A MULTI-WAVELENGTH SIMULTANEOUS STUDY OF THE COMPOSITION OF THE HALLEY-FAMILY COMET 8P/TUTTLE AT THE VLT*. D. Bockelée-Morvan[1] , N. Dello Russo[2], E. Jehin[3], J. Manfroid[3], A. Smette[4], A. Cochran[5], D. Hutsemékers[3], H. Kawakita[6], H. Kobayashi[6], R. Schulz[7], M. Weiler[1], J.-M. Zucconi[9], C. Arpigny[3], N. Biver[1], J. Crovisier[1], P. Magain[3], H. Rauer[8], H. Sana[4], R.J. Vervack[2], H. Weaver[2], [1]Observatoire de Paris, F-92195, Meudon, France (e-mail: dominique.bockelee@obspm.fr), [2]The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 2072, USA, [3]Institut d'Astrophysique et de Géophysique, Sart-Tilman, B-4000, Liège, Belgium, [4]ESO, Alonso de Cordova 3107, Vitacura Casilla 19001, Santiago, Chile, [5]Department of Astronomy and McDonald Observatory, University of Texas at Austin, C-1400, Austin, USA, [6]Department of Physics, Faculty of Science, Kyoto Sangyo University, Motoyama, Kamigamo, Kita-ku, Kyoto 603-8555, Japan, [7]ESA/RSSD, ESTEC, P.O. Box 299, NL-2200 AG Noorwijk, The Netherlands, [8]Institute of Planetary Research, DLR, Rutherfordstr. 2, 12489 Berlin, Germany, [9]Observatoire de Besançon, F-25010, Besançon, France.

Introduction: Determining the composition of cometary nuclei is essential for understanding the formation and evolution of volatile material within our Solar System. Observational evidences support chemical diversity among comets that may reflect the diversity of conditions in comet-forming regions in the solar nebula [1]. On the other hand, comets experienced different processing histories whose importance has to be properly investigated both theoretically and observationally. The orbits of Halley-family comets (HFCs) have evolved to periods less than 200 years, making them the most processed Oort-cloud comets. However, HFCs are underrepresented in compositional surveys.

The 2008 apparition of comet 8P/Tuttle was an excellent opportunity to perform a detailed investigation of the composition of a HFC with modern techniques. 8P/Tuttle made a close approach to Earth at 0.25 AU on 2 January 2008. On 16, 28 January and 4 February UT, we undertook simultaneous spectroscopic observations in the visible and near-IR wavelength ranges using the CRIRES, FORS1, UVES instruments installed at the UT1 and UT2 units of the Very Large Telescope (VLT) of the European Southern Observatory (ESO).

CRIRES observations: High-resolution near-IR observations with CRIRES were undertaken to probe the chemistry of 8P/Tuttle through the detection of rovibrational lines of parent molecules. H_2O, HCN, CH_4, C_2H_2, C_2H_6 and CH_3OH lines near 2.9–3.3 µm were targeted. Spectra were acquired with unprecedented spectral resolution of about 50,000 reducing spectral confusion in regions with a high density of lines.

FORS1 observations: Low-resolution long-slit spectra covering the 330–650 nm region were obtained to study CN, C_2, C_3, NH_2 and CH radicals. Thanks to the simultaneity of the CRIRES and FORS1 observations, it is possible to compare precisely the production rates of CN, C_2 and C_3 to those of their potential parents or grand-parents HCN, C_2H_2 and C_2H_6 observed with CRIRES, and to investigate whether their radial distributions are consistent with major production from these parent species. This is particularly important for CN because there is observational evidence for an additional source of CN (possibly dust grains) [2], while the consistency of the $^{14}N/^{15}N$ ratio in CN and HCN for comet 17P/Holmes is compatible with HCN being the prime parent of CN in cometary atmospheres [3].

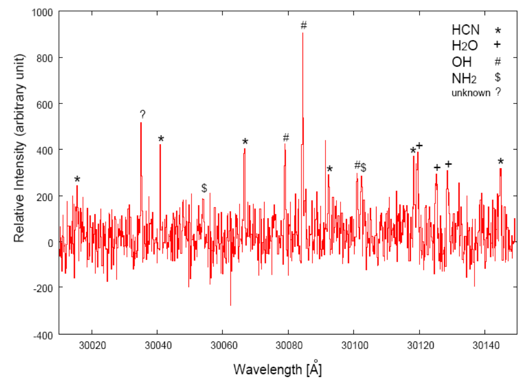

Fig. 1: CRIRES spectrum of 8P/Tuttle (28 Jan. 2008)

UVES observations: High-resolution spectra (R = 80,000) were obtained in the range 304–1040 nm with the measurements of the $^{14}N/^{15}N$ and $^{12}C/^{13}C$ ratios in CN (390 nm band), and of the ortho-to-para ratio of NH_2 (610 nm band), as main goals. We infer $^{14}N/^{15}N$ = 150 ± 25 and $^{12}C/^{13}C$ = 90 ± 20. The ^{15}N enrichment with respect to the terrestrial atmospheric value measured in 8P/Tuttle is consistent with the mean value observed in a dozen other comets (e.g., [4], [6]). From the ortho-to-para ratio of NH_2, we derive a spin temperature of NH_3 of 29 ± 1 K in agreement with measurements in other comets [5].

References: [1] Bockelée-Morvan D. et al. (2005) Comets II, 391–423. [2] Fray et al. (2005) *P&SS,* 53, 1243–1262. [3] Bockelée-Morvan D. et al. (2008) *ApJ*, in press. [4] Hutsemékers D. et al. (2005) *A&A*, 440, L21–L24. [5] Kawakita H. et al. (2001) *Science*, 294, 1089–1091. [6] Jehin et al. this meeting.

* Based on observations collected at the European Southern Observatory, Paranal, Chile (ESO Programmes 080.C-0615 and 280.C-5053).