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A session of the Division of General Physics and Astronomy of the Academy of Sciences of the USSR was held on January 31 and February 1, 1979 at the P. N. Lebedev Physics Institute. The following papers were delivered:

1. *N. G. Basov, É. M. Belenov, S. I. Vedeneev, G. P. Motulevich, and V. V. Nikitin*, Frequency multiplication in the 10^{10}–10^{13} Hz range with the aid of weak superconductive couplings.
2. *N. E. Alekseevskiĭ*, Properties of multicomponent superconductive molybdenum chalcogenides.
3. *É. R. Mustel', V. E. Chernoprud, and N. B. Mulyukova*, Effects of solar activity on the lower layers of the earth's atmosphere.
4. *I. A. Zhitnik, É. Ya. Kononov, V. V. Korneev, V. V. Krutov, S. L. Mandel'shtam, and A. M. Urnov*, Spectra of solar x-ray flares.
5. *V. V. Zheleznyakov and E. Ya. Zlotnik*, Diagnostics of neutral current layers under space conditions.

We publish below brief contents of three of the papers.

N. G. Basov, É. M. Belenov, S. I. Vedeneev, G. P. Motulevich, and V. V. Nikitin. *Frequency multiplication in the 10^{10}–10^{13} Hz range with the aid of weak superconductive couplings.* Great progress has been made in recent years in the stabilization and measurement of gas-laser generating frequencies. However, the accuracy with which laser frequencies can be measured is still short of their frequency stability. This is due primarily to the great difficulty of transferring a radio-band standard frequency into the optical band owing to the lack of good frequency multipliers and mixers for the infrared. Here the use of superconductive weak couplings, for example superconductive point contacts (SPC) may offer promise.

We have studied various operating regimes of SPC and found a nonequilibrium regime in which the nonlinearity is greatest, making possible effective multiplication and shifting of frequencies with harmonic amplitudes 2–3 orders higher than those in normal Josephson contacts. This SPC operating mode is characterized by a high critical current I_c and a low resistance of the SPC in the normal state (R_N). Directly in the region of the contact, "strong" overlapping of the wave functions of the superconductors across the contact is preserved, and, in the case of a nonzero voltage V_0, relatively strong Josephson emission is always present.

When the intrinsic emission of the contact is strong, the reciprocal effect of this emission on the SPC, which multiplies it, becomes significant. As a result, irradiation of the SPC with external microwave radiation at frequency ω produces an additional subharmonic structure on the volt-ampere (I-V) characteristics of the contact that satisfies the generalized Josephson relation

$$2eV_0=\frac{n}{k+1}\hbar\omega,$$

where e is the electron charge, $\hbar$ is Planck's constant, and n and k are integers.

Theoretical analysis of "self-action" within the framework of the generally accepted resistive model of the SPC has made it possible to obtain the amplitude of the subharmonic structure, whose dependence on the power of the incident radiation was found to be stronger than in accordance with the ordinary Bessel law. The calculated results agree closely with experiment. The "self-action" is equivalent to the concept in which the elementary quanta of charge transfer in the SPC are not only pairs of electrons, but also groups of four, six, and so forth.

With respect to the frequency-multiplying process, the subharmonic structure is a second-order effect that appears only at sufficiently large values of I_c. It is very important that when the intrinsic emission of the contact is strong, it is possible to bring about "pure" mixing of two external signals, in which case the intermediate-frequency (i.f.) signal will depend only on the signals being mixed. The amplitude of the i.f. signal in the case of pure mixing of an m-th harmonic of an external signal of frequency ω_1 and amplitude A_1 with an n-th harmonic of an external signal of frequency ω_2 and amplitude A_2 is equal, within the framework of the resistive model, to

$$I_cJ_{-1}\left(\frac{2eI_c\rho}{\hbar\omega_0}\right)J_m\left(\frac{2eA_1}{\hbar\omega_1}\right)J_{-n}\left(\frac{2eA_2}{\hbar\omega_2}\right);$$

here J_{-1}, J_m, and J_{-n} are Bessel functions of the corresponding orders, ω_0 is the natural emitting frequency of the contact, and ρ has the dimensions of resistance and depends only on the geometry of the SPC and on the electrodynamic system into which it is connected. An analogous factor J_1 determines the magnitude of the substructure corresponding to $k=1$. Therefore those SPC in whose I-V characteristics the substructure corresponding to $k=1$ is distinctly evident are optimal for

