APPLICATIONS OF MOLECULAR SPECTROSCOPY USING CASCADED FREQUENCY MULTIPLICATION.

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Molecular spectroscopy in the laboratory supports analytical, atmospheric, planetary and astrophysical sciences through quantitative, high precision, spectral measurements. Atomic and molecular signatures across the electromagnetic spectrum identified and quantified in the laboratory are the basis of remote and in-situ sensing. High-resolution rotational spectroscopy offers high sensitivity and high selectivity for biologic, organic, and inorganic species. However, the THz frequency region is relatively unexplored, mainly due to atmospheric absorption and former technological hurdles. Advances in lithography and microwave telecommunication equipment have facilitated revolutionary new all-solid-state local oscillators (LOs). The LOs developed for the Herschel Space Observatory and ALMA have high conversion efficiency, low spurious harmonic content and wide instantaneous bandwidth. The sources consist of cascaded planar-diode frequency doublers and triplers pumped with an amplified active millimeter wavelength multiplier. A basic system, consisting of a low-noise microwave frequency synthesizer, sensitive detector and lock-in-amplifier enables routine submillimeter and THz spectroscopic measurements. The resulting spectrometer provides a sensitivity of 1 part in 10^8 and offers more flexibility than conventional BWO techniques. Techniques with higher sensitivity that are useful at centimeter wavelengths may be applied to this THz system and should enable increased sensitivities in the THz region without the need for Helium cooled detectors. Such extensions will enable portable, packaged, even commercial utilization of the spectrometer.