THz Quantum Cascade Laser as Local Oscillator in a Heterodyne Receiver

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Heterodyne spectroscopy of molecular rotational lines and fine structure lines of atoms or ions is a powerful tool for the investigation of the interstellar medium as well as planetary atmospheres. The Terahertz (THz) part of the electromagnetic spectrum is especially rich in these lines. Some examples are the CII fine structure line at 1.6 THz, the 1-0 transition of HD at 2.7 THz, and the OI fine structure line at 4.7 THz. Several THz heterodyne receivers are currently under development. One example is GREAT, the German Receiver for Astronomy at THz Frequencies, on board of SOFIA. GREAT is a modular receiver with three frequency bands operating at 1.6-1.9 THz, 2.5-2.7 THz and particular frequencies between 3 THz and 5 THz. A key component of any heterodyne receiver is the local oscillator. It should be a continuous wave, narrow linewidth, and frequency tunable source with at least several μW output power. However, above about 2 THz there is a lack of sources of this kind.

Recently a new type of THz laser, the THz quantum cascade laser (QCL), has been developed. The lasing mechanism is based on interminiband transitions in the conduction band of GaAs/AlGaAs heterostructures. Laser operation between 2.1 THz and 4.4 THz, operation temperatures up to 93 K, and high output power up to 50 mW have been achieved. Although for record performance in terms of output power and temperature the laser is typically not single moded the THz QCL a very promising source for application in a heterodyne receiver. We will report on the characterization of a THz QCL with respect to relevant performance parameters when used as local oscillator. This includes operation in a closed cycle cryocooler, beam profile measurements and pumping of a HEB mixer at 4.4 THz. The prospects for this particular application of a QCL will be discussed.