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A scientific session of the Division of General Physics and Astronomy of the USSR Academy of Sciences was held on September 25 and 26, 1974 at the conference hall of the P. N. Lebedev Physics Institute. The following papers were delivered:

1. L. P. Pitaevskiĭ, Superfluidity of Liquid He^3.
2. N. V. Zavaritskiĭ, Thermoelectric Phenomena in Superconductors.
3. D. A. Kirzhnits and A. D. Linde, The Vacuum Phase Transition and Cosmology.
4. J. Einasto "Latent" Mass in the Galaxies.
5. L. M. Ozernoĭ, Patterns in Systems of Galaxies, and Their Relation to the Problem of "Latent" Mass.

We publish below brief contents of four of the papers.

L. P. Pitaevskiĭ. Superfluidity of Liquid He^3. Contemporary theoretical conceptions as to the structure of the superfluid phases of liquid He^3 are set forth. The point of departure is the experimental fact of the existence of two superfluid phases—the A phase and the B phase. The magnetic susceptibility of the A phase is the same as in the normal state, but that of the B phase is lower. The working hypothesis is that these phases correspond to pairing of fermions in a state with orbital angular momentum $l = 0$, i.e., in the p state. The ordering parameter is a tensor of second rank and the problem consists of establishing the form of this tensor. The most probable model of the B phase is the Balian-Wertheimer model with an isotropic gap. Experimental data on the A phase indicate that it has an anisotropic gap. A phase of this type was proposed by Anderson and Morel. However, this phase is energetically unfavored in the approximation in which the transition temperature is regarded as a small parameter. To eliminate this contradiction, Anderson and Brinkman proposed that paramagnons make a significant contribution to the interaction, so that the interaction comes to depend strongly on the gap. The anisotropic phase can then be made more favorable by adjustment of the parameters. In all, there are six different possible types of anisotropic phases. The choice of type is made with consideration of paramagnetic-resonance data. The A phase has a transverse-resonance frequency shift and a longitudinal resonance with a frequency that depends weakly on the magnetic field. The B phase lacks the transverse-resonance frequency shift, but the longitudinal resonance is present. Both phases of superfluid He^3 are liquid crystals.

N. V. Zavaritskiĭ. Thermoelectric Phenomena in Superconductors. The presence of a temperature gradient in a metal results in the appearance of a thermoelectric voltage. This voltage appears because the heat flux is accompanied by a thermoelectric current. The result is a redistribution of charges over the sample and the appearance of a voltage whose magnitude is such that the current in the specimen stops flowing.

The thermoelectric voltage vanishes when the metal goes over to the superconducting state. Ginzburg[1] drew attention to the fact that the thermoelectric current due to normal excitations in a superconductor remains unchanged, at least near the transition temperature, but that charge transfer offsets the superconductive current of Cooper pairs. The result in a superconductor with a temperature gradient is circulation of the normal-excitation thermoelectric current $j_n = -\alpha\sigma\nabla T$ (α is the coefficient of the differential thermal emf and σ is the conductivity of the metal) and circulation of the superconductive current $j_s \cong -j_n$.

A superconductor is a system whose quantum properties are manifested on the macroscopic scale. The state of the superconducting Cooper pairs is described by assigning a wave function $\Psi = \Psi(r)e^{i\varphi}$. The density n_s of the superconducting pairs is defined as $|\Psi|^2$, and the superconducting current is proportional to the phase gradient: $j_s = (e\hbar n_s/2m)\nabla\varphi$. The presence of a temperature gradient in a superconductor must obviously be accompanied by a phase change along the sample[2] $\Delta\varphi = (2m/e\hbar)(\alpha\sigma/n_s)\Delta T$. Clearly, thermoelectric phenomena can be observed only in a closed circuit composed of superconductors with different characteristics.

One of the phenomena associated with the presence of a temperature gradient in a circuit composed of superconductors consists in the appearance of a magnetic flux in the thermoelectric loop. We know that the magnetic flux in the superconductive loop is $\Phi = n\Phi_0$, where $\Phi = 2.07 \times 10^{-7}$ Oe/cm^2 is the quantum of the magnetic flux in the superconductor and n is an integer. Temperature gradients lead to the appearance of an additional nonquantized thermoelectric magnetic flux[3–5]

$$\Delta\Phi = \frac{2m}{eh}\Phi_0 \oint_L \frac{\alpha\sigma}{n_s}\nabla T \qquad (1)$$

or, if the temperature change takes place on part of the loop,

$$\Delta\Phi = \frac{2m}{eh}\Phi_0 \left[\left(\frac{\alpha\sigma}{n_s}\right)_1 - \left(\frac{\alpha\sigma}{n_s}\right)_2\right]\Delta T; \qquad (2)$$

the subscripts denote the segments of the loop along which the temperature change occurs.

This thermoelectric magnetic flux is small and amounts under optimum conditions to a fraction of Φ_0, but it can be observed in experiment by using a highly sensitive superconductive quantum magnetic fluxmeter for the measurements[6].