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摘要: Context. Supplementing the publications based on the first-light observations with the German REceiver for Astronomy at Terahertz frequencies (GREAT) on SOFIA, we present background information on the underlying heterodyne detector technology. This Letter complements the GREAT instrument Letter and focuses on the mixers itself.
Aims. We describe the superconducting hot electron bolometer (HEB) detectors that are used as frequency mixers in the L1 (1400 GHz), L2 (1900 GHz), and M (2500 GHz) channels of GREAT. Measured performance of the detectors is presented and background information on their operation in GREAT is given.
Methods. Our mixer units are waveguide-based and couple to free-space radiation via a feedhorn antenna. The HEB mixers are designed, fabricated, characterized, and flight-qualified in-house. We are able to use the full intermediate frequency bandwidth of the mixers using silicon-germanium multi-octave cryogenic low-noise amplifiers with very low input return loss.
Results. Superconducting HEB mixers have proven to be practical and sensitive detectors for high-resolution THz frequency spectroscopy on SOFIA. We show that our niobium-titanium-nitride (NbTiN) material HEBs on silicon nitride (SiN) membrane substrates have an intermediate frequency (IF) noise roll-off frequency above 2.8 GHz, which does not limit the current receiver IF bandwidth. Our mixer technology development efforts culminate in the first successful operation of a waveguide-based HEB mixer at 2.5 THz and deployment for radioastronomy. A significant contribution to the success of GREAT is made by technological development, thorough characterization and performance optimization of the mixer and its IF interface for receiver operation on SOFIA. In particular, the development of an optimized mixer IF interface contributes to the low passband ripple and excellent stability, which GREAT demonstrated during its initial successful astronomical observation runs.
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