ENHANCED COSMIC-RAY FLUX TOWARD ζ PERSEI INFERRED FROM STORAGE RING MEASUREMENT OF DISSOCIATIVE RECOMBINATION RATE OF ROTATIONALLY COLD H_3^+

B. J. McCALL[a] , A. J. HUNEYCUTT, R. J. SAYKALLY, *Department of Chemistry, University of California at Berkeley, Berkeley, CA 94720*; T. R. GEBALLE, *Gemini Observatory, 670 North A'ohoku Place, Hilo, HI 96720*; N. DJURIC, G. H. DUNN, *JILA, University of Colorado and NIST, Boulder, CO 80309*; J. SEMANIAK, O. NOVOTNY, *Institute of Physics, Świetokrzyska Academy, 25 406 Kielce, Poland*; A. AL-KHALILI, A. EHLERDING, F. HELLBERG, S. KALHORI, A. NEAU, R. THOMAS, *Department of Physics, SCFAB, Stockholm University, S-106 91 Stockholm, Sweden*; F. OSTERDAHL, *Manne Siegbahn Laboratory, Stockholm University, S-104 05 Stockholm, Sweden*; M. LARSSON, *Department of Physics, SCFAB, Stockholm University, S-106 91 Stockholm, Sweden*.

The H_3^+ molecular ion plays a fundamental role in interstellar chemistry, as it initiates a network of chemical reactions that produce many interstellar molecules. In dense clouds, the H_3^+ abundance is understood using a simple chemical model, from which observations of H_3^+ yield valuable estimates of cloud path length, density, and temperature. On the other hand, observations of diffuse clouds have suggested that H_3^+ is considerably more abundant than expected from the chemical models. However, diffuse cloud models have been hampered by the uncertain values of three key parameters: the rate of H_3^+ destruction by electrons, the electron fraction, and the cosmic-ray ionization rate. Here we report a direct experimental measurement of the H_3^+ dissociative recombination rate under nearly interstellar conditions, using a supersonic expansion discharge source that has been shown (using cavity ringdown spectroscopy) to produce rotationally cold H_3^+ ions. We also report the observation of H_3^+ in a diffuse cloud (towards ζ Persei) where the electron fraction is already known from ultraviolet spectroscopy. Taken together, these results allow us to derive the value of the third uncertain model parameter: we find that the cosmic-ray ionization rate in this sightline is forty times faster than previously assumed. If such a high cosmic-ray flux is indeed ubiquitous in diffuse clouds, the discrepancy between chemical models and the previous observations of H_3^+ can be resolved.

[a]email: bjmccall@astro.berkeley.edu