EPSC Abstracts
Vol. 6, EPSC-DPS2011-1463, 2011
EPSC-DPS Joint Meeting 2011

A Multi-wavelength study with the ESO VLT of comet 103P/Hartley2 at the time of the EPOXI encounter

E. Jehin (1), D. Hutsemékers (1), J. Manfroid (1), A. Decock (1), M. Weiler (2), H. Kawakita (3), Y. Shinnaka (3), M. Hashimoto (3), D. Bockelée-Morvan (4), N. Biver (4), J. Crovisier (4), P. Hartogh (5)
(1) Institut d'Astrophysique de l'Université de Liège, Belgium (ejehin@ulg.ac.be / Fax: + +32(0)43669737), (2) Department of Astronomy and Meteorology, University of Barcelona, Spain, (3) Department of Physics, Kyoto Sangyo University, Japan, (4) LESIA, Observatoire de Paris, Meudon, France, (5) Max-Planck-Institut für Sonnensystemforschung, Katlenburg-Lindau, Germany

Abstract

We report on simultaneous optical and infrared spectroscopic observations of the Jupiter Family comet 103P/Hartley2 performed with the UT-1 and UT-2 8-m Unit Telescopes of the ESO Very Large Telescope (VLT). These coordinated observations were carried on during several nights (2010 Nov. 5, 9, 10 and 11 UT) around the NASA EPOXI encounter with the comet on Nov. 4 [1] and in support to the key program « Water and related chemistry in the Solar System » (HssO) [2] of the Herschel Space Observatory. From high resolution optical spectroscopy of the CN (0,0) 388 nm band using UVES at UT2 we determined the isotopic ratios $^{12}C/^{13}C = 95 \pm 15$ and $^{14}N/^{15}N = 155 \pm 25$ in the CN radical. From the NH_2 (0,9,0) and the H_2O^+ bands around 600 nm, we derived a nuclear spin temperature of 33 ± 3 K for NH_3 and 36 +7/-6 K for H_2O. These values are similar to those found in Oort-Cloud and Jupiter Family comets. From low-resolution long-slit spectroscopy with FORS2 at UT1 we will determine the CN, C_2 and C_3 spatial profiles and their production rates. From the high-resolution near-IR spectra that we collected with CRIRES at UT1 we will measure simultaneously the production rates and mixing ratios of the parent molecules H_2O, HCN, C_2H_6, and CH_3OH that are well detected in our spectra and we will study the link to the daughter species.

1. Introduction

The Jupiter-family comet 103P/Hartley2 did a very close approach to the Earth (0.12 AU) in October and was the target of a worldwide observing campaign [3]. On November 4th, the EPOXI mission (former Deep Impact spacecraft) imaged its nucleus and provided in-situ IR spectroscopy [1]. This comet was also the primary target of a guaranteed time key program of the Herschel Space Observatory with the aim to study the rotational spectrum of H_2O, to measure for the first time in a JFC the $(D/H)_{H2O}$ ratio, and explore molecular and mineral emissions in the far-IR/submm spectrum [2,4,5]. We used several state of the art instruments of the VLT in parallel to provide essential support to these missions and to fully characterize the chemical and isotopic composition of this bright Jupiter-family comet.

2. High resolution spectroscopy in the visible with UVES

The high resolution spectroscopic observations in the optical domain (R=80000, 303–1004 nm) had several objectives, among which measurements of carbon and nitrogen isotopic ratios and the ortho-to-para (OPR) ratios. Synthetic spectra of $^{12}C^{14}N$, $^{13}C^{14}N$, $^{12}C^{15}N$ (0,0) bands at 388 nm were computed using a fluorescence model [6]. The isotope mixture was adjusted to best fit the observed spectrum. The $^{12}C/^{13}C$ ratio is 95 ± 15 close to the solar value (89), and the $^{14}N/^{15}N$ ratio, 155 ± 25, is half that of Earth's value (272), similar to the isotopic ratios that are measured in other comets [7,8]. Based on fluorescence excitation models [9,10] this data set also yields ortho-to-para ratios of NH_2 and H_2O^+ from which spin temperatures of 33 ± 3 K and 36 +7/-6 K are derived, respectively. The later value is in agreement with the ISO measurement of 34 ± 3K made in 1997 [11]. Despite the very strong activity shown by this small nucleus with well-defined gaseous emissions from localized jets, the isotopic composition and spin temperatures of two abundant molecules show that comet 103P/Hartley 2 is not different from other comets, at least in the species for which we have measurements [9].

3. Near-IR high resolution spectroscopy with CRIRES

Infrared high-resolution spectroscopic observations (R=50000, 2.9–3.3 μm) with CRIRES were conducted to measure the production rates and abundance of several parent molecules. We used the adaptive optics (AO) mode to get the best SNR and spatial resolution (9 km/pix), to allow a better detection of minor species and trace the radial profiles. Variations of the line fluxes and their spatial profiles are observed from night to night and are under investigation. Like a previous pilot study on comet 8P/Tuttle (12), an important objective of this program will be to compare HCN and C_2H_6 production rates to those of their daughter products CN and C_2 observed simultaneously with FORS 2 (see below).

4. Low resolution spectroscopy in the visible with FORS2

Long slit spectroscopy (R= 440, 330–660 nm) was performed on UT1 to measure the radial distributions of the CN, C_2 , C_3 , NH_2 radicals in the coma. The slit was put along and perpendicular to the Sun-tail direction. Spatial profiles of the gaseous emissions of CN [383–391 nm], C_3 [398–415 nm] and C_2 [486–521 nm] were extracted by integrating the flux densities, and converted to column densities. The Haser model will be used to fit the CN, C_3 and C_2 column density profiles and to derive production rates, parent (lp) and daughter (ld) scale lengths. Different to the simple assumptions of the Haser model, these species are actually produced in more than one reaction step from several parent species. A complex chemistry model will therefore be used to reproduce the C_2 and C_3 profiles and to investigate the detailed formation of these species. This study benefits from the constraints on the potential parent production rates (e.g. for C_2H_6) provided by the simultaneous IR observations.

Acknowledgements

Based on observations collected at the European Southern Observatory, Paranal, Chile (ESO Prog. 086.C-0958). E.J is Research Associate FNRS, J.M is Research Director FNRS, D.H is Senior Research Associate FNRS and A.D is FRIA PhD Student.

References

[1] A'Hearn, M. et al.: Science, in press, 2011.

[2] Hartogh, P. et al.: P&SS, 57, 1596, 2009.

[3] Meech, K. et al.: ApJ 734, L1, 2011.

[4] Bockelée-Morvan, D. et al.: this conference, 2011.

[5] Hartogh, P. et al. : this conference, 2011.

[6] Zucconi, J. M.; Festou, M. C.: A&A 150, 180, 1985.

[7] Jehin, E., et al. : Earth Moon Planets, 105, 167, 2009.

[8] Manfroid, J., et al. : A&A, 503, 613, 2009.

[9] Shinnaka, Y. et al. : ApJ 729, 2, 81, 2011.

[10] Shinnaka, Y. et al. : in prep. , 2011.

[11] Crovisier, J., et al. 1999, In The Universe as Seen by ISO, ed. P Cox, MF Kessler, ESA-SP 427:161. Noordwijk, Neth.: ESA

[12] Kobayashi H. et al. : A&A 509, A80, 2010.