apertures, situated on the wider wall of the two rectangular waveguides. The analytical approach is based on first determining the transmission attenuation and directivity of an individual coupling aperture and then taking into account the interaction of n apertures and interference of the reflected waves and calculating the attenuation and directivity of the coupler. The attenuation and directivity of an aperture can be based on the author's formula (Zhurnal tekhnicheskoy fiziki, 1960, no. 7):

Design of wideband ....

S/115/63/000/003/007/010
E192/E382

$$C_{1.2} = -20 \log \left| \frac{d^3}{12\ ab\ \gamma} \right| \left\{ \left(\gamma^2 + \right. \right.$$

$$+ \frac{[illegible]}{a^2} \left| [illegible]_e \right| 1 - 1.193 \frac{d}{[illegible]} \ . \cos^2 \frac{n}{a} \ +$$

$$[illegible] \ 1 + [illegible] \ \frac{d}{[illegible]} \ [illegible] \ \frac{h}{[illegible]} \ .$$

$$\frac{[illegible]}{a^2} \sin^2 \frac{[illegible]}{a} \left. \right| \left. \right\} \left. \right|$$

Card 2/4

where d is the diameter of the aperture, a and b are the wider and narrower wall cross-sections of the waveguide, $\gamma = 2\pi/\lambda_\partial$ where λ_∂ is the wavelength in the waveguide, h is the distance of the aperture from the axis of the waveguide and ψ_e and ψ_m are coefficients taking into account the wall thickness t . In a coupler with n equidistantly-spaced apertures, the transmission attenuation C and the directivity D are in the form (Mashkovtsev et al - Radiotekhnika, 1960, no. 4):

$$C_{\partial б} = C_1 - 20 \log n \tag{3a}$$

$$D_{\partial б} = (C_2 - C_1) + 20 \log \left| \frac{n \sin \varphi}{\sin n \varphi} \right| \tag{3б}$$

where $\varphi = 2\pi \ell/\lambda_\partial$ where ℓ is the distance between the neighbouring apertures. The first term in Eqs. (3a) and (3б) represents the attenuation and directivity of an individual aperture, while the second term takes into account the interaction

S/115/63/000/003/007/010
E192/E382

Design of wideband ....

of the system of apertures. When designing a coupling system with the directivity and attenuation as basic parameters, it is first necessary to determine the required length L' of the system by assuming that $C_2 - C_1 = 0$ and that ℓ' lies between 0.37 and 0.40. The number of coupling apertures n is determined from the ratio L'/ℓ' and the transmission attenuation of a single aperture is evaluated from the transmission attenuation C of the system by using Eq. (3a). A coupler with a directivity of 26 db and attenuation of 19 db was designed and constructed. There are 4 figures and 3 tables.

Card 4/4

[illegible] /EWA(h) Im-4/Paa-2/Peb/Pi-4/Pj-4/Pl-4 IJP(c)

ACCESSION NR: AP5015494 621.317.[illegible]

AUTHOR: Akhivez[illegible]

TITLE: Film bolome[illegible] optical transmission [illegible] Class 21, No. 170085

[illegible] izobreteniy [illegible] 9, 1965, 27

TOPIC TAGS: bolometer, film bolometer

ABSTRACT: The proposed film bolometer for optical transmission lines in the millimeter and submillimeter wavelength ranges is positioned at the focus of a collecting lens. To achieve effective absorption of electromagnetic wave energy, it is designed in the form of a grid of parallel strips of absorbing material. The grid is placed [illegible] direction of wave propaga- [illegible] plane is perpendi[illegible] figure

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ACCESSION NR: AP5015494

ASSOCIATION: Khar'kovskiy gosudarstvennyy institut mer i izmeritel'nykh priborov (Khar'kov State Institute of Measures and Measuring Instruments)

SUBMITTED: 13Apr63 ENCL: 00 SUB CODE: NP, EC

NO REF SOV: 000 OTHER: 000 ATD PRESS: 4028

21(7) SOV/56-36-6-31/66

AUTHORS: Akhiyezer, I. A., Polovin, R. V.

TITLE: On the Theory of Relativistic Magnetohydrodynamic Waves (K teorii relyativistskikh magnitogidrodinamicheskikh voln)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 6, pp 1845-1852 (USSR)

ABSTRACT: In the introduction the authors discuss the paper by Hoffmann and Teller (Ref 1) in which the equation of the non-relativistic shock-adiabatic was derived. However, neither the problem of the stability of relativistic magnetohydrodynamic shock waves was investigated, nor was the Tsemplen theorem verified, and, besides, the problem of the direction of the variation of the magnetic field in the shock wave was investigated only for special cases. Also the questions relating to the classification and the particular features of relativistic magnetohydrodynamic discontinuities (contact-, tangential-, Alfven-, fast and slow shock waves) were not investigated. To deal with all these problems was the aim of the present paper. Like in the case of ordinary hydrodynamics, the shock wave also in magnetohydrodynamics develops from a simple wave, in that every point of the liquid with a greater

Card 1/3

SOV/56-36-6-31/66

On the Theory of Relativistic Magnetohydrodynamic Waves

density also moves with higher velocity. The authors first investigate these simple plane waves; each of their values may be represented as a function of the coordinates x and t (Khalatnikov and Stanyukovich already investigated these waves in relativistic magnetohydrodynamics). The authors base their investigations on the system of the relativistic magnetohydrodynamic equations in the case of vanishing viscosity and infinite electric conductivity, and give a mathematical description of the Alfven wave, the magnetosonic waves, as well as of the fast and slow magnetosonic waves. In the following chapter the discontinuities are investigated, viz 1) discontinuities which, relatively to the liquid, are at rest (contact- and tangential discontinuities) and 2) such as are in motion relatively to the liquid (Alfven and shock waves). In the last part of the paper the Tsemplen theorem is proved for shock waves of arbitrary intensity (in nonrelativistic magnetohydrodynamics this has already been proved by Iordanskiy, Polovin, and Lyubarskiy (Refs 16-18)). The theorem states that in the shock wave pressure and density increase if $(\partial s/\partial p)_{w/n} > 0$. The authors finally thank

Card 2/3

On the Theory of Relativistic Magnetohydrodynamic Waves SOV/56-36-6-31/66

A. I. Akhiyezer and G. Ya. Lyubarskiy for valuable discussions. There are 23 references, 17 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physico-technical Institute of the Academy of Sciences of the Ukrainskaya SSR)

SUBMITTED: December 27, 1958

Card 3/3

AUTHORS: Akhiyezer, I. A., Polovin, R. V., Tsintsadze, N. L. SOV/56-37-3-25/62

TITLE: Simple Waves in the Chew, Goldberger, and Low Approximation

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 37, Nr 3(9), pp 756-759 (USSR)

ABSTRACT: Chew, Goldberger, and Low showed that a dilute plasma in a magnetic field in which collisions play an important role, may be defined by a system of magnetohydrodynamic equations with anisotropic pressure. It is of interest to use these equations for investigating the nonlinear motions of a plasma (above all, of simple waves). The present paper deals with this problem. The system of magnetohydrodynamic equations has the following form in the Chew, Goldberger, and Low approximation:

$$\varrho \frac{d\vec{v}}{dt} = \vec{F} + \frac{1}{4\pi}\left[\mathrm{curl}\,\vec{H},\vec{H}\right], \quad F_i = -\frac{\partial p_{ik}}{\partial x_k}, \quad \frac{\partial \vec{H}}{\partial t} = \mathrm{curl}\left[\vec{v}\,\vec{H}\right],$$

$$\mathrm{div} = \vec{H} = 0 \quad \frac{\partial \varrho}{\partial t} + \mathrm{div}(\varrho\vec{v}) = 0, \quad p_{ik} = p_{\perp}\delta_{ik} + (p_{\parallel} - p_{\perp})h_i h_k,$$

Card 1/4

Simple Waves in the Chew, Goldberger, and Low Approximation

SOV/56-37-3-25/62

$$\vec{h} = \vec{H}/H \quad \frac{d}{dt}\left(\frac{p_{\perp}}{\rho H}\right) = 0 , \quad \frac{d}{dt}\left(\frac{\rho_{\parallel} H^2}{\rho^3}\right) = 0$$

The author investigates one-dimensional plane waves in which all magnetohydrodynamic quantities are functions of one of these quantities (e.g. of ρ). ρ on its part depends on the coordinate x and on the time t: $x - V_{\Phi}(\rho)t = f(\rho)$. $V_{\Phi}(\rho)$ denotes the translation velocity of the point where density ρ has a given value; $f(\rho)$ - a function which is reciprocal to the density distribution $\rho(x)$ in the initial instant of time $t = 0$. $f(\rho) = 0$ holds for the self-simulating waves in the ranges of compression $f'(\rho) < 0$ and in the ranges of expansion $f'(\rho) > 0$. The simple waves are closely connected with the waves of small amplitudes. Like in magnetohydrodynamics with scalar pressure, there exist 3 types of waves. The partly very extensive differential equations of the Alfvén waves and magnetic sound waves are written down explicitly. The Alfvén waves propagate without changing their shape. Investigation of the equations of the magnetic sound waves in general form frequently meets with considerable difficulties. The authors deal only with the most

Card 2/4

Simple Waves in the Chew, Goldberger, and Low Approximation SOV/56-37-3-25/62

interesting case in which hydrostatic pressure is considerably lower than magnetic pressure. In the ranges with expansion the density gradient decreases, and in the ranges of compression it increases. In the ranges with expansion ($f' > 0$) and in the self-simulating waves ($f = 0$) density decreases. In the ranges of the compression ($f' < 0$) density increases until a certain expression written down by the authors becomes negative. As soon as this expression equals zero, a compression shock wave is formed. In a fast magnetic sound wave, the quantities $p_{\parallel}$, $p_{\perp}$, H, $p_{\perp}/p_{\parallel}$ change in the same way as in the magnetic sound wave. The authors then investigate a slow magnetic sound wave. There are two possibilities: (1) In the normal case, density changes in the same way as in a fast magnetic sound wave. Shock waves are formed especially in the ranges of compression, and the self-simulating waves are expansion waves.

(2) In the abnormal case the density gradient decreases in the ranges of compression and increases in the ranges of thinning In the ranges of expansion a shock wave is formed. In contrast to magnetohydrodynamics with scalar pressure, expansion shock waves may form in this case. The authors thank A. I. Akhiyezer and G. Ya. Lyubarskiy for useful discussions. There are 8 references, 5 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physical-technical Institute of the Academy of Sciences, Ukrainskaya SSR) Institut fiziki Akademii nauk Gruz. SSR (Physics Institute of the Academy of Sciences of the Gruzinskaya SSR)

SUBMITTED: April 3, 1959

Card 4/4

AKHIYEZER, I.A.; POLOVIN, R.V.

[Motion of a conducting plane in a magnetohydrodynamic medium] O dvizhenii provodiashchei ploskosti v magnitogidrodinamicheskoi srede. Khar'kov, Fiziko-tekhn. in-t AN USSR, 1960. 44-53 p. (MIRA 17:2)

AKHIYEZER, I.A.; POLOVIN, R.V.; TSINTSADZE, N.L.

[Simple waves in Chew's, Goldberger's and Low's approximations] Prostye volny v priblizhenii Ch'iu, Gol'dbergera i Lou. Khar'kov, Fiziko-tekhn. in-t AN USSR, 1960. Page 57. (MIRA 17:3)

AKHIYEZER, I.A.; POLOVIN, R.V.

[Theory of relativistic magnetohydrodynamic waves] K teorii reliativistskikh magnitogidrodinamicheskikh voln. Khar'kov, Fiziko-tekhn. in-t AN USSR, 1960. 54-55 p. (MIRA 17:1)

AKHIYEZER, I.A.; POLOVIN, R.V.

Motion of a conducting piston in a magnetohydrodynamic medium. Zhur. eksp.i teor.fiz. 38 no.2:529-533 F '60. (MIRA 14:5)

1. Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR.
(Magnetohydrodynamics)

S/056/60/038/06/07/012
B006/B056

AUTHORS: Akhiyezer, I. A., Peletminskiy, S. V.

