the projection of the wave vector on a direction perpendicular to the inhomogeneity, $\omega_\ell^2 = 4\pi ne^2/m_e$, $\omega_s^2 = T_e k_\perp^2/m_i$ and $r_D^2 = T_e/4\pi n$. Assuming that $T_e >> T_i$ and $k_\perp^{-2}\ell_T >> r_D^2\ell_n$, and taking into account only the Landau damping for ion sound, we have $\beta'' = (\pi/2)^{1/2}(m_e/m_i)^{1/2}(k_\perp\ell_T)^{2/3}$. Using the known value for γ^2

$$\gamma^2 = \frac{1}{4}\left(\frac{E_o}{4\pi n T_e}\right)^2 \omega_\ell \omega_s$$

we see that the most stable are short-wave oscillations. If the inhomogeneity of T_e is not very large, $\ell_T >> r_D(m_i/m_e)^{3/4}$, then at $k_\perp \lesssim 1/r_D$ we obtain from (4) if m = 1

$$\left(\frac{E_o}{4\pi n T_e}\right)^2 \approx \left(\frac{m_e}{m_i}\right)\left(\frac{\ell_T}{\ell_n}\right).$$

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GAS-LIQUID PHASE TRANSITION IN THE SYSTEM OF SURFACE IMPURITIES OF ^{3}He IN SUPERFLUID SOLUTIONS

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It is shown that a first-order phase transition should be observed on the free surface of an He^3 solution in helium II. This transition is due to condensation of the surface impurities and is accompanied by a kink on the plot of the surface tension against the temperature.

Surface impurity levels of He^3 exist on the free surface of a solution of He^3 in He^4 [1 - 4]. At high temperatures the impurities should behave like a classical two-dimensional ideal gas, as is confirmed by the experiments of Zinov'eva and Boldarev [2]. At low temperatures, as shown by Edwards et al. [3], the surface impurities behave as a Fermi liquid. The authors of [3] have processed their own data under the assumption that at low temperatures the system behaves like a rarefied Fermi gas. This assumption was based on the fact that the experimental dependence of the contribution of the impurities to the surface tension depends quadratically on the chemical potential μ as $T \to 0$, as is typical of a rarefied Fermi gas. It turns out then that the temperature dependence of the surface tension is the same as in a strongly degenerate Fermi system, even at temperatures greatly exceeding the degeneracy temperature of the rarefied gas.

A possible explanation of this fact is that at low temperatures the surface impurities actually form a dense two-dimensional liquid rather than a rarefied gas. In this case the dependence of the impurity part of the surface tension $\Delta\sigma$ on the chemical potential μ should be linear as $T \to 0$, since the derivative $\partial(\Delta\sigma)/\partial\mu$ is the surface density of the impurities, which is always finite in a liquid. As seen from the figure, the experimental data of Edwards et al. can be fitted also to a linear dependence at not too large $\Delta\sigma$. This yields for the liquid a chemical potential $\mu_0 = -1.7°K$ at $\Delta\sigma = 0$ and $T = 0$, and also a surface density $N_s \simeq 2 \times 10^{15}$ cm^{-2}. On the other hand, from the experiments of Zinov'eva and Boldarev we know that the minimum energy of one impurity on the surface is $\varepsilon_0 = -1.7 \pm 0.2°K$. Since ε_0 and μ_0 do not differ greatly in any case (there are no grounds whatever for their being identical), and the chemical potential of a Fermi gas at $T = 0$ is always larger than ε_0, at a certain finite temperature there should occur a first-order phase transition from the two-dimensional gas into a two-dimensional liquid, accompanied by a jump-like change in the surface density of the impurities.

