INTRACAVITY LASER SPECTROSCOPY INTEGRATED WITH FOURIER TRANSFORM DETECTION

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Cavity enhancement of molecular absorption through laser action has made intracavity laser spectroscopy (ILS) a powerful tool for the detection of trace species and weakly absorbing molecules. The effective pathlength for ILS measurements is proportional to the speed of light, leading to a high degree of sensitivity for spectroscopic measurements, and effective pathlengths of up to 70,000 km have been demonstrated with this technique. Fourier-transform spectroscopy (FTS) is a powerful technique for detection of spectroscopic signals, benefitting both from Fellgett's advantage and inherent calibration derived from the interference zero crossings of a single frequency light source. The traditional dispersive ILS system at the University of Missouri – St. Louis has been integrated with a Bruker IFS-125M FTS spectrometer. The two time-based techniques are synchronized using a National Instruments field-programmable gate array (FPGA). The maximum instrumental resolution for the combined technique is improved by nearly an order of magnitude, from 0.02 cm^{-1}resolution for 2 m monochromator with 9th order diffraction to 0.0035 $\mathrm{cm}^{-1}$with the Bruker FTS. Similarly, the detection bandwidth (7 cm^{-1}per dispersed ILS spectrum) also has improved by an order of magnitude, enabling the collection of the entire broadband laser profile (50-100 cm^{-1}) in a single measurement. In addition, a 3-fold improvement in absolute wavenumber accuracy is achieved due to the internal calibration of the FTS detection. The improved resolving power of the integrated spectroscopic system enables Doppler-width limited detection of $5d$-metal diatomic molecules. These species are of fundamental interest for the quantitation of the relativistic effects that dominate their electronic energy structure, and newly observed transitions of platinum sulfide and tungsten sulfide have already been recorded and analyzed. Details of the instrumentation, integration method, and improved capabilities will be presented.