Precision mass measurements with molecular ions: resolving rotational and vibrational energy\textsuperscript{1} DAVID FINK, JORDAN SMITH, SAEED HAMZELOUI, EDMUND MYERS, Florida State University — Precision measurements of the cyclotron frequency ratios $\text{H}_3^+/\text{HD}^+$ and $\text{H}_3^+/\text{He}^+$ have shown differences in the masses of $\text{H}_3^+$ ions due to rotational energy. From this, we have confirmed that some high J,K states of $\text{H}_3^+$ have mean lifetimes exceeding several weeks. Using the lightest $\text{H}_2^+$ ion, we have obtained lower limits on the atomic masses of the deuteron and helium-3 with respect to the proton. To obtain further information on the relative masses of the proton and deuteron, we are now measuring the cyclotron frequency ratio $\text{H}_2^+/\text{D}^+$. From our measurements we can observe the vibrational decay of $\text{H}_2^+$ and identify its vibrational state.

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