TITLE: Application of Quantum-field Theoretical Methods for the Investigation of the Thermodynamic Properties of a Gas of Electrons and Photons

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PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 38, No. 6, pp. 1829 - 1839

TEXT: The idea and the method of applying the quantum field theory for the purpose of investigating the thermodynamic properties of systems of interacting particles date back to Matsubara. A. A. Abrikosov, L. P. Gor'kov, I. Ye. Dzyaloshinskiy, Ye. S. Fradkin, A. A. Vedenov, and A. I. Larkin have already occupied themselves with various forms of applying this method. It was the aim of the present paper to derive the thermodynamic potential of a system of electrons, positrons, and photons in consideration of the interaction between them with an accuracy up to and including terms with $e^4 \ln e^2$, where e is the electron

Card 1/3 √B

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Application of Quantum-field Theoretical Methods for the Investigation of the Thermodynamic Properties of a Gas of Electrons and Photons

charge. First, the idealized problem of the thermodynamic potential of an electron-photon gas with a homogeneous, positively charged background is investigated, in which the background compensates the negative electron charge, so that the task consists in determining the thermodynamic potential of an equilibrium system. In the following, also the part played by the ions existing in physically real systems is taken into account (at not too low temperatures), and finally one goes over to the problem of the energy of black-body radiation in consideration of the interaction between the photons and the electron-positron pairs. After a detailed explanation of the fundamental relations of the thermodynamic perturbation theory and application of Matsubara's quantum-field theoretical method, and after a discussion of the invariance properties of the polarization operator, the problem proper, i. e., that of the thermodynamic potential, is dealt with. Divergences appearing in the high-momentum region of the virtual particles are removed by renormalizing the electron charge and mass, and by redetermination of the vacuum level. General expressions are derived, which take relativistic

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Card 2/3

Application of Quantum-field Theoretical Methods for the Investigation of the Thermodynamic Properties of a Gas of Electrons and Photons

S/056/60/038/06/07/012
B006/B056

effects into account, and asymptotic formulas are derived for the exchange and correlation energies. Finally, corrections to the black-body radiation energy for the interaction between photons and electron-positron pairs are calculated. The authors thank A. I. Akhiyezer for advice and discussions. There are 1 figure and 9 references: 6 Soviet, 1 American, and 1 Japanese.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Institute of Physics and Technology of the Academy of Sciences Ukrainskaya SSR)

SUBMITTED: January 12, 1960

Card 3/3

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B006/B077

24.2200

AUTHORS: Akhiyezer, I. A., Peletminskiy, S. V.

TITLE: Theory of the Magnetic Properties of a Nonideal Fermi Gas at Low Temperatures

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 5(11), pp. 1308-1316

TEXT: This is a study based on the quantum field theory of the effect of the interaction between particles upon the magnetic properties, especially the oscillations of the magnetic moment of a Fermi gas. The authors chose a simple model within the microscopic theory assuming that the interaction of the particles is due to short-range forces and the system in question can be regarded as a gas. Expressions are found for the change of period and the amplitude of the oscillation of the magnetic moment due to the interaction between the particles. The results are valid in a moderate temperature range ($p_0 f_0 \ll 1$, $\omega/\mu \ll 1$, $(\omega/\mu)^2 (p_0 f_0)^2 \ll (\beta\mu)^{-1} \ll 1$; $\mu = p_0^2/2m$ is the chemical potential, and $\omega = e\mathcal{H}/mc$ is the Larmor frequency of the

Card 1/3

86903

Theory of the Magnetic Properties of a Nonideal Fermi Gas at Low Temperatures S/056/60/039/005/020/051
B006/B077

particles in the $\mathcal{H}$-field; β is the reciprocal temperature, f_0 the scattering amplitude of zero-energy particles for $\mathcal{H} = 0$). The following expression is obtained for the oscillations of the gas density

$$\mathfrak{N}_r^{osc} = \frac{m}{\pi}\left(\frac{m\omega}{r}\right)^{3/2}\frac{1}{\beta}\sin\left[\frac{2\pi r}{\omega}(\mu+\Delta\mu)-\frac{\pi}{4}\right]\times$$

$$\times\sum_{k=0}^{\infty}\exp\left\{-\frac{2\pi^2 r}{\beta\omega}\frac{m^*}{m}(2k+1)-\frac{4\pi r}{\omega\tau}\left[(2k+1)^2-\frac{1}{2}\right]\right\}. \quad (22)$$

for the oscillations of the thermodynamic potential per unit of volume:

$$\Omega = \Omega_0 + 2\sum_{r=1}^{\infty}(-1)^r\Omega_r,$$

$$\Omega_r^{osc} = \frac{1}{2\pi^3}\left(\frac{m\omega}{r}\right)^{3/2}\frac{1}{\beta}\cos\left[\frac{2\pi r}{\omega}(\mu+\Delta\mu)-\frac{\pi}{4}\right]\times$$

$$\times\sum_{k=0}^{\infty}\exp\left\{-\frac{2\pi^2 r}{\beta\omega}\frac{m^*}{m}(2k+1)-\frac{4\pi r}{\omega\tau}\left[(2k+1)^2-\frac{1}{2}\right]\right\}. \quad (23)$$

and for the oscillating part of the magnetic moment:

Card 2/3

Theory of the Magnetic Properties of a Nonideal Fermi Gas at Low Temperatures

S/056/60/039/005/020/051
B006/B077

$$M_r^{osc} \cong -\frac{1}{\pi}\frac{e}{c}\left(\frac{m}{r\omega}\right)^{1/2}\frac{\mu}{\beta}\sin\left[\frac{2\pi r}{\omega}(\mu+\Delta\mu)-\frac{\pi}{4}\right]\times$$

$$\times\sum_{k=0}^{\infty}\exp\left\{-\frac{2\pi^2 r}{\beta\omega}\frac{m^*}{m}(2k+1)-\frac{4\pi r}{\omega\tau}\left[(2k+1)^2-\frac{1}{2}\right]\right\}. \qquad (24)$$

If $\omega\tau \gg 1$, then $M_r^{osc} = -\frac{1}{2\pi}\frac{e}{c}\left(\frac{m}{r\omega}\right)^{1/2}\frac{\mu}{\beta}\sin\left[\frac{2\pi r}{\omega}(\mu+\Delta\mu)-\frac{\pi}{4}\right]\mathrm{sh}^{-1}\frac{2\pi^2 r}{\beta\omega}\frac{m^*}{m}$. $\mathcal{N} = -\frac{\partial\Omega}{\partial\mu}$; $M = -\frac{\partial\Omega}{\partial\mathcal{H}} = -\frac{e}{mc}\frac{\partial}{\partial\omega}\Omega$. It is especially pointed out that the oscillation amplitude contains a factor which increases exponentially if the magnetic field $\mathcal{H}$ decreases. The authors thank A. I. Akhiyezer and I. M. Lifshits for their suggestions; Yu. A. Bychkov for discussions. L. D. Landau, A. M. Kosevich, V. M. Galitskiy, A. A. Abrikosov, L. P. Gor'kov, I. Ye. Dzyaloshinskiy, Ye. S. Fradkin, and V. G. Skobov are mentioned. There are 3 figures and 7 references: 5 Soviet, and 2 British.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Institute of Physics and Technology of the Academy of Sciences Ukrainskaya SSR)

SUBMITTED: May 25, 1960

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S/056/61/040/001/034/037
B102/B212

24.7900 (1147, 1158, 1160, 1144)

AUTHORS: Akhiyezer, I. A., Bar'yakhtar, V. G., Peletminskiy, S. V.

TITLE: Theory of high-frequency magnetic susceptibility of a ferrodielectric at low temperatures

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 40, no. 1, 1961, 365-374

TEXT: The ferromagnetic resonance line widths are commonly calculated by phenomenological methods using the relaxation term in accordance with Landau-Lifshits or Bloch. The authors of the present paper wanted to calculate the ferromagnetic resonance line shape by using quantum theory and basing on the microscopic theory of spin wave interactions. The magnetic susceptibility tensor is not determined as usually with the help of an equation of motion but with an application of field theory using Green's two-time function of spin waves. The calculation of Green's spin wave function is based on a Hamiltonian which takes into account both exchange interactions and relativistic interactions between spin waves; the interaction of these spin waves with lattice vibrations is neglected.

Card 1/8

relation: $m_i^o(\vec{k}) = \chi_{il}(\vec{k},\omega)h_l^o(\vec{k})|_{\omega=0}$. The variable magnetic field is described by $\vec{h}(\vec{r},t) = \theta(-t)e^{\varepsilon t}\vec{h}^o(\vec{r})$, $\varepsilon\to+0$; and the relaxation of the magnetic moment is expressed by the relation:

$$m_i(\vec{r},t) = -\frac{i}{(2\pi)^4}\int d\vec{k}e^{i\vec{k}\vec{r}}k_l^o(\vec{k})\int_{-\infty}^{\infty} d\omega\frac{e^{-i\omega t}}{\omega}\left[\chi_{il}(\vec{k},\omega) - \chi^*_{li}(\vec{k},\omega)\right].$$

The relaxation is thus determined by the anti-hermitean part of the tensor χ_{il}; this part also determines the energy absorption of the variable magnetic field. In the following the connection between $K^R_{il}(\vec{r},t)$ and the Matsubara-Green function $\mathcal{K}_{il}(\vec{r},\tau)$ is defined by $\mathcal{K}_{il}(\vec{r}-\vec{r}',\tau-\tau') = -\langle T_\tau\{\hat{M}_i(\vec{r},\tau)\hat{M}_l(\vec{r}',\tau')\}\rangle$, $\hat{M}_i(\vec{r},\tau) = e^{\mathcal{H}\tau}M_i(\vec{r})e^{-\mathcal{H}\tau}$, where T_τ is the chronological operator with respect to the variable τ, which is examined by employing the diagram technique. Using a method of A. A. Abrikosov, L. P. Gor'kov, I. Ye. Dzyaloshinskiy, and Ye. S. Fradkin one obtains: $\chi_{il}(\vec{k},\omega) = K^R_{il}(\vec{k},\omega) = \mathcal{K}_{il}(\vec{k},-i\omega+0)$. The magnetic susceptibility of a

89228

S/056/61/040/001/034/037
B102/B212

dielectric described by the Hamiltonian $\mathcal{H} = \mathcal{H}_0 + \mathcal{H}_3 + \mathcal{H}_4$ is then computed. $\mathcal{H}_0 = \sum_{\vec{k}} \varepsilon_{\vec{k}} c^+_{\vec{k}} c_{\vec{k}}$, where $\varepsilon_{\vec{k}}$ denotes the spin wave energy, $\mathcal{H}_3$ and $\mathcal{H}_4$ are given by

$$\mathcal{H}_3 = \frac{1}{\sqrt{V}} \sum_{1,2,3} \{\Phi(1, 2; 3) c_1^+ c_2^+ c_3 \Delta(k_1 + k_2 - k_3) + \text{к. с.} + \Phi_1(1, 2, 3) c_1^+ c_2^+ c_3^+ \Delta(k_1 + k_2 + k_3) + \text{к. с.}\}, \tag{19}$$

$$\mathcal{H}_4 = \frac{1}{V} \sum_{1,2,3,4} \{\Psi(1, 2; 3, 4) c_1^+ c_2^+ c_3 c_4 \Delta(k_1 + k_2 - k_3 - k_4) + \Psi_1(1, 2, 3; 4) c_1^+ c_2^+ c_3^+ c_4 \Delta(k_1 + k_2 + k_3 - k_4) + \text{к. с.} + \Psi_2(1, 2, 3, 4) c_1^+ c_2^+ c_3^+ c_4^+ \Delta(k_1 + k_2 + k_3 + k_4) + \text{к. с.}\}.$$

$$\varepsilon_k = \sqrt{A_k^2 - |B_k|^2}, \text{ где}$$

$$A_k = \Theta_c (ak)^2 + \mu(H_0 + \beta M_0) + 2\pi\mu M_0 \sin^2 \theta_k, \quad B_k = 2\pi\mu M_0 \sin^2 \Theta_k e^{2i\varphi_k}.$$

μ denotes the double Bohr magneton, a is the lattice constant, Θ_0 is of the order of the Curie temperature, M_0 is the saturation magnetic moment, β the anisotropic constant, H_0 the constant outer magnetic field, $\Theta_{\vec{k}}$ and

89220

S/056/61/040/001/034/037
B102/B212

Theory of high-frequency magnetic...

