constant over the whole velocity range investigated, to within the limits of experimental error.

In the case of helium II, the damping decrement has a clearly-expressed dependence upon the rotational velocity, while the curve showing the dependence of the relative increase in the damping arising as a result of the rotation upon the rotational frequency passes through a maximum (Fig. 1), both in the case of the roughened disk (curve a) and of the smooth disk (curve b). Our attention is drawn to the fact that the ordinate of curve a exceeds that of curve b by a factor of not less than two over the whole range of rotational velocities. The character of the fall of the curve beyond the maximum is quite different for the rough and smooth disks, as is the sign of the curvature.

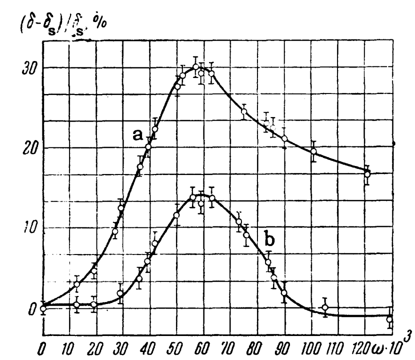

FIG. 1. Relative increase in the disk damping decrement as a function of angular velocity of rotation: a – for disk with roughened surface, b – with smooth surface; δ_s – damping in stationary helium II, δ – damping in rotating helium II; temperature 1.78°K.

In the smooth disk case the curve, near the origin, runs parallel to the x axis, which indicates, evidently, that under these conditions a slippage of the vortices is observed relative to the polished surface (i.e., the vortices are not fixed on the surface).

The temperature dependence of the maximum increase in the relative damping (at $\omega = 55 \times 10^{-3}$ $\sec^{-1}$) for the roughened disk is shown in Fig. 2. It is characteristic that over the whole temperature interval the increase in the damping arising from entrainment of the superfluid component does not exceed 65 – 70% of the damping due to friction with the normal component.

To explain the features of the behavior of the curves presented in Fig. 1, Yu. G. Mamaladze, has suggested that the linear dependence of $(\delta - \delta_S)/\delta_S$ upon ω found at the beginning of the curve gives place to a more complex dependence when the distance between neighboring vortices becomes equal to their effective diameter. On this hypothesis the parameter $\nu = \epsilon/\rho_S\Gamma$ of

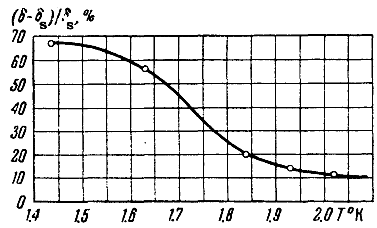

FIG. 2. Temperature dependence of the maximum value of the relative increase in the damping of the disk with roughened surface.

Hall and Vinen, where ϵ is the vortex energy per unit length and Γ is the circulation, was computed from the data of the present experiment. It was found that $\nu = 6$ to 8×10^{-4} cm^2 sec^{-1}, which agrees well with the value found bý Hall himself.

The authors thank Yu. G. Mamaladze and S. G. Matinyan for their valued counsel, and L. A. Zamtaradze, T. G. Shults, and I. M. Chkheidze for their aid in performing the experiment.

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LOCALIZATION OF A HIGH-FREQUENCY INDUCTION DISCHARGE

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We have investigated a high-frequency induction discharge in an axially symmetric magnetic field in the pressure range 1 – 100 mm Hg in various gases (air, hydrogen, and helium).

The discharge was produced by a self-excited pulsed 150 kw oscillator using GU-12A tubes. The pulse-length was one microsecond, the frequency 15 Mcs, and the anode voltage 15 kv. The coil used to produce the high-frequency magnetic field had an inductance of $0.2\,\mu h$ and constituted the entire plate circuit of the oscillator. Two coils were used; the magnetic field produced by one was such as to satisfy the stability condition for a pinch in an equilibrium orbit,[1,2] (i.e., the field at the orbit $H_0 = \overline{H}/3$, where $\overline{H}$ is the mean value of the magnetic field inside the orbit); the field produced by the second coil was essentially uniform. The discharge was excited in the cylindrical vacuum chamber (diameter = 28 cm, height = 3 cm).