 0038-5670/79/080662-04$01.10

mixing.

In the detection, multiplication, or mixing of external-radiation frequencies, the "strong" intrinsic emission of the SPC has the same effect as heterodyne emission when receivers detect weak signals. Fluctuations of the i.f. signal due to fluctuations of the voltage on the SPC are eliminated in pure mixing of signals. This fact is of basic importance for the absolute measurement of laser frequencies. Actually, frequency fluctuations of stabilized lasers amount to 10–100 Hz, whereas the thermal fluctuations of the voltage across the SPC at 4.2 °K are sufficient to produce an i.f. linewidth of about 10^5 Hz (without considering the intrinsic emission). Allowance for the latter makes possible practically complete elimination of the effects of SPC voltage fluctuations on the i.f. spectrum.

The picture thus developed, which takes into account the "self-action" of the intrinsic emission, made it possible to explain the previously observed subharmonics and harmonics of the superconductor's energy gap. Experiments have shown that superconductive weak couplings based on niobium and its alloys remain strongly nonlinear in the frequency range $\gtrsim 8 \cdot 10^{12}$ Hz. Their use makes it possible to multiply and mix frequencies in the range 10^9–10^{13} Hz. In metrological problems, the intermediate klystron and the cumbersome submillimeter HCN laser can already now be eliminated in the frequency-synthesis chain from the radio band to the visible region.

An important problem in frequency multiplication is the dependence of the spectral widths of the harmonics of the multiplied radiation on the number of the harmonic, an effect determined by the statistical properties of the noise shaping the linewidth of the external radiation. If the noise is "white," then $\Delta\omega_n \sim n^2$; here $\Delta\omega_n$ is the spectral width of the n-th harmonic. It is not advantageous to use this radiation to obtain higher-numbered harmonics, since it has $\Delta\omega_n/\omega_n = n\Delta\omega_1/\omega_1$. However, it can be assumed for practical purposes that the noise spectrum is cut off at a certain frequency ω_c. In this case we have $\Delta\omega_n \sim n$ for $\omega_n \gg \omega_c$. For frequency multiplication, therefore, it is desirable to use external-radiation sources with the lowest possible ω_c. The materials of the present report were published in the following sources: G. N. Basov, É. M. Belenov, S. I. Vedeneev, M. A. Gubin, G. P. Motulevich, V. V. Nikitin, V. A. Stepanov, and A. V. Uskov, Kvantovaya Electron. (Moscow) **6**, 1718 (1979) [Sov. J. Quantum Electron. **9**, 1012 (1979)]. É. M. Belenov, S. I. Vedeneev, G. P. Motulevich, V. A. Stepanov, and A. V. Uskov, Zh. Eksp. Teor. Fiz. **76**, 791 (1979) [Sov. Phys. JETP **49**, 399 (1979)]. G. N. Basov, É. M. Belenov, S. I. Vedeneev, M. A. Gubin, G. P. Motulevich, V.V. Nikitin, M. G. Perevalov, V. A. Stepanov, and A. V. Uskov, Kvantovaya Elektron. (Moscow) **5**, 371 (1978) [Sov. J. Quantum Electron. **8**, 213 (1978)]. S. I. Vedeneev and G. P. Motulevich, Fiz. Tverd. Tela (Leningrad **19**, 2973 (1977) [Sov. Phys. Solid State **19**, 1742 (1977)].