A SUPERCONDUCTING SPECTROMETER WITH PHASE-LOCKED JOSEPHSON OSCILLATOR *

S. V. Shitov [1,2], V. P. Koshelets [1,2], P. N. Dmitriev [1], L. V. Filippenko [1], An. B. Ermakov [1,2], V. V. Khodos [3], V. L. Vaks [3]

[1] Institute of Radio Engineering and Electronics, Russian Academy of Sciences (IREE RAS), Moscow, Russia

[2] National Institute for Space Research (SRON), Groningen, the Netherlands

[3] Institute for Physics of Microstructures, Russian Academy of Sciences (IPM RAS), Nizhny Novgorod, Russia

A sensitive heterodyne spectrometer employing a superconducting local oscillator is demonstrated experimentally for the first time at 345 GHz. The research is the continuation of study of a concept of a superconducting submillimeter integrated receiver. The sensor of the phase-locked receiver comprises a quasioptical double-dipole antenna SIS mixer ($T_{RX} \approx 250$ K, DSB), a Josephson-type flux-flow oscillator (FFO) and a twin-SIS harmonic mixer, all integrated on the same silicon chip of size 4 mm by 4 mm. An elliptical silicon lens is the only optical element focusing the beam. Room temperature PLL electronics is used along with a synthesized reference source at about 10 GHz. The effective bandwidth of the PLL circuit of about ± 10 MHz and the hold range of ± 3 GHz are estimated experimentally while locking at 32-th harmonic of the reference source. It was found for the experimental sample that the optimum pump current of the SIS mixer can be adjusted within the range of 14…42 μA simply via change of the bias current of the PLL FFO. The signal from a room temperature semiconductor harmonic multiplier driven by a second synthesizer is used to test the spectrometer; the spectral resolution as low as 10 kHz is estimated. The effect of broadening of a spectral line of SO_2 gas at 326867 MHz is measured for a laboratory gas cell at 300 K within the pressure range of 0.03-0.3 mbar demonstrating the resolution bandwidth better than 1 MHz. This study provides an important input for future development of a balloon-based 500-650 GHz integrated receiver for the Terahertz Limb Sounder (TELIS) scheduled to fly in 2004-2005.

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