INFRARED LASER ABSORPTION SPECTROSCOPY WITH HETERODYNE DETECTION

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Of fundamental importance in the spectroscopy of dilute species is instrumental sensitivity. In laser absorption spectroscopy, extremely high sensitivity is possible and is fundamentally limited only by shot noise, the statistical noise that arises from counting photons. Shot noise limited performance is difficult to reach due to large fluctuations in the intensity of lasers. This additional noise has an approximately 1/f dependence and can be lowered by encoding the experimental signal at high frequency with a modulation technique. In order to escape this noise completely, modulation frequencies greater than 1 MHz must be realized.

Heterodyne spectroscopy is a technique that relies on phase modulation of laser radiation with an electro-optic modulator. This technique is one of the few methods that can encode the experimental signal at frequencies greater than 1 MHz and has been applied to visible and near-IR lasers in the past with great success. In this talk we report the use of heterodyne spectroscopy in the mid-IR and discuss the additional challenges of implementing it in the mid-IR. We demonstrate infrared heterodyne modulation with the study of velocity-modulated molecular-ion absorptions, where we have detected absorptivities as low as 2×10^{-10} cm^{-1} @ 1 Hz bandwidth.