Effect of Feedback on Quantum Cascade Laser Performance

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Abstract

THz quantum cascade lasers are promising solid-state sources for use as local-oscillators in THz heterodyne receiver systems especially when frequencies higher than 2 THz or power exceeding mW are needed. Recent phase locking measurements of THz QCLs to high harmonics of microwave frequency reference sources as high as 2.7 THz [[1], [2]] demonstrate that the linewidth and frequency stability of QCLs can be more than adequate for astrophysical measurements.

Using a novel transceiver with a Schottky diode monolithically integrated into a THz QCL, we have begun to explore the sensitivity of the laser performance on feedback due to retroreflections of the THz laser radiation. The transceiver allows us to monitor the beat frequency between internal Fabry-Perot modes of the QCL or between a QCL mode and external radiation incident on the tranceiver. When feeding back the radiation from a Fabry-Perot type QCL with quasi-static optics we observe reproducible fluctuations of the difference frequency between the QCL modes as either the alignment of or distance to the reflector is changed.

We have also explored the behavior when the difference frequency of the internal laser modes is locked to an $\sim$ 13 GHz microwave reference source (as done in ref. [[3]]) with a linewidth less than 10 Hz. The narrow linewidth allowed us to observe sidebands with a few hundred Hz separation when the retroreflector was vibrated at a fixed frequency. In some cases these sidebands were only 3dB down from the central peak at the locked frequency.

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