that condition for several hours. This led to a decrease in the number of unpaired electrons and a consequent increase in the number of protons per unpaired electron. The accompanying data correspond to a sample in which the number of protons per unpaired electron is of the order of 10^3. As the experiment shows, we had too weak a concentration of unpaired electrons.

Borghini and Abragam[6] have carried out similar experiments.

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MEASUREMENT OF THE LOGARITHMIC DAMPING DECREMENT OF A HOLLOW CYLINDER IN ROTATING HELIUM II

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As is well known, the fundamentals of the theory of the rotation of a superfluid liquid have been set forth in the publications of Feynman, based on Onsager's concept of the existence in rotating helium II of vortex lines. According to these papers, the number of vortex lines grows as the rotational velocity increases, while each such line has a definite energy per unit length. Investigation of the properties of vortex lines in rotating helium II has been carried out both by the stack-of-disks method,[1-3] and by the method of a single disk oscillating about its axis, with the latter parallel to the vortex lines (references 4 and 5, as well as private communication by Hall).

In one of these papers[4] Andronikashvili and Tsakadze have shown that with increasing rotational velocity the logarithmic damping decrement of the disk passes through a maximum, which must be explained (cf. reference 6) by a corresponding change in the elastic-plastic properties of rotating helium II. In accordance with this hypothesis the superfluid component of helium II should, at small velocities of rotation, be regarded as a system of relatively few vortex lines not interacting among themselves, while at large velocities, these lines form a single elastic-plastic tangle. In the two cases, of both low and high velocities, the vortex lines may be considered to be bound at their ends, to a greater or lesser degree, to the surface of the oscillating disk. It was natural to assume that rotating helium II should show different viscous properties in experiments in which the surface of the solid body subjected to retardation moves perpendicular to the direction of the vortex lines and in which it moves parallel to them.

With the object of verifying this hypothesis, the single disk in the previously-described[4,5,7] apparatus was replaced by a hollow cylinder, machined from organic glass and having circular graduations ruled on its cylindrical surface to facilitate its immersion to various depths in the rotating helium II, suspended upside down on an elastic fiber. As in the work with the single disk, the hollow cylinder took part simultaneously in both rotational and oscillatory motion. The cylinder had a diameter of 24.06 mm, a height of 49.80 mm, and a thickness of 0.49 mm. The distance between the rulings was 5.0 mm. The number of rulings was 9. The outer container, which rotated uniformly together with the helium II with which it was filled, had a diameter of 44 mm and a height of 62 mm.

The solution of the hydrodynamic problem of a cylinder immersed in a rotating classical liquid and performing axial-rotational oscillations of small amplitude superimposed upon rotation leads to the formula

$$(\delta_2 - \delta_1) / (l_2 - l_1) = (2\pi^2 r^3 / J) \sqrt{2\eta\rho / \Omega}, \qquad (1)$$

where $\delta_1 (\delta_2)$ is the logarithmic damping decrement for the oscillations of the cylinder when it is immersed in the liquid to a depth $l_1 (l_2)$, r is the radius of the cylinder, η and ρ are the viscosity and density of the liquid, J is the moment of inertia of the suspended system and Ω is the frequency of oscillations.

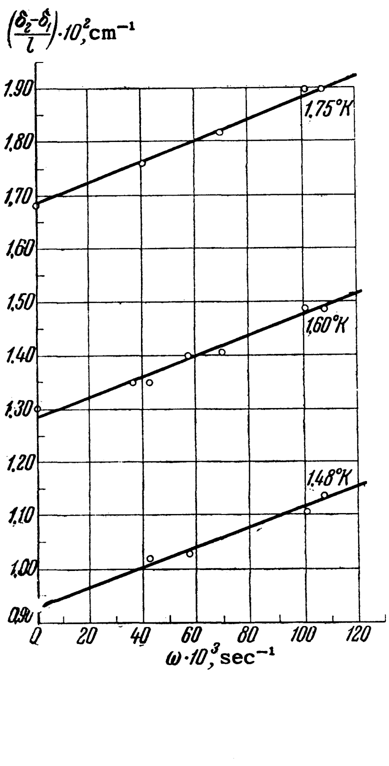
The experiments which we carried out with stationary helium II showed that the viscosity of helium II as determined with the aid of the hollow cylinder agrees with the viscosity measured formerly by É. L. Andronikashvili using the single-disk method.[8]

Experiments performed in water rotating uniformly within the limits $0 < \omega_0 < 100 \times 10^{-3}\ \text{sec}^{-1}$ led to values for the viscosity agreeing with tabulated data. These circumstances permitted us to apply the "inverted beaker" method to the measurement of the damping in rotating helium II when the surface subjected to drag is parallel to the vortex lines.

The hydrodynamic problem of the damping of the motion of a cylindrical surface placed within rotating helium II and performing uniform-rotational motion, on one hand, and harmonic axial-rotational oscillations, on the other, has been investigated by Mamaladze and Matinyan,[9] who obtained the equation

$$\frac{\delta_2 - \delta_1}{l_2 - l_1} = \frac{2\pi^2 r^3 \sqrt{2\eta\rho}}{J\sqrt{\Omega}}\left[1 + \frac{\rho_s B\omega_0}{2\rho\Omega}\right], \tag{2}$$

where ρ_s is the density of the superfluid component, ω_0 is the rotational frequency and B is the mutual friction coefficient of Hall and Vinen.[10]



Dependence of the logarithmic damping decrement for a hollow cylinder immersed in helium II upon the rotational frequency. Curves taken for the case $l = l_2 - l_1 = 1$ cm.

The results of experiments carried out by us at three different temperatures agreed within the limits of experimental error with equation (2) over the whole range of velocities investigated. It is evident from the figure that the dependence found experimentally has a linear form, and that the characteristic maximum of the curve $\delta(\omega)$ found previously[5] in the case of the oscillating disk is absent.

We have thus shown that the viscous properties of rotating helium II do in fact depend upon the direction along which the damping is measured, not only in magnitude, but in their very character.

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