HIGH-RESOLUTION NEAR-INFRARED SPECTROSCOPY OF H_3^+

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Last year we reported on the observation of 70 new rovibrational transitions of H_3^+ in the near-infrared and visible regions.[a] An additional 50 new lines have been observed since then including two hot band transitions in the near-infrared region between 10,300-12,700 cm^{-1}. Both liquid nitrogen and water cooled discharges were used to study the ions. The rotational temperatures of the liquid nitrogen cooled discharge is about 700 K, while the water cooled discharge has a rotational temperature around 1000 K and was used for only a few of the strong high $J>4$ lines and the hot band transitions. These energy levels are above the barrier to linearity ($>10{,}000$ cm^{-1}), the regime in which H_3^+ has enough energy to sample linear configurations. A high-resolution, high-sensitivity spectrometer based on a Ti:sapphire laser and incorporating velocity modulation and phase modulation with heterodyne detection[b], was used to observe the transitions. The transitions are more than 6200 times weaker than the fundamental band. Due to the abundance of strong hydrogen Rydberg transitions, both pure hydrogen and He/H_2 plasmas were used to discriminate and identify the much weaker H_3^+ transitions. The sparsity and weakness of the lines necessitated the use of the predicted intensities and frequencies[cd] to focus the wavelength region of our search. The measured rovibrational energy levels will assist in the development and verification of the theoretical calculations of H_3^+ from first principles, which is the benchmark for *ab initio* theory.

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