Atomic Deuterium Emission and the D/H Ratio in Comets. H. A. Weaver[1], M. F. A'Hearn[2], C. Arpigny[3], M. R. Combi[4], P. D. Feldman[5], G. –P. Tozzi[6], N. Dello Russo[1], and M. C. Festou[7]. [1]The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723 USA; (email: hal.weaver@jhuapl.edu), [2]University of Maryland, College Park, MD, USA, [3]Universite de Liege, Liege, Belgium, [4]University of Michigan, Ann Arbor, MI, USA, [5]Johns Hopkins University, Baltimore, MD, USA, [6]Osservatorio Astrofisico di Arcetri, Florence, Italy, [7]Deceased

Introduction: The deuterium to hydrogen ratio (D/H) is a key indicator of cometary formation conditions and the role played by comets in delivering volatiles and organics to the Earth [1]. In particular, the D/H in cometary water can be compared to that in standard mean ocean water (SMOW) to determine how much of the terrestrial water inventory could be provided by cometary impacts. The D/H ratio in cometary water has been measured in three comets: in 1P/Halley via in situ mass spectrometry [2,3], and in C/1996 B2 (Hyakutake) [4] and C/1995 O1 (Hale-Bopp) [5] by observing submillimeter emission from HDO. In all three cases, the cometary D/H ratio was approximately twice the value in SMOW. During Hubble Space Telescope (HST) observations of C/2001 Q4 (NEAT), we discovered atomic D emission, which is potentially another probe of the D/H ratio in comets.

Hubble Observations: On three different dates (2004 April 24.3, 26.9, and 28.8 UT), the D Lyman-α line at 1215.34 Å was clearly detected during observations of C/NEAT using the Space Telescope Imaging Spectrograph (STIS) on HST (Fig. 1). During that time, the comet's heliocentric distance varied from 1.04 AU to 1.00 AU, the geocentric distance ranged from 0.54 AU to 0.39 AU, and the water production rate was $\sim 1.9 \times 10^{29}$ s^{-1}. The STIS echelle grating E140H was used with a 0.2″ × 6″ slit, which provides a velocity resolution of 5.5 km s^{-1} for a spatially uniform emission, to measure the D line simultaneously with the atomic hydrogen (H) Lyman-α line, both of which were cleanly separated from the terrestrial airglow H and D emissions. The derivation of the H production rate is relatively straightforward, but uncertainty in the photolysis pathways for HDO, the presumed primary source of D in the inner coma, and of the spatial distribution of D, make deriving the D production rate problematic. We discuss these issues, provide our best estimate of the D/H ratio in C/NEAT, and also report on an HST search for D emission from C/2002 T7 (LINEAR) in June 2004.

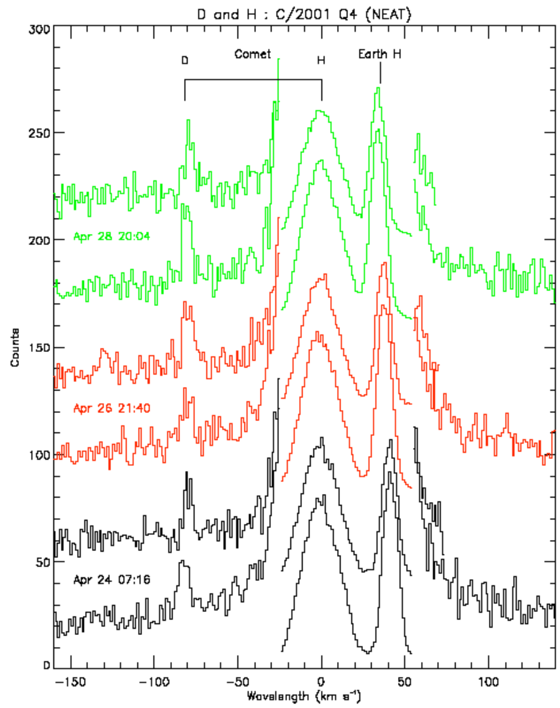

Fig.1: HST/STIS spectra of C/2001 Q4 (NEAT) showing clear detections of atomic deuterium (D) emission in 2 different echelle orders on 3 different dates.

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References: [1] Owen, T. C. & Bar-Nun, A. (2001) *Origins of Life Evol. Bio., 31,* 435-458. [2] Balsiger, H. et al. (1995) *J. Geophys. Res., 100,* 5827-5834. [3] Eberhardt, P. et al. (1995) *LPS XXVII,* 1344–1345. [4] Bockelee-Morvan, D. et al. (1998) *Icarus, 133,* 147-162. [5] Meier, R. et al. (1998) *Science, 279,* 842-844.