This discrepancy may be due to statistical fluctuations, which have a probability of $\sim 1\%$. If further investigations confirm the results of our experiment, one may be led to the assumption that the μ mesons within the considered range of momenta are produced in the atmosphere not only on account of the $\pi \rightarrow \mu$ decay. In our experiment we studied the polarization of μ mesons with momenta $\gtrsim 1.2$ Bev/c at sea level. Muons with these momenta are mainly produced at heights of several kilometers and have momenta of 4 — 5 Bev/c at the moment of their creation. The $K_{\mu 2}$ decay, which makes up 60% of all K decays, may play an essential role in the production of μ mesons with such momenta. The μ mesons in the $K_{\mu 2}$ decay are practically completely polarized, if the energy spectrum of the K mesons in the atmosphere falls off with the energy corresponding to a parameter value $\gamma \geq 2$ (reference 1). For satisfactory agreement with experiment it is sufficient to assume that, at energies of ~ 10 Bev, the number of K mesons amounts to 20% of that of the π mesons. The disagreement with the results of reference 4 is then explained by submitting that the μ mesons whose polarization was measured in reference 4 had significantly lower momenta (~ 2 Bev/c at the moment of creation), to which the contribution from the $K_{\mu 2}$ decay is small.

In this way it is possible to obtain information about the mechanism of the production of μ mesons of high energy by investigating the dependence of the degree of polarization on the μ meson energy.

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*Hayakawa made a similar calculation.[2]

†In the calculation of the transmission coefficient of the positrons in the plates and of the number of positrons exiting into the upper hemisphere, we used the Wilson's[3] theoretical energy-range and scattering-range relations.

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117

THERMODYNAMIC PROPERTIES OF A DEGENERATE PLASMA

A. A. BEDENOV

Moscow State University

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USING the diagram technique developed by Matsubara[1] for statistical Green's functions in quantum statistical mechanics, we have calculated the interaction correction for the thermodynamic potential of a completely ionized degenerate plasma in the case in which the electron plasma is a Fermi gas while the nuclei form a Boltzmann gas.

The calculation is carried out under the assumption that the mean scattering amplitude in the Coulomb field $e^2/\overline{E}$ is small, compared to the mean distance between particles $R : e^2/R\overline{E} \equiv \alpha \ll 1$. We consider the case in which the chemical potential of the electrons μ and the temperature T are of the same order of magnitude; in this case the mean energy $\overline{E}$ is of the same order of magnitude as the temperature T. We may note that under these conditions the plasma is highly compressed; from the inequality

$$e^2/T \sim e^2/\mu \sim e^2/(\hbar^2/mR^2) \ll R$$

it follows that R, the mean distance between particles is much smaller than the Bohr radius: $R \ll \hbar^2/me^2$.

If these conditions are satisfied the thermodynamic potential Ω is expanded in terms of the small parameter α and with accuracy to terms of order $\alpha^{3/2}$ is given by the expression:

$$\Omega = \Omega_0 - \int V_q n_p^e n_{p+q}^e d\mathbf{p}d\mathbf{q} - \frac{2}{3}\sqrt{\pi}e^3\left(2\frac{\partial n_e}{\partial \mu_e} + \frac{\partial n_i}{\partial \mu_i}\right)^{1/2},$$

$$n_p = [1 + \exp(p^2/2m - \mu)/T]^{-1}, \quad n = \int n_p d\mathbf{p}. \quad (1)$$

Here Ω_0 is the thermodynamic potential of an ideal gas of electrons and nuclei, $V_q = 4\pi e^2/q^2$ is the Fourier component of the potential of the Coulomb interaction $e^2/|\mathbf{x}|$, μ_e and μ_i are the chemical potentials for the electrons and for the nuclei.

The second term in Eq. (1) represents the exchange energy of the electrons which, since it refers to a single particle, is e^2/R in magnitude. The third term in Eq. (1) is the result of the self-consistent interaction between the particles; its order of magnitude is $(e^2/R)(e^2/RT)^{1/2}$ (for a single particle).

We may note that the result given in reference 2 is not correct: this result does not take account of the exchange energy of the electrons and the self-consistent term has been computed incorrectly. This term was computed by means of the Debye-Hückel method; however, this approach cannot be used because the mean wavelength of an electron in a compressed plasma is comparable to the mean distance between particles R.

We are indebted to Academician L. D. Landau for discussion of this problem.

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118

INTERACTION BETWEEN K AND π MESONS

V. I. OGIEVETSKIĬ

Joint Institute for Nuclear Research

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THE question of the existence of a direct interaction between K and π mesons has been discussed in several papers.[1-5] Because of the pseudoscalar nature of π mesons, a direct three-boson coupling of the type KKπ is possible only if the K mesons do not have a definite parity[2] or if only combined parity IC is conserved in this interaction.

In a recent paper, Pais[5] discussed the original hypothesis that the parity of charged and neutral K mesons is different. In this case, the demand of charge independence in the pion-nucleon system places strong restrictions on the Lagrangian for strong interactions. Many reactions, for example, the charge exchange one $K^+ + n \to K^0 + p$, turn out to be forbidden. In order to avoid this difficulty, the parity-conserving [Kπ]-interaction

$$[K\pi] = f\,(2m_K)\,[\bar{K}^+K^0\pi^+ + \bar{K}^0K^+\pi^-], \qquad (1)$$

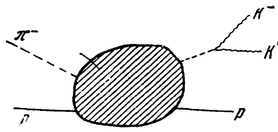
is introduced. Here m_K is the mass of the K meson. This coupling violates, of course, the symmetry property of strong interactions.[5,6*] Pais considers that the coupling of Eq. (1) makes the main contribution to the "forbidden" reaction noted above. The coupling constant f evaluated from the charge-exchange reaction, turns out to be of the order of the electromagnetic constant e (the real expansion parameter is $(f^2/4\pi)(m_K/m_\pi)^2 \sim 0.3$).

In discussing the consequences of his hypothesis, Pais finds it necessary not only to resort to perturbation theory for the [Kπ]- and [NKY]-couplings, but also to make assumptions about the behavior of the S matrix far from the energy shell.

The pair production of K mesons

$$\pi^- + p \to K^- + K^0 + p. \qquad (2)$$

seems to us to be of interest in verifying the existence of the [Kπ]-interaction (1). This reaction is, according to Pais,[6] forbidden by the symmetry properties of the baryon-meson interactions, and would occur only as a result of the interaction (1). Therefore, the pair production (2) can be represented by the graph (see the figure): after virtual



π^--p scattering; the π^- turns into K^- and K^0. If we go over into the system A in which the momentum of the final proton is equal to the sum of momenta of the π^- meson and the initial proton, then the momenta of the K mesons will be equal in magnitude and opposite in direction.

If, in fact, a pair of K mesons is produced as a result of the reaction (1), in the system A the angular distribution of K mesons should be isotropic. Such a reference system always exists. Its velocity relative to the laboratory system is

$$\mathbf{v} = c^2(\mathbf{l} - \mathbf{p})/(\omega + Mc^2 - E), \qquad (3)$$

where $\mathbf{l}$, ω, and $\mathbf{p}$, E are the momenta and total energy of the π^- meson and final proton, respectively, in the laboratory system; M is the mass of the proton.†

There will not, of course, be complete isotropy, since the final state interaction has not been taken into account, and the [Kπ]-coupling was calculated only to first order. However, here it is not neces-