

## USING NICE-OHVMS LINESHAPES TO STUDY RELAXATION RATES AND TRANSITION DIPOLE MOMENTS

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Noise Immune Cavity Enhanced Optical Heterodyne Velocity Modulation Spectroscopy (NICE-OHVMS) is a successful technique that we have developed to sensitively, precisely, and accurately record transitions of molecular ions.<sup>a</sup> It has been used exclusively as a method for precise transition frequency measurement via saturation and fitting of the resultant Lamb dips. NICE-OHVMS has been employed to improve the uncertainties on  $\text{H}_3^+$ ,  $\text{CH}_5^+$ ,  $\text{HeH}^+$ , and  $\text{OH}^+$ , reducing the transition frequency uncertainties by two orders of magnitude.<sup>bcd</sup>

Because NICE-OHVMS is a saturation technique, this provides a unique opportunity to access information about the ratio of the transition dipole moment to the relaxation rate of the transition. This can be done in two ways, either through comparison of Lamb dip depth to the transition profile or comparison of the absorption intensity and dispersion intensity. Due to the complexity of the modulation scheme, there are many parameters that affect the apparent intensity of the recorded lineshape. A complete understanding of the lineshape is required to make the measurements of interest.

Here we present a model that accounts for the heterodyne modulation and velocity modulation, assuming that the fundamental lineshape is represented by a Voigt profile. Fits to data are made and interpreted in order to extract the saturation parameter.

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<sup>a</sup>K.N. Crabtree *et al.*, *Chem. Phys. Lett.* **551**, 1 (2012).

<sup>b</sup>J.N. Hodges *et al.*, *J. Chem. Phys.* **139**, 164201 (2013).

<sup>c</sup>A.J. Perry *et al.*, *J. Mol. Spectrosc.* **317**, 71 (2015).

<sup>d</sup>A.J. Perry *et al.*, *J. Chem. Phys.* **141**, 101101 (2014).

<sup>e</sup>C.R. Marcus *et al.*, *Astrophys. J.* **817**, 138 (2016).