

BASELINE-FREE MEASUREMENT OF TEMPERATURE, PRESSURE, AND CONCENTRATION FROM MOLECULAR FREE INDUCTION DECAY

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Broadband laser absorption spectrometers have enabled sensing of temperature, pressure and absorber mole fraction in gaseous systems with high sensitivity and precision. However, recovering thermodynamic conditions from the measured spectrum can be complicated by the need to correct for the background intensity spectrum of the laser source (the 'baseline'). Baseline correction becomes challenging for highly modulated laser spectra (e.g. from non-linear spectral broadening processes or etalon effects in the optical system) as well as in the presence of broadband absorption from large molecules (e.g. hydrocarbons). In this talk, we demonstrate a technique for measuring temperature, pressure, and species concentration from an absorption spectrum without the need to correct for the laser intensity spectrum. This technique is based on the time domain description of absorption spectroscopy – where the typical absorption features manifest as the temporal dynamics of the excited molecules. We demonstrate the fitting technique by accurately measuring temperature and pressure from the broadband spectrum of water vapor over a range exceeding 1000 K. Further, we apply the technique to a broadly absorbing mixture by accurately recovering species concentrations from a mixture of ethane and methane. This mixture absorbs continuously for more than 500 cm^{-1} in the near-infrared, and thus poses a significant challenge for traditional baseline correction methods. By eliminating the need to correct for the laser intensity spectrum, our results address a significant limitation of broadband laser absorption spectroscopy for sensing applications.