$\varphi_{\vec{k}}$ are the polar angles of $\vec{k}$. Ψ and Φ are given by

$$\left.\begin{array}{l}\Psi(1,2;3,4) = -\mu(4M_0)^{-1}\theta_c a^2(k_1k_2 + k_3k_4)\\ |\Psi_2| \ll |\Psi_1| \ll |\Psi|\end{array}\right\} \text{при } 1 \gg ak \gg \sqrt{\frac{\mu M_0}{\theta_c}} \quad (20)$$

$$\begin{aligned}\Phi(1,2;3) = -\pi\mu\sqrt{2\mu M_0}\,(&\sin 2\theta_1(e^{-i\varphi_1}u_1^* + e^{i\varphi_1}v_1)(u_2^*u_3 + v_2^*v_3) + \\ &+ \sin 2\theta_2(e^{-i\varphi_2}u_2^* + e^{i\varphi_2}v_2^*)(u_1^*u_3 + v_1v_3) + \\ &+ \sin 2\theta_3(e^{i\varphi_3}u_3 + e^{-i\varphi_3}v_3)(v_1^*u_2^* + v_2^*u_1^*)),\end{aligned} \quad (21)$$

$$\left.\begin{array}{l}|\Phi_1| \sim |\Phi|; \quad |\Psi_1| \sim |\Psi_2| \sim |\Psi|\\ \Psi(1,2;3,4) = -{}^1/{}_2\mu^2\beta(u_1^*u_2^*u_3u_4 + 4u_1^*v_2^*v_3u_4 + v_1^*v_2^*v_3v_4)\end{array}\right\} \text{при } ak \ll \sqrt{\frac{\mu M_0}{\theta_c}}, \quad (22)$$

где $^{8)}$

$$u_k = \sqrt{(A_k + \varepsilon_k)/2\varepsilon_k}, \quad v_k = -e^{2i\varphi_k}\sqrt{(A_k - \varepsilon_k)/2\varepsilon_k}.$$

One obtains:

$$\begin{aligned}\chi_{xx}(k,\omega) &= \tfrac{1}{2}\mu M_0U_1(k)\{[\varepsilon_k - \omega - i\gamma(k)]^{-1} + [\varepsilon_k + \omega + i\gamma(k)]^{-1}\},\\ \chi_{yy}(k,\omega) &= \tfrac{1}{2}\mu M_0U_2(k)\{[\varepsilon_k - \omega - i\gamma(k)]^{-1} + [\varepsilon_k + \omega + i\gamma(k)]^{-1}\},\\ \chi_{xy}(k,\omega) &= -\tfrac{1}{2}i\mu M_0\{U(k)[\varepsilon_k - \omega - i\gamma(k)]^{-1} - U^*(k)[\varepsilon_k + \omega + i\gamma(k)]^{-1}\},\\ \chi_{yx}(k,\omega) &= \tfrac{1}{2}i\mu M_0\{U^*(k)[\varepsilon_k - \omega - i\gamma(k)]^{-1} - U(k)[\varepsilon_k + \omega + i\gamma(k)]^{-1}\};\end{aligned} \quad (31)$$

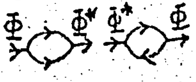
$$\begin{aligned}U_1(k) &= |u_k|^2 + |v_k|^2 + u_k^*v_k + u_kv_k^*,\\ U_2(k) &= |u_k|^2 + |v_k|^2 - u_k^*v_k - u_kv_k^*,\\ U(k) &= 1 + u_k^*v_k - u_kv_k^*.\end{aligned} \quad (32)$$

Card 5/8

89228
S/056/61/040/001/034/037
B102/B212

Theory of high-frequency magnetic...

with $\gamma(\vec{k}) = \mathrm{Im}\Sigma(\vec{k}, -i\varepsilon_{k}+0)$. The relaxation of the transverse magnetic moment is then investigated, and using the relation mentioned above, the resonance line width $\gamma(\vec{k})$ is determined. Diagrams of the type



are expressed in second perturbation theory approximation by

$$\mathrm{Im}\,\Sigma_{\Phi}(k, -i\omega+0) = (2\pi)^{-3}\int dk'\,|\Phi(k', k-k'; k)|^{2}\,[(n_{k'}+1)(n_{k-k'}+1) - n_{k'}n_{k-k'}]\,\delta(\omega-\varepsilon_{k'}-\varepsilon_{k-k'}) + 2(2\pi)^{-3}\int dk'\,|\Phi(k, k'; k+k')|^{2}\,[n_{k'}(n_{k+k'}+1) - (n_{k'}+1)\,n_{k+k'}]\,\delta(\omega+\varepsilon_{k'}-\varepsilon_{k+k'}). \quad (37)$$

For graphs of the type as shown in Figs. 4-5 formula (40) holds. Finally the resonance line shape is investigated; here it is necessary to know $\gamma(0) = \mathrm{Im}\Sigma(0, -i\varepsilon_{0}+0)$; ε_{0} denotes the frequency of the homogeneous resonance which is a function of the shape of the body: $\varepsilon_{0} = \mu(H_{0}+\beta M_{0})^{1/2}(H_{0}+\beta M_{0}+4\pi M_{0})^{1/2}$. For two limiting cases

$$\gamma(0) = \begin{cases} \frac{2}{5\pi}\left(\frac{3}{8}\right)^{1/2}\mathrm{cth}\,\frac{\varepsilon_{0}}{4T}\left(\frac{\mu M_{0}}{\Theta_{c}}\right)^{1/2}\left(\frac{4\pi}{3}-\frac{H_{0}}{M_{0}}-\beta\right)^{1/2}\mu M_{0}, & \frac{4\pi}{3}-\frac{H_{0}}{M_{0}}-\beta \ll 1 \\ A\,\mathrm{cth}\,\frac{\varepsilon_{0}}{4T}\left(\frac{\mu M_{0}}{\Theta_{c}}\right)^{1/2}\left(\frac{H_{0}}{M_{0}}+\beta\right)^{1/2}\mu M_{0}, & \frac{H_{0}}{M_{0}}+\beta \ll 1 \end{cases} \quad (43)$$

$$A = \frac{\pi}{4}\int_{0}^{\pi/6}\cos^{2}\vartheta\,\sqrt{1-4\sin^{2}\vartheta}\,d\vartheta.$$

Card 6/8

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B102/B212

Theory of high-frequency magnetic...

holds, and $\gamma(\vec{k})$ is given by

$$\gamma(k) = \operatorname{Im}\Sigma_{\Psi}(k, -i\varepsilon_k + 0) = \frac{1}{4(2\pi^6)}\left(\frac{\mu\theta_c}{M_0}\right)^2\left(\exp\frac{\varepsilon_k}{T} - 1\right)a^4\int dk'\,dk''\,(kk' + kk'' + k'k'' - k''^2)^2\,(n_{k'} + 1)\,n_{k''}\,n_{k+k'-k''}\,\delta(\varepsilon_k + \varepsilon_{k'} - \varepsilon_{k''} - \varepsilon_{k+k'-k''}). \quad (46)$$

For $\varepsilon_{\vec{k}} \sim T$ the following is valid $\gamma(\vec{k}) \approx (T/\theta_0)^4\theta_0$. Finally the authors thank A. I. Akhiyezer for suggestions. M. I. Kaganov and V. M. Tsukernik are mentioned. There are 5 figures and 12 references: 8 Soviet-bloc and 4 non-Soviet-bloc.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Institute of Physics and Technology, Academy of Sciences Ukrainskaya SSR)

SUBMITTED: July 18, 1960

Card 7/8

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Theory of high-frequency magnetic...

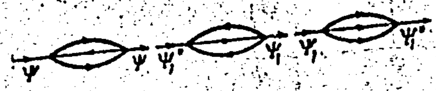

Рис. 4

Fig. 4

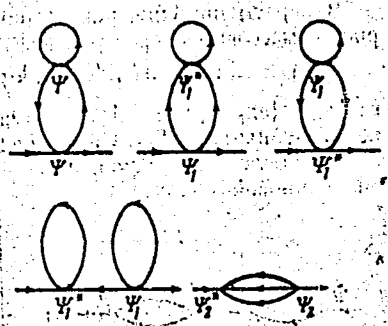

Рис. 5

Fig. 5

Card 8/8

27959
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D274/D303

9,3700(1057,1163)

AUTHOR: Akhiyezer, I.O.

TITLE: On the theory of electromagnetic properties of many-particle systems

PERIODICAL: Ukrayins'kyy fizychnyy zhurnal, v. 6, no. 4, 1961, 435-447

TEXT: A system of many charged particles is investigated by the methods of the quantum theory of fields. Using Kubo's method (Ref. 1: J. Phys. Soc. Japan, 12, 570, 1957), one obtains, in the linear approximation with respect to the external field H, the following relationship between current and field:

$$J_\mu(q,\omega) = K_{\mu\nu}(q,\omega)\, A^e_\nu(q,\omega), \qquad (3)$$

where

$$K_{\mu\nu}(x - x') = -i\theta(t - t')\mathrm{Sp}\{\rho_0[j_\mu(x), j_\nu(x')]\}, \qquad (2)$$

ρ_0 being the equilibrium density-matrix in the absence of the ex-

Card 1/7

27959
S/185/61/006/004/001/015
D274/D303

On the theory of electromagnetic...

ternal field, Ω - the thermodynamic potential, β - the reciprocal temperature, ζ - the chemical potential, N - the number-of-particles operator. Between the function $K_{\mu\nu}$ and Green's temperature function $\bar{K}_{\mu\nu}$, the following relationship is established

$$K_{\mu\nu}(q,\omega) = \bar{K}_{\mu\nu}(q,q_4)\ {}_{q_4 - i\omega - 0}, \qquad (5)$$

Further, one obtains

$$J_\mu(q,\omega) = P_{\mu\nu}(q,\omega)\, A_\nu(q,\omega), \qquad (9)$$

where P is the polarization operator and A is the total field, composed of the external field and the polarization field. Using Maxwell's equations, expressions for the electric and magnetic susceptibility are derived:

$$\varkappa(q,\omega) = \omega^{-2} P_l(q,\omega),$$
$$\chi(q,\omega) \equiv \frac{\tilde{\chi}(q,\omega)}{\mu(q,\omega)} = q^{-2}\{P_t(q,\omega) - P_l(q,\omega)\} \qquad (13)$$

Card 2/7

27959
S/185/61/006/004/001/015
D274/D303

On the theory of electromagnetic...

The poles of the components of the function $K_{\mu\nu}$ determine the eigenoscillations of the system; for an isotropic system, two types of such oscillations are found: longitudinal (plasma) oscillations, and transverse (electromagnetic). The dispersion relations of these oscillations are

$$\varepsilon(q, \omega), = 0, \tag{18}$$

and

$$\frac{q^2}{\mu(q, \omega)} - \omega^2 \varepsilon\,(q, \omega) = 0. \tag{19}$$

The energy dissipation of the external field is derived:

$$\bar{\mathscr{E}} = 2(2\pi)^{-3}\int dq \sum_{\omega=-\infty}^{\infty} \omega(N_\omega + 1)\times$$
$$\times\left\{|J_i^e(q, \omega)|^2 \operatorname{Im}\left[\frac{q^2}{\mu} - \omega^2\varepsilon\right]^{-1} + |J_i^e(q, \omega)|^2\omega^{-2}\operatorname{Im}(-\varepsilon)^{-1}\right\}, \tag{22}$$

and for the case of non-periodic field:

Card 3/7

27959
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D274/D303

On the theory of electromagnetic...

$$\Delta\mathcal{E} = 2(2\pi)^{-3}\int d\mathbf{q}\int_{-\infty}^{\infty} d\omega\cdot\omega(N_\omega + 1)\times$$
$$\times\left\{|J_i^e(\mathbf{q},\omega)|^2 \operatorname{Im}\left[\frac{q^2}{\mu} - \omega^2\varepsilon\right]^{-1} + |J_i^e(\mathbf{q},\omega)|^2\omega^{-2}\operatorname{Im}(-\varepsilon)^{-1}\right\}. \quad (23)$$

By means of Eq. (23) it is possible to determine the energy losses of a heavy, charged particle which passes through the system with velocity v.; in this case:

$$-\frac{dE}{dt} = \frac{2(ze)^2}{(2\pi)^3}\int d\mathbf{q}\int_{-\infty}^{\infty} d\omega\frac{\omega}{1 - e^{-\beta\omega}}\delta(\omega - \mathbf{q}\mathbf{v})\operatorname{Im}\frac{v^2 - [\varepsilon(\mathbf{q},\omega)\mu(\mathbf{q},\omega)]^{-1}}{\frac{q^2}{\mu(\mathbf{q},\omega)} - \omega^2\varepsilon(\mathbf{q},\omega)}. \quad (24)$$

Expressions for the electric and magnetic susceptibility of a relativistic plasma are derived. Further, the values of the suscepti-

Card 4/7

27959
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D274/D303

On the theory of electromagnetic...

bilities $\varkappa$ and χ are found for several limiting cases. Case a) the frequency ω is very small as compared to the mean momentum $\bar{p}$ of the plasma particles; then

$$\chi(0,\ 0) = \frac{e^2}{6\pi^2}\int_0^\infty \frac{dp}{\varepsilon_p} n_p. \tag{34}$$

At low temperatures:

$$\chi(0,\ 0) = \frac{e^2}{6\pi^2}\ln\frac{\zeta + \sqrt{\zeta^2 - m^2}}{m} \tag{35}$$

Eq. (34) was obtained (by the method of kinetic equation) by A.A. Rukhadze and V.P. Silin (Ref. 9: ZhTF, 38, 645, 1960). Case b) the frequency and wave vector are small in comparison to $\bar{p}$; expressions are derived for the real parts of $\varkappa$ and χ which are equivalent to those obtained by Silin; if thereby $\omega > q$, the imaginary parts vanish. Case c) $\omega = q$; then $\varkappa$ and χ are real quantities. Further, the effect of ions in the system is considered.

