Mid-infrared heterodyne receiver based on a superconducting hot electron bolometer and a quantum cascade laser

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The mid-infrared frequency region plays a vital role in the modern astronomic research, which includes early cosmic evolution, star and galaxy formation, and the planet's atmosphere research. However, the high-resolution spectrometer in this frequency region is still under developed. This paper focused on the development of a heterodyne receiver based on a superconducting hot electron bolometer as a mixer and a quantum cascade laser at 10.6 μm as a local oscillator.

A superconducting NbN hot electron bolometer working at 4 K was utilized as the mixer, with a combination of a hyper-hemispherical lens and a spiral antenna employed as the coupling element. A distributed feedback quantum cascade laser providing more than 30 mW power at 10.6 μm served as the local oscillator. The double sideband receiver noise temperature ($T_{DSB,Rec}$) was characterized with a Hg lamp as hot load and room temperature blackbody as cold load, and the $T_{DSB,Rec}$ was measured to be about 5000 K with an intermediate frequency bandwidth of 2.8 GHz.

This development paves a new way to the high resolution spectroscopy at mid-infrared frequencies.