CAVITY-ENHANCED, FREQUENCY-AGILE RAPID SCANNING (FARS) SPECTROSCOPY: MEASUREMENT PRINCIPLES

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We present the principles of frequency-agile, rapid scanning (FARS) spectroscopy, a new technique for high-bandwidth, cavity-enhanced, laser absorption measurements. This method enables a visible or near-infrared probe laser beam to be frequency tuned over several tens of GHz using a microwave source, a waveguide phase modulator and a filter cavity. For the types of cavity-enhanced methods discussed here, the optical resonator itself is used to select a single sideband of the modulated laser spectrum, obviating the need for a separate filter cavity. FARS offers several important advantages over conventional cw laser tuning methods based on thermal or mechanical methods. These include, high speed tuning with sub-ms switching times, the ability to select arbitrary frequency steps or chirp rates, and the realization of a spectrum detuning axis with sub-kHz level precision. We discuss how FARS can be applied to cavity ring-down spectroscopy and other cavity-enhanced methods to enable rapid and accurate measurements of line parameters and to give noise-equivalent absorption coefficients at the 10^{-12} cm^{-1} Hz$^{-1/2}$ level.