Card 5/7

27959
S/185/61/006/004/001/015
D274/D303

On the theory of electromagnetic...

that at low temperatures, the ions have a greater effect whereas at high temperatures their effect decreases. The expressions for the susceptibilities of a relativistic plasma, derived above, are the first terms of an expansion of $\varkappa$ and χ in series in powers of e^2 (e^2 being the scattering cross section of electrons or positrons). Such an expansion is valid (under certain conditions) for not too small ω and q, whereas for small values of ω and q it may not hold. Further, the dispersion relations of transverse (electromagnetic) oscillations of a relativistic plasma are derived (for the high-frequency range):

4

$$\omega^2 = q^2 + \frac{e^2}{\pi^2}\int_0^\infty \frac{p^2dp}{\varepsilon_p} n_p \qquad (44)$$

For longitudinal oscillations, an expression is derived for the case of ω and q small in relation to $\underline{p}$. Finally, the dispersion relations for homogeneous, non-relativistic, plasma oscillations are obtained. There are 13 references: 8 Soviet-bloc and 5 non-Soviet-bloc. The references to the English-language publications

Card 6/7

27959
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D274/D303

On the theory of electromagnetic...

read as follows: R. Kubo, J. Phys. Soc. Japan, 12, 570, 1957; H. Kanazawa, S. Misawa, E. Fujita, Prog. Theor. Phys., 23, 426, 1960; H. Kanazawa, N. Matsudaira, Prog. Theor. Phys., 23, 433, 1960.

ASSOCIATION: Fizyko-tekhnichnyy instytut AN USSR Kharkiv (Physicotechnical Institute AS UkrSSR Khar'kov)

SUBMITTED: December 7, 1960

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Card 7/7

22146

S/056/61/040/003/026/031
B112/B214

26.2340

AUTHOR: Akhiyezer, I. A.

TITLE: Theory of interaction of a charged particle with a plasma in a magnetic field

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 40, no. 3, 1961, 954-962

TEXT: The interaction of a nonrelativistic charged particle with an electron plasma in a constant homogeneous magnetic field $\vec{H}$ is investigated. The particles of mass M and momentum $\vec{p}$ traversing the plasma belong to energy levels $E_{\nu,p_z} = \eta(\nu+1/2)m/M + p_z^2/2M$, if $\eta = eH/mc$, the Larmor frequency of the plasma electron. The energy loss of the particle on traversing the plasma is calculated according to a method given by A. Akhiyezer and Faynberg (Ref. 1: Nuovo Cim., Suppl., 3, 591, 1956), and the following general expression is obtained:

Card 1/3

22146

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B112/B214

Theory of interaction of...

$$-\frac{d}{dt}E_{\nu,p_z} = \frac{2e^2m\eta}{(2\pi)^2}\sum_{\nu'}\int_{-\infty}^{\infty}\frac{\omega d\omega}{1-e^{-\beta\omega}}\int\frac{d\vec{k}}{k^2}\Lambda_{\nu\nu'}\left(\frac{k_t}{\sqrt{2m\eta}}\right)\times \mathrm{Im}\frac{\varkappa(\vec{k},\omega)}{1+\varkappa(\vec{k},\omega)}\,\delta(E_{\nu' p_z} - E_{\nu',p_z-k_z} - \omega),$$

where $\varkappa = \varepsilon-1$, ε the dielectric constant,

$\Lambda_{\nu\nu'}(a) = \int_0^{\infty} ds\, J_0(2a\sqrt{s})L_\nu(s)L_{\nu'}(s)e^{-s}$ (J_0 - Bessel function, L_ν - Laguerre polynomial), and $k_t^2 = k_x^2 + k_y^2$. This formula is specialized in different ways, and, among other things, a result is obtained which was also obtained by A. G. Sitenko and K. N. Stepanov (Ref. 3: Tr. fiz.-mat. fakulteta KhGU, 7, 5, 1958). Further, a formula for $\varkappa$ is derived:

$$\varkappa(\vec{k},\omega) = -\frac{2e^2m\eta}{(2\pi)^2}\frac{1}{k^2}\sum_{\nu,\nu'}\int_{-\infty}^{\infty}dp_z\Lambda_{\nu\nu'}\left(\frac{k_t}{\sqrt{2m\eta}}\right)\frac{n_{\nu p_z}-n_{\nu',p_z-k_z}}{\varepsilon_{\nu p_z}-\varepsilon_{\nu',p_z-k_z}-\omega-i\vartheta},$$

where $\varepsilon_{\nu,p_z} = \eta(\nu+1/2) + p_z^2/2m$, $n_{\nu,p_z} = \left[\exp\left\{\beta(\varepsilon_{\nu p_z}-\mu)\right\} + 1\right]^{-1}$. Here, β is the

Card 2/3

reciprocal temperature, μ the chemical potential, and ϑ the angle between $\vec{k}$ and $\vec{H}$. This expression is also specialized and the real and imaginary parts of $\varkappa$, that is, the frequency and the damping coefficient are calculated. The asymptotic behavior of $\Lambda_{\nu\nu'}(a)$ for $a \rightarrow 0$ is investigated in an appendix. A. I. Akhiyezer is thanked for the discussion of his results. There are 1 figure and 8 references: 6 Soviet-bloc and 2 non-Soviet-bloc.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Institute of Physics and Technology, Academy of Sciences, Ukrainskaya SSR)

SUBMITTED: October 27, 1960

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27204

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26.2311

AUTHORS: Akhiyezer, A. I., Akhiyezer, I. A., Sitenko, A. G.

TITLE: Contribution to the theory of plasma fluctuations

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 41, no. 2(8), 1961, 644-654

TEXT: This article deals with the theoretical determination of the spectral distributions and correlation functions of various fluctuating quantities, including the distribution function of particles, and also with the determination of the scattering cross sections of electromagnetic waves by plasma fluctuations without collisions. The authors study a free plasma and a plasma located in a constant homogeneous magnetic field. The possible difference between the electron and ion temperatures is taken into account. In accordance with the general theory (H. B. Callen, T. A. Welton, L. D. Landau, and Ye. M. Lifshits), fluctuations in a plasma that is in perfect statistical equilibrium can be investigated if the tensor of its dielectric constant is known. V. V. Tolmachev, S. V. Tyablikov, and Yu. L. Klimontovich determined equations for the spatial correlation

Card 1/9

27205

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Contribution to the theory of...

functions of particle systems undergoing electromagnetic interaction. V. D. Shafranov calculated the correlation functions of microcurrents from the equations of motion. F. G. Bass, M. I. Kaganov, and V. P. Silin investigated plasma fluctuations, taking spatial dispersion into consideration. The Fourier components of the correlators of charge transverse current density in a plasma read

$$\langle \rho^2 \rangle_{k\omega} = \frac{T}{2\pi}\frac{k^2}{\omega}\frac{\operatorname{Im}\varepsilon_l}{|\varepsilon_l|^2} = \frac{T(ak)^2}{4\sqrt{\pi}as}\frac{e^{-z^2}+\mu e^{-\mu^2 z^2}}{[1+(ak)^2-\varphi(z)-\varphi(\mu z)]^2+(\pi/4)z^2(e^{-z^2}+\mu e^{-\mu^2 z^2})^2},$$

$$\langle j_t^2 \rangle_{k\omega} = \frac{T}{2\pi}\omega(\eta^2-1)^2\frac{\operatorname{Im}\varepsilon_t}{|\eta^2-\varepsilon_t|^2} = \frac{T\omega}{\sqrt{\pi}}\left(\frac{\omega}{\Omega}\right)^2\frac{(1-\eta^2)^2 z e^{-z^2}}{[\omega^2(1-\eta^2)/\Omega^2-2\varphi(z)]^2+\pi z^2 e^{-2z^2}}. \qquad (4)$$

This indicates that at ka $\gtrsim 1$ low-frequency oscillations are the most important factor in fluctuation spectra of ϱ and $\vec{j}$. The correlation

Card 2/9

27204

function of the charge density reads

$$\langle \varrho(\vec{r}\,', t)\varrho(\vec{r}\,'', t)\rangle = 2e^2 n_0 \left[\delta(\vec{r}) - \frac{1}{4\pi a^2}\frac{e^{-r/a}}{r}\right], \quad \vec{r} = \vec{r}\,' - \vec{r}\,'' \qquad (7).$$

The spectral distributions of fluctuations of the electric and magnetic fields read:

$$\langle E^2\rangle_{k\omega} = \frac{8\pi T}{\omega}\left(\frac{\operatorname{Im}\varepsilon_l}{|\varepsilon_l|^2} + 2\frac{\operatorname{Im}\varepsilon_t}{|\eta^2 - \varepsilon_t|^2}\right),$$

$$\langle H^2\rangle_{k\omega} = \frac{16\pi T}{\omega}\eta^2\frac{\operatorname{Im}\varepsilon_t}{|\eta^2 - \varepsilon_t|^2}. \qquad (9)$$

respectively. The resulting correlation functions for the field strengths read:

$$\langle \vec{E}(\vec{r}\,', t)\,\vec{E}(\vec{r}\,'', t)\rangle = 8\pi T\left[\delta(\vec{r}) + \frac{1}{8\pi a^2}\frac{e^{-r/a}}{r}\right], \quad \langle \vec{H}(\vec{r}\,', t)\,\vec{H}(\vec{r}\,'', t)\rangle = 8\pi T\delta(\vec{r}) \quad (10).$$

The spectral distribution of fluctuations in an electron gas for

27204

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$T \ll mv_0^2/2$ (v_0 - limiting velocity) reads

$$\langle \rho^2 \rangle_{k\omega} = \frac{3}{4} \frac{\hbar \zeta k^2}{1 - e^{-\hbar\omega/T}} \left\{ \frac{1}{2} z \theta (1 - |z|) \left[\left(\zeta + 1 - \frac{z}{2} \ln \frac{1+z}{1-z} \right)^2 + \left(\frac{\pi z}{2} \right)^2 \right]^{-1} + \right.$$
$$\left. + \delta \left(\zeta + 1 - \frac{z}{2} \ln \left| \frac{z+1}{z-1} \right| \right) \operatorname{sign} z \right\}, \qquad (11)$$
$$\theta(z) = \begin{cases} 0, & z < 0 \\ 1, & z > 0 \end{cases},$$

where $z = \omega/kv_0$ and $\zeta = \dfrac{(kv_0/\Omega)^2}{3}$. The spectral distribution of charge-density fluctuations in a plasma in the high-frequency range reads

$$\boxed{\begin{aligned} \langle \rho^2 \rangle_{k\omega} = \frac{T}{4} \left(\frac{k\omega}{\Omega} \right)^2 \frac{(\omega^2 - \omega_H^2)^2}{\omega^4 \cos^2 \vartheta + (\omega^2 - \omega_H^2)^2 \sin^2 \vartheta} \times \\ \times (\delta(\omega - \omega_+) + \delta(\omega + \omega_+) + \delta(\omega - \omega_-) + \delta(\omega + \omega_-)). \end{aligned}} \qquad (14).$$

