on the input channel.

This may mean, in particular, that the widths of the decay are different in the cases of level production with input-channel spins S = 0 and S = 1. Comparing the values of t_p, t_α, and t_γ for the 2114-keV resonance, we get $\Gamma^{(1)}_{\gamma 0}/\Gamma^{(0)}_{\gamma 0} = 7$. Here $\Gamma^{(0)}_{\gamma 0}$ and $\Gamma^{(1)}_{\gamma 1}$ are the γ widths corresponding to input-channel spins S = 0 and S = 1, respectively.

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CURRENT-VOLTAGE CHARACTERISTIC OF AN IRRADIATED SUPERCONDUCTING POINT CONTACT

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It is known at present that point contacts between superconductors have properties analogous to the properties of Josephson tunnel junctions [1 - 3]. However, the existence of such an outward analogy with the tunnel junction, the properties of which have been well investigated both experimentally and theoretically, has not clarified fully the mechanism of the effect observed in superconducting junctions. A superconductiong-contact model proposed and investigated theoretically in [5] has made it possible to explain the main observed features. This theory explained, for example, the presence of a vertical section (stp) on the current-voltage characteristic I(V) at a voltage $V = \hbar\omega/2e$ under the influence of weak microwave radiation. It can be shown that the formula obtained in [5] for I(V) under irradiation is valid only when $V = \hbar\omega/2e$, and the question of the form of the current-voltage characteristic near the step remains unclear. In particular, according to [5], V(I) is not a single-valued function in the case of irradiation, i.e., the form of the measured current-voltage characteristic near the step should depend on the measurement conditions (either the current through the contact or the voltage on it is specified).

In this paper we calculate on the basis of the model proposed in [5] the I(V) characteristic under irradiation, particularly near the step, and compare the result with experiment. We have found that V(I) is a single-valued function and therefore the form of the observed current-voltage characteristic is independent of the measurement conditions.

We write down the equation for the phase difference ϕ of the ordering parameter in the presence of external radiation, in terms of dimensionless variables [5]:

$$\dot{\phi} + \sin\phi = j + j_1 \sin(\Omega\tau) , \quad (1)$$

Here $\tau = t/t_0$, $t_0 = \hbar/2eI_cR$, I_c - critical current of the contact, $j = I/I_c$ - current through the contact (assumed constant). The last term in the right side of (1) corresponds to an external signal with amplitude $I_1 = j_1 I_c$ and frequency $\omega = \Omega/t_0$. To determine the current-voltage characteristic from (1), it is necessary to find the voltage $v(\tau) = d\phi/d\tau$ and to average it in time. Equation (1) can be investigated under the assumption $\Omega \gg 1$

(actually the inequality need not be strong). If we are interested in the form of the current-voltage characteristic at voltages not too close to Ω (position of the step), then the solution can be sought in the form $\phi - v\tau + \psi$, where v is the average voltage and ψ is an oscillating function of small amplitude ($\psi \sim 1/j$, j_1/Ω; $j \sim v \sim \Omega$). Then, solving (1) by iteration with respect to ψ, we obtain

$$i = i_o(v) - \frac{i_1^2}{8\Omega^2(\Omega - v)} - \frac{i_1^2}{8\Omega v(v + \Omega)} \quad . \tag{2}$$

Here $j_0(v) = v + 1/2v + \ldots = (1 + v)^{1/2}$ is the current-voltage characteristic in the absence of irradiation [5]. It is clear from (2) that at voltages not too close to Ω the correction to the current-voltage characteristic due to the irradiation is of second order in j_1. However, this correction increases when the difference $\Omega - v$ decreases. In this case the second term of (2) becomes more appreciable, leading to a drop of the current-voltage characteristic if $v < \Omega$ and to a rise if $v > \Omega$. The closer v to Ω, the larger this drop (when $\Omega - v \lesssim j_1/\Omega$, expression (2) no longer holds). The last term in (2) describes the lowering of the entire current-voltage characteristic upon irradiation.

