Performance of twin-slot antenna coupled NbN hot electron bolometer mixers at frequencies ranging from 1.4 to 4.7 THz

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For astronomical observations at frequencies beyond 1 THz, heterodyne detection with NbN hot electron bolometer (HEB) mixers is preferable. In this research we improve the coupling of incoming radiation to the HEB using twin-slot antennas. Our experiments focus on the performance of our antenna designs with frequencies at interesting molecular emission lines corresponding to 1.4, 1.9, 2.7, and 4.7 THz. We make detailed analysis of the performance of the 1.4 THz HEB and demonstrate an excellent measured receiver noise temperature T_{rec} of 480 K with a noise bandwidth of 3 GHz.

Incoming radiation is coupled to the superconducting bridge quasi-optically. Often this is done by a spiral antenna, which is convenient because of its large bandwidth. Using a twin-slot antenna should in principle offer a better coupling efficiency, because it has the same linear polarization as the LO source (QCL). In practice however, the performance of twin-slot antenna at frequencies has been below expectations. We demonstrate improved antenna coupling at high frequencies beyond 1 THz. We compare the spectral response and noise temperature of twin-slot coupled HEBs with design frequencies at the molecular lines at 1.4, 1.9, 2.67, and 4.7 THz. Furthermore we make a detailed analysis of the performance of 1.4 THz HEBs, including the frequency response and the dependence on the resistance and geometry of the bridge.