Then the authors determine the electron and ion density fluctuations separately. They also determine the fluctuations of the distribution functions for the plasma particles, the electron temperature T^e and the ion temperature T^i being assumed to differ. A non-isothermal plasma can be regarded as a quasi-equilibrium system, and the fluctuations occurring in it can be studied with the aid of fluctuation theory. The following expression is obtained for the Fourier components of electron and ion density fluctuations:

$$\delta n^e(\mathbf{k}, \omega) = i\frac{k}{\omega}\frac{1}{\varepsilon(k, \omega)}\left(Y^e_{k\omega}(1 + 4\pi\varkappa^i) + Y^i_{k\omega}4\pi\varkappa^e\right),$$
$$\delta n^i(\mathbf{k}, \omega) = i\frac{k}{\omega}\frac{1}{\varepsilon(k, \omega)}\left(Y^e_{k\omega}4\pi\varkappa^i + Y^i_{k\omega}(1 + 4\pi\varkappa^e)\right); \qquad (18),$$
$$Y^a_{k\omega} = \int\frac{\mathbf{kv}}{k}\left(\omega - \mathbf{kv} + \frac{i}{\tau^a}\right)^{-1}y^a(\mathbf{v}, \mathbf{k}, \omega)\,d\mathbf{v},$$

where $\varepsilon = 1 + 4\pi(\varkappa^e + \varkappa^i)$; $\varkappa^e$ and $\varkappa^i$ denote the electrical susceptibilities of electrons and ions respectively. From this the following expression is obtained for the spectral distribution of charge density fluctuations:

27204 S/056/61/041/002/026/028
B125/B138

Contribution to the theory of...

$\langle \rho^2 \rangle_{\vec{k}\omega} \equiv e^2 \langle |\delta n^e - \delta n^i|^2 \rangle_{\vec{k}\omega} = \frac{2k^2}{\omega|\varepsilon|^2} \mathrm{Im}\{T^e \varkappa^e + T^i \varkappa^i\}$. The correlators of the distribution functions are given by

$$\langle f^a(\mathrm{v}) f^b(\mathrm{v}') \rangle_{\mathbf{k}\omega} = 2\pi\delta_{ab} F_0^a(v)\,\delta(\mathrm{v}-\mathrm{v}')\,\delta(\omega - \mathbf{k}\mathrm{v}) \pm \pm 2\pi \cdot 4\pi e^2 k^{-2} F_0^a(v)\, F_0^b(v')\, S^{ab}(\mathrm{v},\mathrm{v}'), \qquad (22)$$

the upper (lower) sign indicates equal (different) particles. The authors then generalize the results obtained to the case where the plasma is located in a constant and homogeneous magnetic field $\vec{H}_0$. Then, the correlators of the fluctuations of electron density and magnetic field strength are given by

$$e^2 \langle |\delta n^e|^2 \rangle_{\mathbf{k}\omega} = \frac{k_i k_j}{\omega^2} \langle j_i^e j_j^e \rangle_{\mathbf{k}\omega},$$

$$\langle \delta H_i \delta H_j \rangle_{\mathbf{k}\omega} = \left(\frac{4\pi}{\omega}\right)^2 \frac{\eta^2}{(\eta^2-1)^2} e_{ilm} e_{jl'm'} k^{-2} k_l k_{l'} \langle j_m j_{m'} \rangle_{\mathbf{k}\omega}, \qquad (27)$$

$$e \langle \delta n^e \delta H_j \rangle_{\mathbf{k}\omega} = -\frac{4\pi i}{c\omega} \frac{\eta^2}{\eta^2 - 1} e_{jm'l} \frac{k_m k_{m'}}{k^2} \{\langle j_m^e j_l^e \rangle_{\mathbf{k}\omega} + \langle j_m^e j_l^i \rangle_{\mathbf{k}\omega}\}.$$

Card 6/9

where e... is a completely antisymmetric tensor of third rank. The scattering of electromagnetic waves by fluctuations in a free plasma is determined only by the electron density fluctuations. For a plasma located in a magnetic field $\vec{H}_0$, it is also necessary to take account of the fluctuations $\delta\vec{H}$ of the magnetic field. In the absence of a magnetic field, the differential scattering coefficient for an unpolarized wave reads

$$d\Sigma = \frac{1}{4\pi}\left(\frac{e^2}{mc^2}\right)^2\left(\frac{\omega}{\omega_0}\right)^2\sqrt{\frac{\varepsilon}{\varepsilon_0}}(1+\cos^2\theta)\,\langle|\delta n'|^2\rangle_{q\Delta\omega}\,do\,d\omega, \qquad (28)$$

where θ is the scattering angle, do is the element of the solid angle $\vec{k}$, $\varepsilon \equiv \varepsilon(\omega) = 1 - \Omega^2/\omega^2$, $\varepsilon_0 = \varepsilon(\omega_0)$. In this formula, the frequency can be changed arbitrarily. In the presence of a magnetic field, the expression

$$d\Sigma=\frac{1}{2\pi}\left(\frac{e^2}{mc^2}\right)^2\left(\frac{\omega_0\omega}{\Omega^2}\right)^2 R\left\{|\xi|^2<|\delta n^e|^2>_{q\Delta\omega}-\frac{en_0}{mc}\frac{\omega}{\Omega^2}\operatorname{Im}(\xi A_l\langle\delta n^e\delta H_l\rangle_{q\Delta\omega})+\right.$$

$$\left.+\frac{n_0}{4\pi mc^2}\frac{\omega^2}{\Omega^2}A_i^* A_l\langle\delta H_i\delta H_l\rangle_{q\Delta\omega}\right\}do\,d\omega, \qquad (29)$$

$$R=\eta^2\left\{\eta_0\left(|e_0|^2-\frac{|e_0k_0|^2}{k_0^2}\right)\varepsilon_{ij}e_i^*e_j^0\right\}^{-1},\quad \xi=(\varepsilon_{ij}^0-\delta_{ij})e_i^*e_j^0,$$

$$A_l=(\varepsilon_{kl}-\delta_{kl})e_k^*e_{lml}(\varepsilon_{mj}^0-\delta_{mj})e_j^0,$$

holds instead of (28), where $\vec{e}$ is the polarization vector of the scattered wave. At equal temperatures of electrons and ions, the spectrum of scattered radiation, in the absence of a magnetic field, consists of a line broadened by the Doppler effect ($\Delta\omega\lesssim qs$) and sharp maxima at $\Delta\omega=\pm\Omega$, if $aq\ll 1$. For $\Delta\omega\gg qs_e$ there occurs only scattering by Langmuir oscillations. In the most interesting case $\Delta\omega/qs_i\gg\ln(T^e/T^i)$, the following equation holds for $\Delta\omega/qs_i\gg\ln(T^e/T^i)$ and $\Delta\omega\sim\omega_s(q)$:

$$d\Sigma=\frac{e^2k_e^4T^e(1+\cos^2\theta)}{16\pi(mc^2)^2(k_e^2+q^2)}\left\{\delta\left(\Delta\omega-\omega_s(q)\right)+\delta\left(\Delta\omega+\omega_s(q)\right)\right\} \qquad (33).$$

27204

S/056/61/041/002/026/028
B125/B138

Contribution to the theory of...

For $\omega_0 \gg \omega_+$ and $T^e = T^i$ and $(\Delta\omega)_{eff} \ll \omega_0 \sin\theta$, the integral scattering coefficient reads

$$d\sum = \frac{n_0}{4}\left(\frac{e^2}{mc^2}\right)^2 \left(\frac{\omega_0}{\Omega}\right)^4 (R|f|^2)_{\omega=\omega_0} \frac{1+2(aq)^2}{1+(aq)^2}\, do \qquad (35).$$

There are 25 references: 19 Soviet and 6 non-Soviet. The two most recent references to English-language publications read as follows: E. E. Salpeter. Phys. Rev., 120, 1528, 1960; J. P. Dougherty, D. T. Farley. Proc. Roy. Soc., A 259, 79, 1960.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physicotechnical Institute of the Academy of Sciences Ukrainskaya SSR). Khar'kovskiy gosudarstvennyy universitet (Khar'kov State University)

SUBMITTED: March 30, 1961

Card 9/9

AKHIYEZER, I.A.; BAR'YAKHTAR, V.G.; PELETMINSKIY, S.V.

Theory of high frequency magnetic susceptibility of ferrodielectrics at low temperatures. Zhur. eksp. i teor. fiz. 49 no.1:365-374 Ja '61. (MIRA 14:6)

1. Fiziko-tekhnicheskiy institut AN Ukrainskoy SSR.
(Dielelectrics--Magnetic properties)

34651
S/056/62/042/002/040/055
B108/B104

24.6714

AUTHOR: Akhiyezer, I. A.

TITLE: Development of fluctuations in a plasma with unstable distribution function

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 2, 1962, 584 - 591

TEXT: The unstable fluctuations (increasing with time) arising in a plasma when a beam of charged particles passes through are studied. The expectation values of the fluctuation amplitudes are determined and from them the author comes to the correlation functions (in particular, mean square amplitudes) for the different physical quantities (electrical field, charge density, density and velocity of the beam). These correlation functions and square fluctuation amplitudes involve terms which with time increase in proportion with $N_B^{1/2} \exp(N_B^{1/2})$. N_B is the electron density in the beam. If the velocity of the beam particles is great as compared with the mean thermal velocity of the plasma electron: resonance will occur between the beam-in-

Card 1/2

S/056/62/043/006/042/067
B183/B102

AUTHORS: Akhiyezer, A. I., Akhiyezer, I. A.

TITLE: Coexistence of superconductivity and ferromagnetism

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 43, no. 6(12), 1962, 2208 - 2216

TEXT: Contrary to the assumption that nonsuperconducting ferromagnetic regions separated by superconducting intermediate layers exist in solid solutions of ferromagnetic metals in superconductors (B. Matthias, H. Suhl, Phys. Rev. Lett., 4, 51, 1960), it is shown here from theoretical studies that superconductivity and ferromagnetism may, in principle, coexist in the same spatial regions. The Cooper problem (J. Bardeen, L. Cooper, J. Schrieffer, Phys. Rev., 106, 162, 1957) is investigated taking account of the interaction between the conduction electrons via phonon and spin-wave exchange. The interaction energy due to emission and absorption of spin waves is calculated. This depends mainly on the orientation of the s-electron spin. Starting from the Schrödinger equation for the wave function of the Cooper problem the potentials for the exchange of spin waves and phonons between the electrons are derived. Then the relationship

Card 1/2

Coexistence of superconductivity... S/056/62/043/006/042/067
B183/B102

between the forbidden-band width and the Curie temperature is formulated mathematically. The following was found for the spin wave exchange between the electrons: If pairing occurs in the singlet state the forbidden-band width decreases with increasing Curie temperature; but if it occurs in the triplet state with the spin projections ± 1 the forbidden-band width does not depend on the Curie temperature. In solid solutions of ferromagnetic metals, the Curie temperature increases with increasing concentration of the ferromagnetic component while the Debye temperature is almost independent of the concentration. Thus, with small concentrations of the ferromagnetic component, the critical temperature increases with increasing concentration whereas in the case of high concentrations it decreases with increasing concentration, irrespective of the spin state of the interacting electrons. There are 2 figures. ✓

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physicotechnical Institute of the Academy of Sciences Ukrainskaya SSR)

SUBMITTED: July 2, 1962

Card 2/2

S/056/63/044/002/045/065
B111/B186

AUTHOR: Akhiyezer, I. A.

