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Resolving the Ro-Vibrational State of Single H_2^+ Ions to Increase the Precision of a Cyclotron Frequency Ratio Measurement of H_2^+/D^{+1} DAVID FINK, Florida State University — Redevelopment of a technique of simultaneous cyclotron frequency measurement [1] has allowed us to measure the cyclotron frequencies of H_2^+ and D^+ with enough mass resolution to differentiate (using the mass-energy relation) between vibrational states of the H_2^+ ion in a few hours of data taking. By repeated measurements over several weeks we have tracked the ro-vibrational decays of single H_2^+ ions to the vibrational ground state, and, in some cases, identified specific rotational levels. This allowed us to more precisely correct the measured H_2^+/D^+ mass ratios for H_2^+ rotational energy, which was the largest source of uncertainty in our previous measurement of the H_2^+/D^+ CFR [2]. Details of the ro-vibrational analysis will be presented along with final results for a deuteron-to-proton mass ratio [3]. [1] S. Rainville, J. K. Thompson and D. E. Pritchard, Science 303, 334 (2004). [2] D. J. Fink and E.G. Myers, PRL 124, 013001 (2020). [3] D. J. Fink and E. G. Myers, submitted to Phys. Rev. Lett.

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