If the concentration of the solution is such that the condensation temperature is $T_c \gg |\mu_0 - \varepsilon_0|$, then we can put $\mu_0 - \varepsilon_0 = 0$ in the calculation of T_c. The chemical potential of the gas in then equal to

$$\mu_g = \epsilon_0 + \frac{\pi\hbar^2}{m} n_s (1 + V) - T \ln\left(1 - e^{-\frac{\pi\hbar^2}{mT} n_s}\right),$$

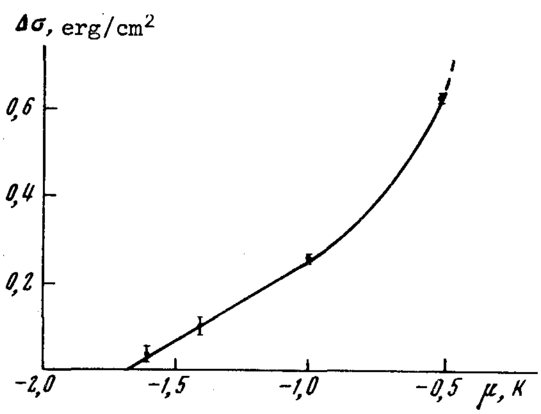
where n_s is the surface density of the impurity gas, m is the effective mass of the impurities, and V is a dimensionless constant characterizing the interaction of the impurities with one another. The fact that the interaction in a two-dimensional Fermi gas is appreciable even at low density was noted in [3]. On the other hand, the chemical potential of the liquid, in view of its low compressibility and high degeneracy temperature, can be set equal to μ_0. From the condition that the chemical potentials be equal we obtain a connection between the condensation temperature and the density of the gas, namely $T_c = \pi\hbar^2 n_s/m\lambda$, where λ is a constant of the order of unity, and is connected with V by the relation $e^\lambda - e^{-\lambda V} = 1$. The dependence of T_c on the impurity-particle density n in the volume is obtained by equating ε_0 to the chemical potential of the impurities in the volume

$$n = 2\left(\frac{MT_c}{2\pi\hbar^2}\right)^{3/2} e^{\epsilon_0/T_c}$$

where M is the effective mass of the volume impurities.

At the point $T = T_c(n)$, the plot of the surface tension against the temperature at fixed n is continuous, but the derivative $\partial\sigma/\partial T$ experiences a discontinuity, which is connected with the discontinuity $N_s - n_s$ of the surface density by the relation

$$\left(\frac{\partial\sigma}{\partial T}\right)_{T_c - 0} - \left(\frac{\partial\sigma}{\partial T}\right)_{T_c + 0} = (N_s - n_s)\frac{(\partial\mu/\partial n)_T}{\partial T_c/\partial n} = -(N_s - n_s)\frac{\epsilon_0}{T_c}.$$



If the ratio of the liquid volume to the free-surface area is infinite, then the entire surface is covered by the gas phase at $T > T_c$ and by the liquid at $T < T_c$. There is no region of phase stratification. This region appears if the indicated ratio is finite. The width ΔT of the temperature interval near T_c, in which two surface phases coexist on the surface of the liquid layer of thickness z at large values of z, is given by the formula

$$\frac{\Delta T}{T_c} = -\frac{N_s - n_s}{zn}\frac{T_c}{\epsilon_0}.$$

At finite z, the derivative $\partial\sigma/\partial T$ is continuous.

To observe surface condensation in measurements of surface tension, the accuracy must be sufficient to observe the kink on the $\sigma(T)$ curve. We note in this connection that a much more strongly pronounced singularity should be observed in the temperature dependence of the velocity of the surface second sound [4], which should experience a large discontinuity at the condensation point.

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SUPERCONDUCTIVITY IN NON-EQUILIBRIUM WITH REPULSION BETWEEN PARTICLES

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In the fundamental formulas of superconductivity theory, the coupling constant enters in combination with the quantity 1 - 2n, where n is the occupation number of the fermion states. This suggests that superconductivity can appear in such "non-superconducting" systems in which both factors have an unusual sign, namely, repulsion between particles predominates, but on the other hand an inverted level population is produced[1)].

In the simplest metallic model, the time τ_R of recombination of the electrons and holes, which leads to the vanishing of the population inversion, is so short that to produce the inversion, if at all possible, continuous pumping would be necessary. This creates a number of complicated problems. We discuss below a model in which the time τ_R has been appreciably increased and one can expect superconductivity to appear as a result of a single action of the pump pulse.

[1)] We have learned that similar arguments were advanced also by A.G. Aronov and V.L. Gurevich.