

## HIGH-RESOLUTION NEAR-INFRARED SPECTROSCOPY OF $\text{H}_3^+$ ABOVE THE BARRIER TO LINEARITY

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Twenty transitions from the fourth overtone and combination bands of  $\text{H}_3^+$  ( $5\nu_2^1$ ,  $5\nu_2^3$ ,  $5\nu_2^5$ ,  $2\nu_1 + 2\nu_2^2$ , ...) have been observed. These transitions, which are more than 4600 times weaker than the fundamental band, occur in the near-infrared region and probe energy levels above the barrier to linearity ( $>10,000 \text{ cm}^{-1}$ ), the regime in which  $\text{H}_3^+$  has enough energy to sample linear configurations. The detection of these transitions required the development of a high-resolution, high-sensitivity ( $\Delta I/I \sim 1 \times 10^{-7}$ ) spectrometer based on a Ti:Sapphire laser and incorporating velocity modulation, heterodyne detection, noise subtraction, and multi-passing. Both pure hydrogen and He/ $\text{H}_2$  plasmas were used to discriminate between  $\text{H}_3^+$  and Rydberg transitions of  $\text{H}_2$ . The primary motivation for continuing the study of vibrational states beyond those spectroscopically probed to date<sup>a</sup> is to assist in the development of theoretical calculations of  $\text{H}_3^+$ . The measured rovibrational energy levels provide an experimental check of ab initio calculations in this region, which present a unique challenge to theorists<sup>bcd</sup>.

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<sup>a</sup>C. M. Lindsay and B. J. McCall, *J. Mol. Spectrosc.* **210**, 60 (2001).

<sup>b</sup>A. Alijah, P. Schiffels, and J. Hinze, *manuscript in preparation*, (2001).

<sup>c</sup>L. Neale, S. Miller, J. Tennyson, *Astrophys. J.* **464**, 516, (1996).

<sup>d</sup>J.K.G. Watson, *personal communication*, 1996.