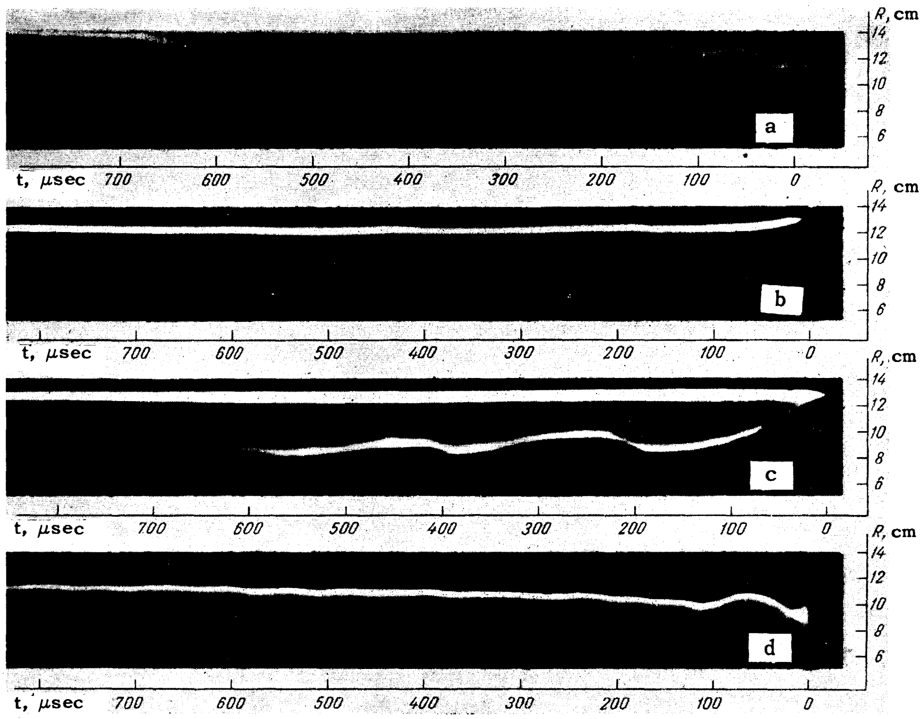
In the figure are shown typical streak photographs of discharges in various gases taken with an SFR-2 camera. The slit in the objective of the camera was parallel to the radius of the vacuum chamber. The radius R = 14 cm corresponds to the wall of the vacuum chamber. The equilibrium orbit is at a distance of approximately 4 cm from the side wall of the vacuum chamber. In air or hydrogen (Fig. 1, a and b) at a pressure of 10 mm Hg the breakdown occurs at 2 — 3 cm from the side wall and clearly defined plasma loops are formed; the small radii of these loops are approximately 5 mm. The large radius of the loop in air expands at a velocity of 3×10^4 cm/sec; the radius of the loop in hydrogen contracts at a velocity of 10^4 cm/sec. The loops exist for the duration of the oscillator pulse. In helium (cf. figure) the plasma loop which is formed at breakdown separates into two separate loops, which exist simultaneously.

With all other conditions being approximately the same the oscillation frequency of the plasma loops is inversely proportional to the mass of the gas: in air — 16 kcs, in helium — 6 kcs, and in hydrogen — 4 kcs. The loop current, measured by changing the oscillator frequency, is approximately 200 amp; the intensity of the induced electric field is approximately 1,000 v/cm. The current in the loop is determined by measuring the loop inductance.[3]

Spectroscopic measurements of the discharge in hydrogen at a pressure of 10 mm Hg (ISP-50 spectrometer) indicate that the current channel contains only atomic hydrogen ions. The electron temperature, as determined from the relative intensities of the H_α, H_β, and H_γ lines, is approximately 5000°, corresponding to a plasma conductivity of 2×10^{13}.

The nature of the discharge changes in a uniform magnetic field; in discharges in helium and air the current flows in a localized region at the sidewall of the chamber and does not form plasma loops. In the discharge in hydrogen there is a clearly defined loop, the small radius of which is approximately 5 mm; the oscillations of the large radius fall off much more rapidly than in the cases cited above.

