A 4.7-THz quantum-cascade laser as local oscillator for the GREAT heterodyne spectrometer on SOFIA

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Heterodyne spectroscopy of molecular rotational lines and atomic fine -structure lines is a powerful tool in astronomy and planetary research. It allows for the study of the chemical composition, the evolution, and the dynamical behaviour of astronomical objects such as molecular clouds and star-forming regions. For frequencies beyond 2 THz, SOFIA, the Stratospheric Observatory for Infrared Astronomy, is currently the only platform which allows for heterodyne spectroscopy at these frequencies. One example is the OI fine-structure line at 4.7 THz, which is a main target to be observed with GREAT, the German Receiver for Astronomy at Terahertz Frequencies, on board of SOFIA.

We report on the development of a 4.7-THz local oscillator (LO) for the heterodyne spectrometer GREAT on SOFIA. The LO combines a quantum-cascade laser (QCL) with a compact, low-input-power Stirling cooler. The 4.7-THz QCL is based on a hybrid design and has been developed for continuous-wave operation, high output powers, and low electrical pump powers [1]. Efficient carrier injection is achieved by resonant longitudinal optical phonon scattering. This design allows for an operating voltage below 6 V. The amount of generated heat complies with the cooling capacity of the Stirling cooler of 7 W at 65 K with 240 W of electrical input power [2]. Frequency stabilization is achieved by locking the emission from the QCL to an absorption line of CH3OH using a pyroelectric detector and a PID control loop [3]. The design of the LO and its performance in terms of output power, frequency accuracy, frequency stability, and beam profile as well as its implementation in GREAT will be presented.

References

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