We seek the solution of (1) near the step in the form $\phi = \chi + \psi_r$, where $\chi = v\tau + \psi_s$, where ψ_s is the slowly varying part of the phase (with period $v - \Omega$) corresponding to harmonics of various frequencies (the second term of (2) is due to the contribution of just these harmonics); ψ_r is the rapidly varying part of the phase (with period $v \sim \Omega$) and corresponds to the natural and induced voltage oscillations. Substituting this expression in (1) we obtain, taking the smallness of ψ_r into account

$$\dot{\chi} + \dot{\psi}_\delta + \sin\chi + \psi_\delta \cos\chi = i + i_1 \sin(\Omega\tau) . \tag{3}$$

Averaging (3) over the fast oscillations, we obtain for the rapidly varying function

$$\dot{\chi} + \langle \psi_\delta \cos\chi \rangle = j \; . \tag{4}$$

Subtracting (4) from (3) we obtain an equation for ψ_r, from which we get in first order in v^{-1} $\psi_r = \cos\chi/\dot{\chi}(\tau_0) - (j_1/\Omega)\cos(\Omega\tau)$, where τ_0 is a certain fixed instant of time. After substituting this expression in (4), the equation for χ takes the form

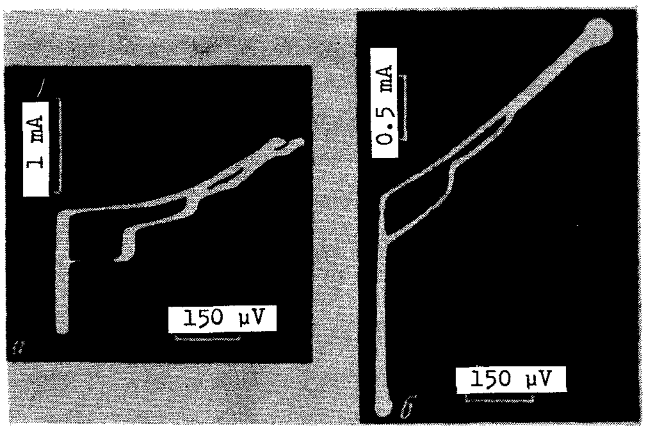
$$\dot{\chi} - (i_1/2\Omega)\cos(\chi - \Omega\tau) = i - \frac{1}{2\dot{\chi}(\tau_o)} \quad . \tag{5}$$

Equation (5) can be reduced to a form similar to the equation for ϕ without radiation. Integrating this equation, we obtain the form of the current-voltage characteristic:

$$i = \begin{cases} i_a(v) + \sqrt{(v - \Omega)^2 + (i_1/2\Omega)^2}, & v \neq \Omega \\ i_a(\Omega) - (i_1/2\Omega)\cos\theta , & v = \Omega \; . \end{cases} \tag{6}$$

where θ is the phase difference between the induced and natural voltage oscillations, and $j_a = \Omega + 1/2v$. We see that the current-voltage characteristic near the step has the same form as when $v = 0$ in the absence of radiation, i.e., it is a single-valued function also near the step. At a certain distance from the step, when $|v - \Omega| \gg j_1/\Omega$, expression (6) goes over into relation (2) if $|v - \Omega| \ll \Omega$. We can similarly calculate the critical current at any irradiation intensity. It turns out that $I_c(j_1) = I_c|J_0(j_1/\Omega)|$, and the amplitude of the step is $I = 2I_c|J_1(j_1/\Omega)|$, where J_0 and J_1 are Bessel functions of zero and first order, respectively.

We measured in the experiment the current-voltage characteristic of Nb-Nb point contacts heated by irradiation under different conditions, viz. at a specified current and at a specified voltage on the contact. The degree of contact pressure was regulated from the outside of the helium cryostat, making it possible to obtain current-voltage characteristics of various types. In this investigation we were interested in the current-voltage characteristics corresponding to the resistive state at $I > I_c$, with a resistance ~ 1 ohm. According to our estimates, the radius of the contacts was $\leq 3 \times 10^{-6}$ cm in this case. The contacts were exposed to 2- and 4-mm radiation of 10^{-5} - 10^{-8} W power at 4.2°K. The specified voltage regime was effected by connecting the junction in a low-resistance circuit with an internal voltage-source resistance 10^{-2} ohms with a series resistor of 10^{-1} for the measurement of the current.