A plasma loop in a uniform magnetic field



Streak photographs of the discharges: a) air, p = 7 mm Hg; J = 200 amp; b) hydrogen, p – 10 mm Hg, J = 200 amp; c) helium, p – 10 mm Hg, J = 260 amp; d) helium, p – 60 mm Hg, J = 220 amp.

which is subject to electrodynamic forces tends to reduce its large radius, contracting to the center of the vacuum chamber.[2] However no essential difference was observed in the behavior of the plasma loops in the two series of experiments indicated above. This may be due to the fact that the electrodynamic forces, which are proportional to the square of the current, are small or to the presence of strong dissipative forces due to the high gas density.

Thus, it has been established that in a high-frequency induction discharge at pressures above 1 mm Hg sharply defined plasma loops are formed; these remain separated from the walls of the vacuum chamber and exist for the duration of the high-frequency magnetic field pulse.

The authors are indebted to R. A. Latypov for assistance in the construction of the apparatus and for help in carrying out the experiments, V. A. Kiselev for carrying out the spectroscopic measurements, and L. M. Kovrizhnykh, M. S. Rabinovich and I. S. Shpigel' for a discussion of the results which have been obtained.

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MAGNETOSTRICTION OF ANTIFERROMAGNETIC NICKEL MONOXIDE

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DATA on the magnetostriction of antiferromagnets are at present lacking in the literature. On the basis of general considerations, however (the presence of domain structure), the magnetostriction of antiferromagnets should have an appreciable magnitude, at any rate larger than that of ordinary paramagnets.

We have measured the magnetostriction of polycrystalline nickel monoxide, NiO, prepared by the standard ceramic technique. Before the magnetostriction measurements, the room-temperature mass susceptibility and the Curie point of the specimens were measured by way of control. The measurements showed that in fields up to 7000 oe, the susceptibility is slightly field-dependent and equal to 6×10^{-6}; the Curie point was determined by the jump in Young's modulus and was 251° C. These data agree with results obtained for NiO by other authors.[1]

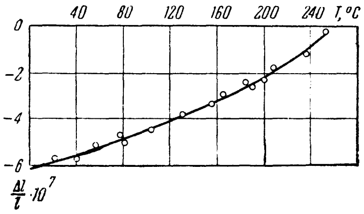

FIG. 1. Temperature dependence of the magnetostriction of NiO in a field of 14,200 oe.

The magnetostriction measurements were made by the wire-probe method by use of a photoelectro-optical amplifier. Figure 1 shows the temperature dependence of the transverse magnetostriction, measured in a field of 14,200 oe. The magnetostriction has a negative sign and decreases monotonically on approach to the Curie point. Figure 2 shows the field dependence of the transverse magnetostriction at various temperatures, and also the longitudinal magnetostriction at room temperature; the latter has a positive sign. What attracts attention is the fact that there is a certain "critical" field ($H_c \approx 5000$ oe) below which the magnetostriction is practically zero. Only after attainment of this field does the increase of magnetostriction begin.

In our opinion the magnetostriction in antiferro-

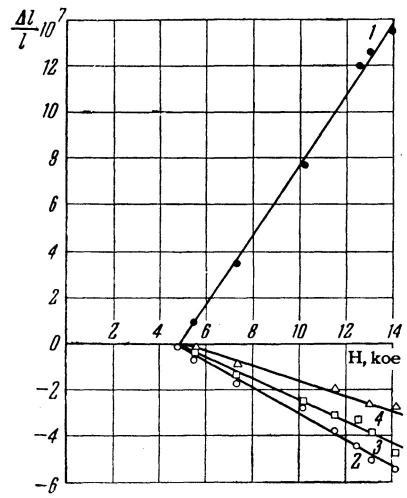

FIG. 2. Longitudinal and transverse magnetostriction of NiO. 1, longitudinal magnetostriction at 21°C; 2, transverse magnetostriction at 21°C; 3, at 53°C; 4, at 74°C.