and $\lambda_{cr}(m = 1) = 3d^2/2\lambda \approx 2\lambda_{cr}(m = 0)$, as was indeed observed in experiments both with a neodymium laser ($\lambda_{cr_1} \approx 5$ cm, $\lambda_{cr_2} \approx 16$ cm) and with a helium-neon gas laser ($\lambda_{cr_1} \approx 8.5$ cm, $\lambda_{cr_2} \approx 25.5$ cm) for a grid with $d \sim 2 \times 10^{-2}$ cm.

The beam easiest to cut up with a raster is one with a near-rectangular radial distribution of the intensity. However, even for any radial distribution of the radiation intensity density I(r) one can choose a raster with radially-dependent cell areas s(r) such that the power passing through each cell is close to the threshold value, $s(r) \sim I(r)/P_{thr}$. The transverse gradient of the sub-beam is then significantly weakened by diffraction, so that its bending and its scattering are decreased. The results of this investigation extend considerably the possible use and manifestation of waveguide self-focusing.

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## LOW-FREQUENCY MAXIMA OF THE DENSITY OF STATE OF PHONONS. HARMONICS AND SUBHARMONICS OF THE ENERGY GAP OF $Nb_3Sn$

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1. Detailed tunnel investigations of the energy gap of $Nb_3Sn$ were reported in [1], and four values (4.70, 2.24, 1.50, and 0.36 meV) were obtained for the gap $2\Delta$. The principal maximum of the tunnel density of states (the region of the second and third gaps) corresponds to an energy $2\Delta_{eff} = 1.9$ meV, where $\Delta_{eff}$ is the effective value of the gap in $Nb_3Sn$.

It was shown earlier [3, 4] that the use of low-resistance contacts with microscopic short circuits makes it possible to observe clearly all the singularities of the tunnel characteristics.

In the present paper we report an investigation of the differential conductivity (dI/dV) and of its derivative ($d^2I/dV^2$) both in the voltage region $V < 2\Delta$ and in the region $V > 2\Delta$, for $Nb_3Sn$-Pb, $Nb_3Sn$-Sn, and $Nb_3Sn$-Al tunnel junctions with micro-short-circuits. We used junctions with resistances $10^{-2}$ - 1 ohm/mm$^2$.

2. At low voltages, maxima of the differential conductivity (gap subharmonics) are observed at voltages $V_n = (\Delta_{eff} + \Delta_m)/n$, where n is an integer and $\Delta_m$ is the energy gap of the second metal. As a rule, the amplitude of the even

subharmonics was larger than the amplitude of the odd ones. Subharmonics corresponding to even values of n only were observed on the differential-conductivity curves of some of the junctions.

Figures 1a and 1b show plots of the differential conductivity against the voltage for two $Nb_3Sn$-Pb junctions. In the first case (Fig. 1a) one can see both even and odd subharmonics. In the second case (Fig. 1b), only even subharmonics of the gap appear. It is clearly seen from the figure that the amplitude of the observed maxima decreases very slowly. We were therefore able to observe high-order subharmonics. It should be noted that when the subharmonic amplitude is increased the principal maximum of the conductivity, corresponding to $\Delta_{eff} + \Delta_m$, decreases.

In addition to the effective-gap subharmonics, which make up the main structure, several first subharmonics of the other gaps are also observed (these subharmonics are designated by unmarked arrows in the figure).

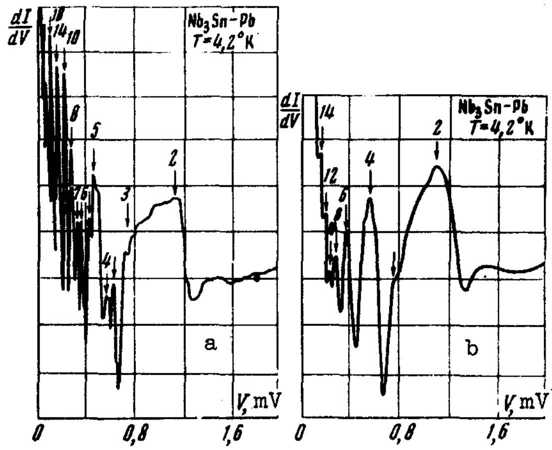


Fig. 1. Subharmonics of two $Nb_3Sn$-Pb tunnel junctions. The numbers above the arrows denote the numbers of the subharmonics of the sum $(\Delta_{eff} + \Delta_{Pb})$. The unmarked arrows designate subharmonics connected with other gaps of $Nb_3Sn$.