TITLE: Bounds imposed on the Regge trajectory by maximum analyticity

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 44, no. 2, 1963, 697 - 702

TEXT: The course of the Boson-Regge trajectory $\alpha(t)$ is known for slightly negative t values from πN and NN scattering experiments. The author extrapolates this trajectory into the range of positive and highly negative t values. $\alpha(t)$ is assumed to have "maximum analyticity", i.e., it is expressed by

$$\alpha(t) = \frac{1}{\pi}\int_1^\infty \frac{\tilde{\alpha}(t')\,dt'}{t'-t}, \quad \tilde{\alpha}(t') > 0, \quad (1)$$

or

$$\alpha(t) = \alpha(t_1) + \frac{t-t_1}{\pi}\int_1^\infty \frac{\tilde{\alpha}(t')\,dt'}{(t'-t)(t'-t_1)}, \quad \tilde{\alpha}(t') > 0 \quad (2).$$

The bounds for the possible course of $\alpha(t)$ which result from the analytical properties (1) or (2) are derived under the assumption that the values of the function $\alpha(t)$

Card 1/4

S/056/63/044/002/045/065
B111/B186

Bounds imposed on the ...

and its derivative $\alpha'(t)$ are known at any point $t_1 < 1$ (1 is the value of the threshold energy). For $t < 1$, $\alpha(t) > 0$ and is an R function. If $\alpha(t)$ is given by (1) then the following inequality is valid:

$$\max\{0; \alpha(t_1) + \alpha'(t_1)(t - t_1)\} \leqslant \alpha(t) \leqslant \alpha(t_1) + \alpha'(t_1)(t - t_1)(1 - t_1)/(1 - t), \quad (4).$$

The region of the (α, t) plane where the trajectory may lie is marked by dashed lines in (Fig. 1) and is bounded by the curves B_1: $\alpha = \alpha(t_1) + \alpha'(t_1)(t - t_1)$ and B_2: $\alpha = \alpha(t_1) + \alpha'(t_1)(t - t_1)(1 - t_1)/(1 - t)$. At high energies $\sqrt{s}$, the decrease of the scattering amplitude with increasing scattering angle θ is bounded by

$$\max\{s^{-\alpha(0)}; s^{\varphi_1(s, \cos\theta)}\} \leqslant A(s, \cos\theta)/A(s, 1) \leqslant s^{\varphi_2(s, \cos\theta)},$$

$$\varphi_1 = -{}^1/_2\alpha'(0) \cdot s(1 - \cos\theta),$$

$$\varphi_2 = -\alpha'(0)\, s(1 - \cos\theta)\,[2 + s(1 - \cos\theta)]^{-1}. \quad (5),$$

which also follows from (4). One can also derive the smallest possible mass m of a particle with spin 1 belonging to the given trajectory:

$$|m(1)|^2 \geqslant 1 - \frac{\alpha'(t_1)(1 - t_1)^2}{1 + \alpha'(t_1)(1 - t_1) - \alpha(t_1)} \quad (t_1 \leqslant 0) \quad (6).$$

If $\alpha(t)$ is given by (2)

and if t_2 is arbitrary but smaller than 1, then the formulas

$$\max\{0; g_1 + g_2(t - t_1)\} \leqslant \frac{\alpha(t) - \alpha(t_2)}{t - t_2} \leqslant g_1 + g_2(t - t_1)\frac{1 - t_1}{1 - t} .$$

where

$$g_1 = \frac{\alpha(t_2) - \alpha(t_1)}{t_2 - t_1} \geqslant 0, \qquad g_2 = \frac{\alpha(t_2) - \alpha(t_1) - \alpha'(t_1)(t_2 - t_1)}{(t_2 - t_1)^2} \geqslant 0. \tag{7}$$

$$s^{\varphi_3(s, \cos\theta)} \leqslant A(s, \cos\theta)/A(s, 1) \leqslant s^{\varphi_4(s, \cos\theta)},$$

$$\varphi_3 = -\tfrac{1}{2}\alpha'(0)\,s(1 - \cos\theta) + \tfrac{1}{4}\alpha''(0)\,s^2(1 - \cos\theta)^2[2 + s(1 - \cos\theta)]^{-1},$$

$$\varphi_4 = \min\{-\tfrac{1}{2}\alpha'(0)\,s(1 - \cos\theta) + \tfrac{1}{8}\alpha''(0)\,s^2(1 - \cos\theta)^2, \; -\tfrac{1}{2}[\alpha'(0)]^2[\alpha''(0)]^{-1}\}. \tag{9}$$

$$\alpha(t_1) + \alpha'(t_1)(m^2_{min} - t_1) + \tfrac{1}{2}\alpha''(t_1)(1 - t_1)(m^2_{min} - t_1)^2/(1 - m^2_{min}) = t \quad (t_1 \leqslant 0) \tag{10}$$

and Fig. (2) are obtained in analogy to (4), (5), (6) and Fig. 1. $\alpha''(t)$ is the second derivative of $\alpha(t)$. There are 2 figures.

S/056/63/044/002/045/065
B111/B186

Bounds imposed on the ...

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physicotechnical Institute of the Academy of Sciences Ukrainskaya SSR)

SUBMITTED: September 9, 1962.

Fig. 1.

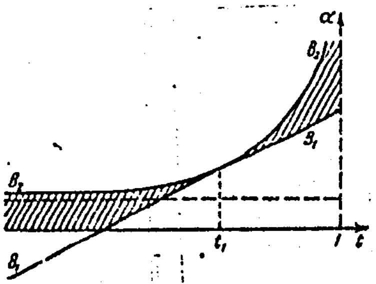
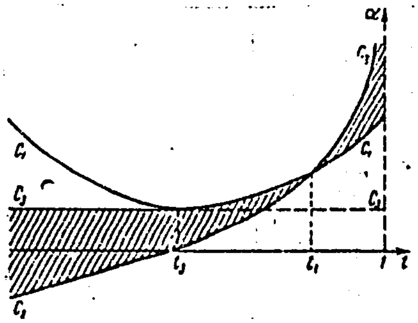


Fig. 2.



Card 4/4

AKHIYEZER, A.I.; AKHIYEZER, I.A.

On the coexistence of superconductivity and ferromagnetism.
Zhur.eksp.i teor.fiz. 43 no.6:2208-2216 D '62. (MIRA 16:1)

1. Fiziko-tekhnicheskiy institut AN Ukrainskoy SSR.
(Superconductivity) (Ferromagnetism)

L 17347-63 EWT(1)/BDS/FCC(w) AFFTC/ASD/IJP(C)
ACCESSION NR: AP3006812 S/0185/63/008/008/0813/0820

55
58

AUTHOR: Akhiyezer, I. O.

TITLE: Collective oscillations in a mixture of Fermi and Bose liquids

SOURCE: Ukrayins'ky*y fizy*chny*y zhurnal, v. 8, no. 8, 1963, 813-820

TOPIC TAGS: Fermi liquid, Bose liquid, zero sound, Bose Fermi liquid, collective oscillations, boson, fermion

ABSTRACT: Collective oscillations in a mixture of Fermi and Bose liquids were investigated by a method analogous to that used by Landau to prove the existence of zero sound in the Fermi liquid. It is shown that the oscillations of modified zero sound can be propagated in a mixture of the two liquids. With small concentrations of the Bose liquid in the mixture, the modified zero sound becomes a zero sound, and with small concentrations of the Fermi

Card 1/3 2

L 17347-63

ACCESSION NR: AP3006812

2

liquid it becomes Bose liquid phonons. Dispersion formulas are derived for the oscillations in a simple case. Depending on the relationship between the quantities characterizing the mixture, either one or two types of oscillations of modified zero sound are possible. Namely, oscillations are always possible in the mixture when oscillation velocity is greater than the maximum cutoff velocity of ferminons and greater than the velocity of sound in a Bose liquid, the density of which is equal to the boson density in the mixture. In addition, if the forces between the same kind of particles are stronger than the forces between different types of particles, a second type of oscillations can also occur with the velocity of fermions. It was also established that oscillations of fermion spins (spin sound) can also take place in the mixture. An interpretation of modified zero sound as oscillations in a system of quasi-particles interacting through a self-consistent field is given. "In conclusion I wish to thank E. M. Lifshits and O. O. Vedenov for valuable discussions." Orig. art. has: 2 figures and 17 formulas.

ASSOCIATION: Fizy*ko-tekhnichny*y insty*tut AN URSR, Khar'kov (Physicotechnical Institute, AN URSR

Card 2/~~3~~2

L 17155-63 EPR/EWT(d)/EPF(c)/EWT(l)/EPF(n)-2/BDS AFFTC/ASD/
IJP(C)/SSD Ps-4/Pr-4/Pu-4 GG/WW
ACCESSION NR: AP3006813 S/0185/63/008/008/0821/0829

76
73

AUTHOR: Akhiyezer, I. O.

TITLE: Amplification of collective oscillations in quantum liquids

SOURCE: Ukrains'ky*y fizy*chny*y zhurnal, v. 8, no. 8, 1963, 821-829

TOPIC TAGS: quantum liquid, Fermi liquid, Bose liquid, collective oscillation, zero sound, roton, phonon, quantum liquid experiment, collective oscillation amplification

ABSTRACT: The possibility of amplifying collective oscillations in quantum liquids (zero sound in Fermi liquids, rotons and phonons in Bose liquids) using beams of particles with a beam velocity greater than the phase velocity of particle oscillations is studied theoretically. A detailed analysis is presented for the case when the particles in a beam generate coherent oscillations. In such a case the increment of the increase in oscillations is especially large and is equal to $N^{1/3}$, where N is the flux density. It is noted that, if the beam consists of charged particles, amplification of collective oscillations is impossible at high density. The

Card 1/2

L 17155-63

ACCESSION NR: AP3006813

3

possibility of amplifying oscillations in He^3 and He II is considered. It is established that the most favorable experiments would be those using ion beams in He II. The problem of observing amplified oscillations from the spectral and angular distribution of scattered neutrons and of scattered light is discussed. "The author thanks O. I. Akhiyezer for valuable suggestions and V. G. Bar'yakhtar for discussion." Orig. art. has: 19 formulas.

ASSOCIATION: Fizy*ko-tekhnichny*y insty*tut AN URSR, Khar'kov (Physicotechnical Institute, AN URSR)

SUBMITTED: 14Jan63 DATE ACQ: 30Sep63 ENCL: 00

SUB CODE: PH NO REF SOV: 009 OTHER: 007

Card 2/2

L 18654-63 EWT(1)/BDS/EEC(b)-2/ES(w)-2 AFFTC/ASD/ESD-3/AFWL/IJP(C)/ SSD Pab-4/Pi-4/Po-4

ACCESSION NR: AP3005503 S/0057/63/033/008/0935/0942

75

73

AUTHOR: Akhiyezer, I. A.

TITLE: On the reflection theory of electromagnetic waves from plasma 21

SOURCE: Zhurnal tekhnicheskoy fiziki, v. 33, no. 8, 1963, 935-942

TOPIC TAGS: incoherent reflection, electromagnetic-wave reflection, plasma reflection, incoherent electromagnetic-wave reflection, reflected-radiation spectrum

ABSTRACT: The incoherent reflection of EM waves from a semi-infinite plasma has been theoretically investigated for a case when the plasma fluctuations, which cause the reflection angle and frequency of reflected waves to differ from the incidence angle and frequency of incident waves, are taken into account. The investigation shows that at sufficiently small damping of incident and/or reflected waves the spectrum of reflected radiation consists of 1) Doppler broadening of the principal line and 2) sharp peaks associated with possible propagation of collective oscillations in plasma. Consideration of the

Card 1/2

L 18654-63
ACCESSION NR: AP3005503 2

boundary leads to a substantial difference between the reflection and dispersion coefficients when the frequency of the incident or reflected wave is of the same order of magnitude as the plasma frequency. The difference exists for all frequencies in the case of glancing incidence or reflection. "In conclusion, I wish to express my gratitude to F. G. Bass for valuable suggestions and discussion." Orig. art. has: 26 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR, Khar'kov (Physicotechnical Institute, AN SSSR)

SUBMITTED: 12Jul62	DATE ACQ: 06Sep63	ENCL: 00
SUB CODE: PH	NO REF SOV: 004	OTHER: 003

Card 2/2

AKHIYEZER, I.A.

Restrictions imposed on the variation of the Regge trajectory by maximum analyticity. Zhur. eksp. i teor. fiz. 44 no.2: 697-702 F '63. (MIRA 16:7)

1. Fiziko-tekhnicheskiy institut AN UkrSSR.

S/0056/64/046/001/0300/0306

ACCESSION NR: AP4012558

AUTHORS: Akhiyezer, I. A.; Daneliya, I. A.; Tsintsadze, N. L.