Oscillograms of current-voltage characteristic of an Nb-Nb point contact at 4.2°K without irradiation and following application of 4-mm radiation; a - specified current regime, b - specified voltage regime.

The main experimental results are shown in the figure, in the form of oscillograms of the current-voltage characteristics for a point contact with the current (Fig. 1a) or voltage (Fig. 1b) specified. Each figure shows two characteristics, viz., without irradiation (smooth curve) and with 4-mm radiation applied (curve with steps). Qualitatively, the form of the current-voltage characteristic was independent of either the radiation frequency or the values of I_c and R. We note the following: First, the action of microwave radiation of 10^{-5} W power on a point contact results not only in steps on the current-voltage characteristic, corresponding to the fundamental frequency and its harmonics, but also a lowering of the entire I(V) curve relative to its position in the absence of radiation, i.e., relative to $I_0(V)$. At high powers, the current-voltage characteristic was close to ohmic and the amplitude of the steps decreased to zero. At low radiation power, ($\sim 10^{-8}$ W), however, the drop of the I(V) curve was small, and this curve was lower than $I_0(V)$ at $V < \hbar\omega/2e$, and higher at $V > \hbar\omega/2e$. Second, the form of the current-voltage characteristics was qualitatively the same in both regimes.

We have thus calculated, on the basis of the model proposed in [5], the current-voltage characteristic of an irradiated superconducting point contact and its dependence on the radiation intensity. The experimental results are in good agreement with the calculation, thus evidencing the applicability of the model proposed in [5] to the investigated system.

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EXPERIMENTAL INVESTIGATION OF THE "MEMORY" EFFECT OF He-Ne LASERS

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It was shown in [1] that when radiation from an He-Ne laser is fed back to the resonator by a moving reflecting mirror, induced oscillations with frequencies $\nu_0 \pm p\nu_D$ can be excited in the laser under certain conditions. Here ν_0 is the frequency of the probing signal, ν_D the Doppler frequency, and p is an integer. The region of induced oscillations at two frequencies corresponding to one longitudinal mode was determined theoretically in [2]. We have thus established that a gas laser has a "memory." The present paper is devoted to an experimental investigation of the volume of the He-Ne laser "memory."

Experimental Setup

The experiment was performed with the setup described in [1, 2]. The He-Ne laser generated at two wavelengths, $\lambda_1 = 0.63$ μ and $\lambda_2 = 3.39$ μ. The discharge length in the laser tube was ~ 60 cm. The pressure in the tube was ~ 1 mm Hg. The He:Ne partial-pressure ratio was 6:1. The resonator length was L = 1 m. The laser operated in the TEM_{00q} mode at several longitudinal modes. The radiation emerging from one of the resonator mirrors was incident on the moving reflector. The energy at the wavelength λ_2 in the backward beam, limited in the plane of the resonator mirror to a cross section diameter equal to the diameter of the emerging beam, was 10^{-2} - 10^{-1} the energy emerging from the laser. The frequency-shifted signal fed back to the laser caused modulation of the radiation at the shift frequency. The output radiation traversed the distance between the resonator mirrors and the external moving reflector many times. The beam passed through the second resonator mirror to a photomultiplier. The spectra of the low-frequency beat signals were photographed from the screen of a spectrum analyzer.

Results

1. It was established in the first series of experiments that after the cessation of the feedback signals at the wavelengths λ_1 and λ_2, the stimulated generation simultaneous at the frequencies $\nu_0 \pm p'_D$ and $\nu_0 \pm p''_D$ was revealed (by the beat signals) during a time not exceeding 3 minutes. Here ν'_D and ν''_D are the Doppler frequencies at the wavelengths λ_1 and λ_2. The beat spectrum then revealed signals corresponding to a single wavelength. There was