CAVITY-ENHANCED SPECTROSCOPY OF MOLECULAR IONS IN THE MID-INFRARED WITH UP-CONVERSION DETECTION AND BREWSTER-PLATE SPOILERS

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Molecular ions are challenging to study with conventional spectroscopic methods. Laboratory discharges produce ions in trace quantities which can be obscured by the abundant neutral molecules present. The technique Noise Immune Cavity Enhanced Optical Heterodyne Velocity Modulation Spectroscopy (NICE-OHVMS) overcomes these challenges by combining the ion-neutral discrimination of velocity modulation spectroscopy with the sensitivity of Noise-Immune Cavity-Enhanced Optical Heterodyne Molecular Spectroscopy (NICE-OHMS), and has been able to determine transition frequencies of molecular ions in the mid-infrared (mid-IR) with sub-MHz uncertainties when calibrated with an optical frequency comb[a]. However, the extent of these studies was limited by the presence of fringes due to parasitic etalons and the speed and noise characteristics of mid-IR detectors.

Recently, we have overcome these limitations by implementing up-conversion detection and dithered optics. We performed up-conversion using periodically poled lithium niobate to convert light from the mid-IR to the visible to be within the coverage of sensitive and fast silicon detectors while maintaining our heterodyne and velocity modulation signals. The parasitic etalons were removed by rapidly rotating CaF_2 windows with galvanometers, which is known as a Brewster-plate spoiler[b], which averaged out the fringes in detection. Together, these improved the sensitivity by more than an order of magnitude[c] and have enabled extended spectroscopic surveys of molecular ions in the mid-IR.

[a] J. N. Hodges, A. J. Perry, P. A. Jenkins II, B. M. Siller, and B. J. McCall, *J. Chem. Phys.* (2013), **139**, 164201.

[b] C. R. Webster, *J. Opt. Soc. Am. B* (1985), **2**, 1464.

[c] C. R. Markus, A. J. Perry, J. N. Hodges, and B. J. McCall, *Opt. Express* (2017), **25**, 3709–3721.