TITLE: Contribution to the theory of conversion and scattering of electromagnetic waves in a nonequilibrium plasma

SOURCE: Zhurnal eksper. i teoret. fiz., v. 46, no. 1, 1964, 300-306

TOPIC TAGS: plasma, nonequilibrium plasma, nearly unstable plasma, electromagnetic wave scattering, electromagnetic wave conversion, spontaneous emission in plasma, plasma fluctuation waves, plasma external waves, critical plasma fluctuation, nonlinear wave interaction, Doppler scattering

ABSTRACT: The conversion and scattering of electromagnetic waves in a nearly unstable plasma are investigated, with principal emphasis on wave scattering and conversion in which the intensity of the produced radiation becomes anomalously large by virtue of the existence

ACCESSION NR: AP4012558

of critical fluctuations. The spontaneous emission caused by the scattering of an external longitudinal wave by critical plasma fluctuations and by the transformation of such a wave into a transverse wave is also included. Two cases of nonlinear wave interactions are considered, the passage of a plasma with hot electrons through cold ions and the passage of a fast charged-particle beam through a plasma. The spontaneous emission caused by the conversion of fluctuating longitudinal wave. Only Doppler scattering is included in the analysis of induced scattering of waves by particles." In conclusion we wish to thank A. I. Akhiyezer, V. P. Silin, and A. A. Rukhadze for valuable discussions." Orig. art. has: 30 formulas.

ASSOCIATION: None

SUBMITTED: 21Jun61 DATE ACQ: 26Feb64 ENCL: 00

SUB CODE: PH NO REF SOV: 004 OTHER: 003

Card 2/2

ACCESSION NR: AP4031154 S/0056/64/046/004/1331/1334

AUTHORS: Akhiyezer, I. A.; Bolotin, Yu. L.

TITLE: On the theory of interactions between charged particles and a nonequilibrium plasma

SOURCE: Zh. eksper. i teor. fiz., v. 46, no. 4, 1964, 1331-1334

TOPIC TAGS: plasma stability, charged particle, plasma oscillation, correlation technique

ABSTRACT: In view of the possibility of anomalously large fluctuations arising in an almost unstable nonequilibrium plasma, which can lead to an anomalously large cross section for the scattering of light in such a plasma and to anomalously large coefficients for the scattering of longitudinal waves and conversion of such waves into transverse waves, the authors investigate the interaction between charge particles in a nonequilibrium plasma consisting of hot elec-

Card 1/3

ACCESSION NR: AP4031154

trons moving with respect to cold ions. The analysis is confined to linear theory and no attempt is made to find any limitation on the growth of the critical fluctuations or to determine their ultimate amplitude. The energy lost by a particle interacting with the plasma traversed by a compensated beam of charge particles is also considered. A difference is found to exist in the structure of the expressions for the particle energy loss due to excitation of Langmuir oscillations when $\theta_0 \sim 1$ and $\theta_0 << 1$ (θ_0 is the angle between the particle and beam velocities) is explained. It is shown that the particle loss due to the excitation of plasma oscillations become anomalously large as the plasma approaches an unstable state. "In conclusion we wish to thank A. I. Akhiyezer, A. A. Vedenov, and K. N. Stepanov for valuable discussions." Orig. art. has: 10 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physicotechnical Institute, Academy of Sciences UkrSSR)

ACCESSION NR: AP4031154

SUBMITTED: 16Sep63
DATE ACQ: 07May64
ENCL: 00

SUB CODE: ME, EM
NR REF SOV: 003
OTHER: 002

S/2781/63/000/003/0081/0091

ACCESSION NR: AT4036044

AUTHOR: Akhiyezer, I. A.

TITLE: Contribution to the theory of reflection of electromagnetic waves from a plasma

SOURCE: Konferentsiya po fizike plazmy* i problemam upravlyayemogo termoyadernogo sinteza. 3d, Khar'kov, 1962. Fizika plazmy* i problemy* upravlyayemogo termoyadernogo sinteza (Plasma physics and problems of a controlled thermonuclear synthesis); doklady* konferentsii, no. 3. Kiev, Izd-vo AN UkrSSR, 1963, 81-91

TOPIC TAGS: plasma research, plasma reflection, plasma electromagnetic property, electromagnetic wave reflection, microwave plasma

ABSTRACT: Unlike the customary theoretical analysis of incoherent reflection of electromagnetic waves from a plasma, where the analysis is limited to the solution of the problem of the scattering by an

Card 1/3

ACCESSION NR: AT4036044

infinite plasma, in the present paper the coefficient of incoherent reflection of electromagnetic waves from the plasma is determined with allowance for the boundary. Allowance is made for the plasma fluctuations which cause the reflection angle and the frequency of the reflected waves to differ from the incidence angle and the frequency of the incident wave. In the case of sufficiently small damping of the incident or reflected wave (but not necessarily both), the spectrum of the reflected radiation consists of the Doppler broadening of the fundamental line and sharp peaks connected with the possibility of the propagation of collective oscillations in the plasma (Langmuir oscillations, and in the case of strong non-isothermy also sound oscillations). Conditions are obtained under which the coefficient of reflection of the electromagnetic waves from the plasma coincides (apart from a normalization factor) with the scattering coefficient in an unbounded plasma. Allowance for the plasma boundary leads to an appreciable difference between the reflection coefficient and the scattering coefficient if the fre-

ACCESSION NR: AT4036044

quency of the incident or reflected wave is equal in order of magnitude to the plasma frequency, and also for all frequencies in the case of glancing incidence or reflection. "In conclusion I am grateful to F. G. Bass for valuable remarks and a discussion." Orig. art. has: 26 formulas.

ASSOCIATION: None

SUBMITTED: 00 DATE ACQ: 21May64 ENCL: 00

SUB CODE: ME NR REF SOV: 003 OTHER: 003

Card 3/3

L 1593-66 EWT(1)/EPF(n)-2/EWG(m)/EPA(w)-2 IJP(c) AT

AM5007590

BOOK EXPLOITATION

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533.9

76
B+1

44,55 44,55 44,55 44,55 44,55

Akhiyezer, A. I.; Akhiyezer, I. A.; Polovin, R. V.; Sitenko, A. G.; Stepanov, K. N.

21,44,55

Collective oscillations in plasma (Kollektivnyye kolebaniya v plazme) Moscow, Atomizdat, 1964. 0162 p. illus., biblio. 3,700 copies printed.

TOPIC TAGS: plasma physics, plasma oscillation, charged particle, magnetic field plasma stability,,particle distribution, particle scatter

PURPOSE AND COVERAGE: This book is a presentation of the theory of linear oscillations in "Collisiouless" plasma in which paired collisious do not exert significant influence on its oscillations properties. Three basic problems are presented in the book: natural oscillations spectra, stability and instability of various particle distributions, and fluctuations in homogeneous plasma. The book will be of interest to scientists working in the fields of physical and technological problems such as: diffusion of radio waves in the ionosphere and other plasmas, stellar radioemission, microrediowave amplification and generation with the aid of plasma, acceleration of charged particles in plasma, relaxation in plasma, plasma diagnosis, etc.

L 1593-66
AM5007590

0

TABLE OF CONTENTS (abridged):

SUBMITTED: 26Sep64

SUB CODE: ME, NP

OTHER: 045

NR REF SOV: 100

L 11068-65 EWT(l)/EWG(k)/EPA(sp)-2/EPA(w)-2/EEC(t)/T/EEC(b)-2/EWA(m)-2 Pi-4/ [illegible]

[illegible] AP [illegible] S/0056/64/047/003/0952/0957

[illegible] 4041 [illegible]

AUTHORS: Akhiyezer, I. A.

[illegible] to the theory of nonlinear motions of a nonequilibrium plasma

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 47, no. 3, 1964, 952-957

[illegible] equilibrium plasma, plasma wave propagation, plasma electron temperature, plasma ion temperature

ABSTRACT: By investigating the propagation of simple waves in a [illegible] plasma with the aid of the kinetic equation, without [illegible] the author [illegible] finite amplitude when the plasma consists of [illegible] By [illegible] plasma [illegible]

Card 1/3

L 11068-65
ACCESSION NR: AP4046412

2

namic equations, except that the number of hydrodynamic quantities is no longer finite. These equations are employed further to investigate simple waves in the nonequilibrium plasma. It is shown that depending on the character of the initial electron velocity [illegible] (for multi-[illegible] distribution) four cases are possible: [illegible] streaming) in compression regions [illegible] waves [illegible] discontinuities (or multistream [illegible] simple waves [illegible] regions with self-similar compression [illegible] for which no discontinuities that are not [illegible] in their motion [illegible] compression [illegible] appear [illegible] discontinuities [illegible] and rarefaction regions, for which [illegible] value. The uniform ex-[illegible] larger (or smaller) than some critical [illegible] electrons and [illegible] contraction of a plasma [illegible] thank F. V. [illegible] is also treated. "In conclusion [illegible] and K. N. Stepanov for valuable [illegible]" Orig. art. has: 9 formulas.

ACCESSION NR: AP4046412

ASSOCIATION: Fiziko-tekhnicheskiy [illegible] Akademii nauk Ukrainskoy [illegible] (Physicotechnical Institute, Academy of Sciences, Ukrainian SSR)

ENCL: 0[illegible]

SUBMITTED: 05Mar64

OTHER: 00[illegible]

NR REF SOV: [illegible]

SUB CODE: ME

L 22746-65 SSD IJP(c) AT
Pz-6/Pab-10

[illegible] 5006/2260/2275

[illegible]

[illegible]

[illegible] fluctuation,

TOPIC TAGS: plasma turbulence, [illegible]
[illegible] fluctuation, fluctuation amplitude, [illegible]

ABSTRACT: The possible pectral distribution of stationary fluctuations that can [illegible] determined with a greater degree of accuracy than in earlier [illegible] 2224, 1962;

Ietvlashvili, DAN SSSR [illegible] exceeding that unbounded plasma. A collisionless plasma [illegible] background of cold ions [illegible] trons drifting through a background of cold ions [illegible] stationary distributions of [illegible] It is shown that stationary distributions of two-temperature sound (s). It is shown that in an unbounded plasma fluctuations exist in the long-wave region only, and that in an unbounded plasma the amplitude of the stationary fluctuations in the scalar potential increases

Card 1/2

[illegible] EWA(m)-2 Pz-6/

[illegible] /0677

[illegible]

TITLE: [illegible]

[illegible] 667-677

[illegible] ity, plasma electron oscillation, plasma ion [illegible] particle motion, turbulent plasma, acoustic wave

Card 1/3

3

L 14[illegible]-65
ACCESSION NR: AP4043645

a smooth variation and a large value near the stability boundary [illegible] the interaction between the part[illegible] the plasma can [illegible] the detailed [illegible]

[illegible] of the [illegible] particular [illegible]

[illegible] the particle [illegible] as function [illegible] fluctuations determines [illegible] momentum of the [illegible]

[illegible] for valuable discussions. [illegible]

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physicotechnical Institute, Academy of Sciences UkrSSR)

L 14027-65
ACCESSION NR: AP4043645

ENCL: 00

SUBMITTED: 29Feb64

OTHER: 003

L 1586-66 EWT(1)/ETC/EWG(m)/EPF(n)-2/EPA(w)-2 IJP(c) AT

ACCESSION NR: AP5015433 44, 55 UR/0185/65/010/006/0581/0585 57

51/B

AUTHOR: Akhiyezer, I. O. (Akhiyezer, I. A.)

