IN SITU ULYSSES SPACECRAFT OBSERVATIONS OF COMETARY ION TAILS' MAGNETIC FIELD STRUCTURE. A. Rees[1], G. H. Jones[2,3], A. Balogh[1,4] [1]Space & Atmospheric Physics Group, The Blackett Laboratory, Imperial College London, London SW7 2BW, UK, [2]Mullard Space Science Laboratory, University College London, Holmbury St. Mary, Dorking, Surrey, UK, [3]Centre for Planetary Sciences, University College London, UK, [4]International Space Science Institute, Bern, Switzerland.

Introduction: The emission of neutral gas by cometary nuclei results in the addition of ionized material to the solar wind [1]. This mass-loading of the solar wind flow results in the local deceleration of the wind, and the consequent distortion of the magnetic field embedded in the flow, as first demonstrated during the planned tail crossing of 21P/Giacobini-Zinner by the *International Cometary Explorer* spacecraft [2].

The ESA/NASA Ulysses spacecraft, which is in a polar orbit about the Sun, has serendipitously encountered the ion or plasma tails of at least three comets, all of which are long-period: C/1996 B2 (Hyakutake), C/1999 T1 (McNaught-Hartley), and C/2006 P1 (McNaught). Ulysses's magnetometer instrument [3] provides unique information on the magnetic field structures of these tails, well downstream of the respective comae. We shall report on the magnetic field structures observed, and the possible causes for them.

Ulysses cometary tail crossings

The three known cometary tail crossings can and have been recognized using three solar wind parameters: draping of the magnetic field, as discussed above; the direct detection of cometary pickup ions, and the deceleration of the solar wind by the addition to it of cometary material.

C/1996 B2 (Hyakutake). This first unplanned comet tail crossing occurred on May 1, 1996, at 3.73 AU from the Sun, and first recognized through the clear draping pattern present in the heliospheric magnetic field [4]. Concurrently, cometary pickup ions were also detected at Ulysses [5], and a previously-noted, striking decrease was seen in solar wind proton density [6]. The tail section encountered had left the comet at approximately 0.35 AU from the Sun, and traveled 3.39 AU radially to reach Ulysses around 7 days following formation.

Analysis of the magnetic field data indicate that Hykatake's tail axis was oriented at 63-70 degrees to the anti-Sunward direction; part of this large tail tilt can be explained by the nucleus's large orbital velocity, but it is suspected that the pressure of surrounding solar wind on the tilted tail may be responsible. Other alternative causes being explored are an extended source within the coma that trailed the nucleus position.

C/1999 T1 (McNaught-Hartley): Pickup ions from this comet were detected on October 19 and 20, 2000 [9]. McNaught-Hartley's tail ions were detected within the interplanetary counterpart of a coronal mass ejection, ICME, suggesting that the cometary pickup ions detected in situ at Ulysses were channeled to the spacraft along magnetic field lines within the ICME [7]. Magnetic field structuring during two periods of cometary pickup ion detection suggest that Ulysses may have encountered the ion tail itself, i.e. a portion of tail that had been physically displaced from its nominal location.

C/2006 P1 (McNaught). In January-February 2007, McNaught became the brightest comet as seen from Earth in 40 years. Ulysses was fortuitously downstream of the comet, detecting pickup ions during February 4-9 [8]. The magnetic field structure was complex, but did show variations in field orientation clearly linked to the draping of the heliospheric magnetic field. Changes in solar wind parameters during the tail crossing period complicates the interpretation significantly. A full analysis of this dataset, and a comparison to the data from the other two comets will be presented.

References: [1] Alfvén H. (1957) *Tellus, 9*, 1, 92-96. [2] Slavin J. A. et al. (1986) *Geophys. Res. Lett. 13*, 283-286 [3] Balogh A. et al. (1992), *Astron. Astrophys. Suppl. Ser., 92*, 221-236. [4] Jones G. H. et al. *Nature, 404,* 574-576. [5] Gloeckler G. et al. (2000) *Nature 404,* 576-578. [6] Riley P. et al. (1998) J. Geophys. Res. 103, 1933-1940. [7] Gloeckler G. et al. (2004) Astrophys. J. 604, L121-L124 [8] Neugebauer M. et al. (2007) *Astrophys. J. 667,* 2, 1216-1266.

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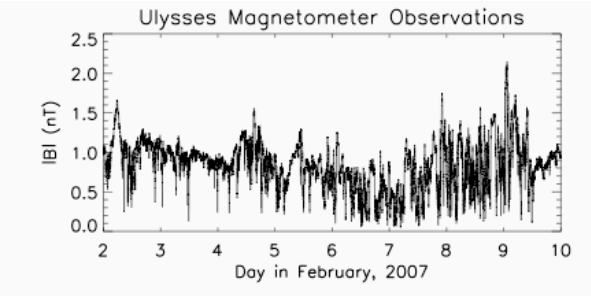

Magnetic field magnitude measured by the Ulysses magnetometer during the crossing of Comet McNaught's ion tail.