Earlier tunnel experiments have revealed first-order gap subharmonics for the simple metals Pb, Sn, and Hg [2 - 5]. The indicated subharmonics are usually connected with multiparticle tunneling [2, 6]. Another possible explanation is connected with Josephson radiation [7]. Both mechanisms, however, should lead to a considerable decrease of the amplitude of the subharmonic with increasing subharmonic number, but this was not observed.

3. We investigated the derivative of the differential conductivity at voltages $V > 2\Delta$. All tunnel junctions of $Nb_3Sn$ with other metals revealed a distinctive jump of $d^2I/dV^2$ in the region of the voltage $V_{ph} = \Delta_{ph} + \Delta_{eff} + \Delta_m$, where $\Delta_{ph} = 6.2 \pm 0.6$ mV ($V_{ph}$ corresponds to the voltage at the middle of the jump of $d^2I/dV^2$). The second metal was either Pb ($\Delta_m = 1.33$ meV) or Al ($\Delta_m = 0$). $\Delta_{eff} = 1.9$ meV. We assume that the observed jump of $d^2I/dV^2$ is connected with the maximum of the phonon density of states of $Nb_3Sn$. This jump is shown in Fig. 2.

It should be noted that in $Nb_3Sn$ the jump of $d^2I/dV^2$ has a much larger amplitude and is more abrupt than the jump corresponding to the longitudinal phonons of lead[1]. In the investigation of the temperature dependence of the static resistance R(T) for $Nb_3Sn$ there is observed in R(T) a term proportional to $\exp(-T_0/T)$ [8, 9]. This term may be connected with the scattering of the electrons by "optical" phonons with energy gap $kT_0$ in the spectrum. $kT_0 = 6.7$ meV for $Nb_3Sn$, in good agreement with the value of $\Delta_{ph}$ obtained in our tunnel experiments.

[1]The singularities connected with the phonon spectrum of lead can hardly be seen in Fig. 1. They were revealed by special measurements of Al-Pb tunnel junctions.

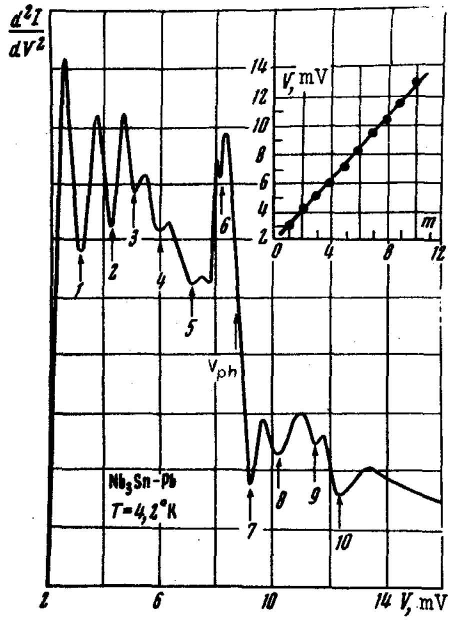


Fig. 2. Plot of $d^2I/dV^2$ vs. V for an $Nb_3Sn$-Pb junction at a voltage $V > (\Delta_{eff} + \Delta_{Pb})$. The numbers are those of the harmonics of $\Delta_{eff}$. $V_{ph} = \Delta_{ph} + \Delta_{eff} + \Delta_{Pb}$. The insert shows the dependence of the positions of the minima of $d^2I/dV^2$ on the number of the harmonic.

Besides the indicated jump of $d^2I/dV^2$, detailed investigations of many junctions suggest the presence of a second small jump of $d^2I/dV^2$ in the region $\Delta'_{ph} \approx 3.5$ meV. Its amplitude is much smaller and it appears distinctly only in those cases when the amplitude of the gap harmonics is small. We assume that this second jump of $d^2I/dV^2$ is also connected with the maximum of the phonon density of states in $Nb_3Sn$.

4. At voltages $V > 2\Delta$, harmonics $V_m = m\Delta_{eff}$ were observed in some cases for $Nb_3Sn$-Pb junctions. These harmonics are marked by arrows on Fig. 2. We have observed these harmonics up to m = 10. All the minima on the $d^2I/dV^2$ curve agree well with the foregoing linear dependence. It is possible that they are connected with the inelastic interaction of a pair of tunneling electrons with the superconducting pairs.

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## EFFECTIVENESS OF EXCITATION OF LASING IN AN $F_2 + H_2$ MIXTURE BY A BEAM OF RELATIVISTIC ELECTRONS

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To obtain the maximum parameters of a pulsed chemical laser using an $F_2 + H_2$ mixture it is necessary to increase considerably the volume and pressure of