TITLE: Interaction of charged particles with a turbulent plasma in a magnetic field 21,44,55

SOURCE: Ukrayins'kyy fizychnyy zhurnal, v. 10, no. 6, 1965, 581-585

TOPIC TAGS: turbulent plasma, plasma interaction, plasma electron temperature, plasma magnetic field

ABSTRACT: The author considers the interaction of charged particles with a turbulent plasma in a magnetic field. The palsma is assumed to consist of cold ions and hot electrons moving through the magnetic field with a velocity exceeding the velocity of sound. The energy transferred by the particle to the plasma per unit time is determined. The dependence of the energy transferred per unit time on the velocity of the particles is shown to be unaffected by the details of the turbulence spectrum. In not very strong magnetic fields energy transfer is especially large if the angle between the velocity and the magnetic

Card 1/2

L 1586-66
ACCESSION NR: AP5015433

6

field lies within the interval (θ_+, θ_-) given by

$$\theta = \cos^{-1}\left\{(uv)^{-1}[s^2 \pm (v^2 - s^2)^{1/2}(u^2 - s^2)^{1/2}]\right\}.$$

For θ inside this interval the energy transfer is proportional to the effective temperature of turbulent fluctuations T*. For θ at the boundaries of this interval the energy transfer is proportional to $T^{*3/2}$ or to T^{*2}. In very strong magnetic fields the energy transfer is proportional to T*. In both cases the energy of the particle decreases or increases if θ is below or above a certain critical angle respectively. 'In conclusion I express my gratitude to K. M. Stepanov 44,55 for useful discussions.' Orig. art. has: 14 formulas.

ASSOCIATION: Fizyko-tekhnichnyy instytut AN URSR, Kharkiv [Fiziko-tekhnicheskiy institut AN UkrSSR, Khar'kov (Physicotechnical Institute, AN UkrSSR) 44,55

SUBMITTED: 18Aug64 ENCL: 00 SUB CODE: ME, EM

NR REF SOV: 005 OTHER: 001

Card 2/2 KP

L 8294-66 EWT(1)/ETC/EPF(n)-2/EWG(m) IJP(c) AT

ACC NR: AP5028919 SOURCE CODE: UR/0185/65/010/011/1161/1167

44,55 44,55

67

B

AUTHOR: Akhiyezer, I. O. -- Akhiyezer, I. A.

ORG: Physicotechnical Institute, AN UkrSSR (Fizyko-tekhnichnyy instytut AN UkrSSR)

TITLE: The fluctuations and scattering of particles in a turbulent plasma

SOURCE: Ukrayins'kyy fizychnyy zhurnal, v. 10, no. 11, 1965, 1161-1167

21,44,55

TOPIC TAGS: turbulent plasma, electron plasma, ionized plasma, ion interaction, plasma interaction, particle interaction, particle scatter

ABSTRACT: An investigation was made of a stationary distribution of the turbulent fluctuations in a plasma consisting of cold ions and hot electrons moving with respect to the ions at a velocity u exceeding the velocity of sound s. The case of a low supercriticality $1 - s/u \ll 1$ was considered. It was found that at some definite values of the wave vector almost all the turbulent waves propagate inside a narrow cone around the direction u, the angle of aperture of this cone being much smaller than the Cerenkov angle. At some other values of the wave vector almost all turbulent waves propagate along the surface of the Cerenkov cone. From an investigation of the interaction of charged particles with a turbulent plasma it was found that the intensity of interaction is determined by the level of fluctuations in the plasma. The dependence of the change in the energy of the particle per unit time on the magnitude

Card 1/2

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AKHIYEZER, A. I.

[illegible]

waves that can be established in a plasma [illegible] with a velocity that exceeds the [illegible] trons which move with respect to the ions [illegible] the time-independent distribution [illegible] shown that in addition to the time-independent [illegible] of stationary [illegible] fluctuations due to the random [illegible] excitation is possible, namely [illegible] of the random waves in a [illegible]

L 47366-65

ACCESSION NR: AP5008752

cular distribution varies periodically. The deduction is based on obtaining self- [illegible] solutions for the differential eq[illegible] are s[illegible] [illegible] and analyzing the asymptot[illegible] [illegible] formula

[illegible] Fiziko-tekhnicheskiy inst[illegible] (Physico-[illegible] Institute, Academy of Sciences [illegible])

SUBMITTED: [illegible] ENCL: [illegible] SUB CODE: NP

NO REF SOV: [illegible] OTHER: [illegible]

Card 2/2

[illegible]

ACCESSION NR: [illegible]

AUTHOR: Akhiyezer, I. A.

TITLE: Scattering and transformation of electromagnetic waves in a turbulent plasma

SOURCE: Zhurnal eksperimental'noy [illegible]

[illegible]

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Longitudinal [illegible] acoustic waves is studied. It is shown that [illegible] scattering can be used for plasma diagnostics and to verify certain theoretical [illegible] spontaneous emission from [illegible] due to [illegible] waves is a [illegible]

[illegible] Academy [illegible]

L 08812-67 EWT(l) IJP(c) AT/GD (N) SOURCE CODE: UR/0000/65/000/000/0059/0062
ACC NR: AT6020436

43

AUTHOR: Akhiyezer, I. A.

ORG: none

TITLE: "Pulsating" distributions of turbulent sound waves in plasma

SOURCE: AN UkrSSR. Vzaimodeystviye puchkov zaryazhennykh chastits s plazmoy (Interaction of charged particle beams with plasma). Kiev, Naukova dumka, 1965, 59-62

TOPIC TAGS: turbulent plasma, sound wave, acoustic wave

ABSTRACT: The distribution of turbulent sound waves in a plasma with cold ions and hot electrons moving with a velocity greater than the speed of sound is considered. The equations of B. B. Kadomtsev, et al (*ZhETF*, 1962, 43, 2234) are generalized by adding a time dependent term. These equations are analyzed under the assumption that short waves are the only important ones; derivative terms which do not depend on the correlating function are thus neglected. Appropriate substitution in the resulting equation reduces the number of variables and attention is directed to the study of similar solutions and their asymptotic forms are derived. It is shown that the "pulsating" distributions of fluctuations have periods which can be expressed in terms of random acoustic wave amplitudes. These fluctuation distributions are of a type distinct from those described in three articles in the bibliography. Orig. art. has: 10 formulas.

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L 08813-67 EWT(1) IJP(c) AT/GD (N) SOURCE CODE: UR/0000/65/000/000/0051/0059

ACC NR: AT6020435

46

AUTHOR: Akhiyezer, I. A.

ORG: none

TITLE: Theory of turbulence in a two-temperature plasma

SOURCE: AN UkrSSR. Vzaimodeystviye puchkov zaryazhennykh chastits s plazmoy (Interaction of charged particle beams with plasma). Kiev, Naukova dumka, 1965, 51-59

TOPIC TAGS: electron beam, plasma beam interaction, turbulent plasma

ABSTRACT: A more precise description of turbulent fluctuations in "cold ion" plasma is given by taking account of the random forces occurring in such a plasma when subjected to electron beam interaction with a velocity greater than the speed of two-temperature sound. Generalizing the equations of Kadomtsev and Petviashvili and introducing kinetic terms for random forces, steady state fluctuations are described. The spectral and angular distribution of the fluctuations are obtained first for the short wavelength limit. It is shown that the source term here is very important. Further, a somewhat longer wave case is considered, where it is found that all turbulent waves propagate along the direction of the electron beam or along the Cerenkov angle. It is noted that the stationary distribution of the fluctuations is characterized by the amplitude of oscillations and their phase, and for proper determination of the physical

Card 1/2

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ACC NR: AT6020435

situation in the plasma their history must be known. Orig. art. has: 19 formulas.

SUB CODE: 20/ SUBM DATE: 11Nov65/ ORIG REF: 007/ OTH REF: 002

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L 1564-66 EWT(1) IJP(c)

ACCESSION NR: AP5019244 UR/0056/65/049/001/0296/0301

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29

B

AUTHOR: Akhiyezer, I. A. 44,55

TITLE: On the possibility of anomalous fluctuations in ferromagnets and antiferromagnets 44,55

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 49, no. 1, 1965, 296-301

TOPIC TAGS: ferromagnetism, antiferromagnetism, spin wave spectrum

ABSTRACT: The author studies the spectral and angular distributions of fluctuations in systems of oriented spins, such as exist in ferro- and antiferromagnets in which directional flow of electrons is produced either by injection from the outside or by application of an electric field. The analysis is based on solving the linearized kinetic equation for the Fourier components of the electron distribution function and Maxwell's equations for the Fourier components of the electric field and the magnetic induction, and determining the correlators of the various quantities characterizing the system. The same approach is used for ferro- and antiferromagnets. It is shown that the amplitude of the spin waves becomes anomalously large when the electron velocity approaches a critical value at which spin-wave instability sets in. The presence of these anomalous fluctuations leads to

Card 1/2

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ACCESSION NR: AP5019244

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a sharp increase of the differential cross section for scattering of slow neutrons in the ferro- and antiferromagnets, so that slow neutron scattering can be used for the observation of these anomalous fluctustions. "I thank A. I. Akhiyezer and V. G. Bar'yakhtar for valuable advice and a discussion." Orig. art. has: 18 44,55 formulas. 44,55

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physico-technical Institute, Academy of Sciences, UkrSSR) 44,55

SUBMITTED: 15Feb65 ENCL: 00 SUB CODE: SS, NP

NR REF SOV: 006 OTHER: 001

Card 2/2 50

ACC NR: AP6036060 SOURCE CODE: UR/0056/66/051/004/1227/1235

AUTHOR: Akhiyezer, I. A.; Borovik, A. Ye.

ORG: Physicotechnical Institute, AN UkrSSR (Fiziko-tekhnicheskiy institut, AN UkrSSR)

TITLE: Nonlinear motions of a plasma with an arbitrary electron velocity distribution

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 51, no. 4, 1966, 1227-1235

TOPIC TAGS: plasma, nonlinear plasma, electron motion, Maxwell distribution, rarefaction wave, compression wave, electron velocity distribution

ABSTRACT: One-dimensional finite-amplitude motions in a nonequilibrium plasma consisting of hot electrons and cold ions are investigated. Stationary waves and also nonstationary multibeam flows of the simplest type (Riemann or simple waves) are considered. It is shown that solitary waves may be of two types, depending on the nature of the electron velocity distribution. The particle density and electrostatic potential increase in solitary compression waves whereas in rarefaction

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waves these quantities decrease. When the electron distributions are such that solitary rarefaction waves are produced, the reflection of electrons from the potential barrier produced by the wave may result in the formation of quasi-shock rarefaction waves (in contrast to quasi-shock compression waves arising in a plasma with a Maxwellian electron distribution). The sign of variation of the quantities characterizing the plasma in a multibeam simple wave is established. It is shown that depending on the nature of the initial electron velocity distribution, either the normal case may be encountered, when discontinuities (or additional ion beams) arise on the compression regions, or the anomalous case, when the discontinuities arise in the rarefaction regions. In conclusion, the authors wish to express their appreciation to R. V. Polovin and K. N. Stepanov for useful discussions. Orig. art. has: 21 formulas and 2 figures. [Authors' abstract] [AM]

SUB CODE: 20/ SUBM DATE: 11May66/ ORIG REF: 003/ OTH REF: 002/

L 07406-67 EWT(1) IJP(c) GD/AT

ACC NR: AT6020576 (N) SOURCE CODE: UR/0000/65/000/000/0139/0142

37

B+/

AUTHOR: Akhiyezer, I. A.

ORG: none

TITLE: On the interaction of charged particles with a turbulent plasma 2

SOURCE: AN UkrSSR. Vysokochastotnyye svoystva plazmy (High frequency properties of plasma). Kiev, Naukovo dumka, 1965, 139-142

TOPIC TAGS: turbulent plasma, plasma beam interaction, plasma charged particle, plasma temperature

ABSTRACT: Energy loss (or gain) per unit time by a charged particle moving through a turbulent plasma is calculated from a general expression which depends on the charge density correlator. This correlator is written out explicitly for the "sonic" region of the plasma which has a much higher electron than ion temperature. It is shown that under these conditions, the plasma temperature gradients, rather than temperature, determine the energy losses. The substantial contribution to the loss is limited to the region around resonance, so that a small number of parameters is needed to specify the loss per unit time. This result also implies that turbulence spectrum peculiarities do not have a strong effect on the resulting losses. In addition, the rate of change of particle energy is derived in an analytic form, giving the dependence on particle

Card 1/2

L 07406-67

ACC NR: AT6020576

velocity and direction. Orig. art. has: 9 formulas.

SUB CODE: 20/ SUBM DATE: 19Nov65/ ORIG REF: 002/ OTH REF: 002

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AKHIYEZER, N. I.

Kratkiy obzor trudov p. l. Chebysheva. V. Kn. P. L. Chebyshev, Izbrannyye matematicheskiye trudy. M. - L., GTTI (1946), 171-189.

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Moscow-Leningrad, 1948