EPSC Abstracts
Vol. 6, EPSC-DPS2011-1817, 2011
EPSC-DPS Joint Meeting 2011

Monitoring of comet 103P/Hartley 2: evolution of the dust and gas activity

L.M. Lara (1), Z.Y. Lin(1,2)
(1) Instituto de Astrofisica de Andalucia (CSIC), Granada, Spain (lara@iaa.csic.es /Fax: +34 958 814530), (2) Institute of Astronomy, National Central University, Taiwan

Abstract

The comet 103P/Hartley 2, target of the EPOXI mission (NASA) was monitored from July to December 2010. The goal of the campaign was to characterize the comet activity evolution from 1.7 AU to perihelion at 1.06 AU, as well as to follow the evolution of the dust coma morphology during this passage. Long-slit spectra and optical broadband images were acquired with the instrument CAFOS mounted at the 2.2. m telescope at Calar Alto Observatory (CSIC-MPG). The evolution of the dust coma morphology from the R Johnson images shows no clear features aside the dust tail. The Afρ parameter, as a proxy of the dust production rate, measured in a circular aperture of 5000 km radius at the comet distance varies from 13 cm at 1.7 AU to $\sim$ 150 cm at the perihelion. The dust radial or azimuthally averaged profiles versus projected cometocentric distance ρ can be linearly fit in log-log representation. The slope m of these fits ranges from -0.95 to 1.3.

1. Introduction

Deep Impact was the first mission to look beneath the surface of a comet (i.e. 9P/Tempel 1) [1]. Following the Deep Impact encounter with 9P/Tempel 1, the spacecraft was left on an orbit that gave the possibility of redirecting it to 103P/Hartley 2. The comet nucleus was planned to be flown by on November 4, 2010.

An extensive monitoring of the comet activity long before, during, and after the fly-by has taken place all around the world [6]. The aims were to characterize the comet activity pattern as the comet approached perihelion, to perform ground-based simultaneous observations with the mission fly-by and to put in context a large-scale gas and dust coma with the detailed nucleus and near-nucleus environment observed by the instruments on board the EPOXI mission.

In this presentation, we exploit the optical data acquired since July 7 to December 26, 2010 to analyse the gas and refractory component of the coma.

2. Observations and data reduction

The comet was monitored from the Calar Alto Observatory (CSIC-MPG, near Almería, Spain) July 14 to December 26, 2010. All comet observations were done in service mode with telescope tracking at the comet's proper motion.

Imaging data were obtained with the central 1k $\times$ 1k pixels of the instrument CAFOS (pixel size: 0.53", FOV 9'$\times$9') mounted at the 2.2 m telescope. The comet was imaged with Johnson R broadband filter by acquiring consecutive series of 5 to 10 images. Appropriate bias, darks and flat field frames were also taken each night, and the usual data reduction was made. If photometric conditions prevailed, photometric stars were observed at an airmass similar to the comet observations for absolute flux calibration.

The spectroscopic measurements were done using the grism B400 providing us with an observable spectral range between 280 and 1000 nm with a wavelength scale of 0.97 nm per pixel. For absolute calibration, observations of appropriate spectrophotometric standard stars were acquired. For the comet observations, the slit width is 2", whereas the usable selected length is 10.6'. The spectrophotometric standard star was observed with a width of 5" and the same slit length.

Details on the images and spectra reduction and calibration can be found in [3] and [4].

The images, regardless the sky conditions, have been used to study the dust coma morphology, the azimuthally averaged profile of surface brightnesses, whereas in photometric sky conditions, the images have been used for analysing the behaviour of Afρ as a function of projected cometocentric distance ρ and of r_h.

On the other hand, the spectra have provided us with CN, C_2, C_3 and NH_2 production rates in the frame of the Haser modelling ([2]), and with dust brightness profiles as a function ρ in the east-west direction.

Table 3 lists the details of acquired observations.

3. Results

The evolution of the dust coma morphology from the R Johnson images shows no further feature than the dust tail and a bright jet detected when the comet was at shorter heliocentric distances. This jet turns on and off [5] aand it is not clearly detected at any time on the images obtained during the monitoring campaign. This structure is enhanced by making use of the radial renormalization and the Larson-Sekanina method. It is also confirmed by the distortion of the isophotes at the same position angle (PA).

The Afρ parameter, as a proxy of the dust production rate, measured in a circular aperture of 5000 km radius at the comet distance varies from 13 cm at 1.7 AU to ~ 150 cm at the perihelion. The dust radial or azimuthally averaged profiles versus projected cometocentric distance ρ can be linearly fit in log-log representation. The slope m of these fits ranges from -0.95 to 1.3.

The gas (CN, C_3, C_2, and NH_2) production rate, Q_i, have been measured at few heliocentric distances. The quotient $Q_{C_2}/Q_{CN} \sim 1.3$ places 103P/Hartley 2 as a typical comet in terms of long-chain hydrocarbon abundance. The gas-to-dust mass ratio is $\sim 3-6$, indicating that 103P/Hartley 2 is a relatively gas-rich comet.

Table 1: Log of observations

Date 2010	r_h (AU)	Δ (AU)	α (deg)	PA (deg)
July 14	1.726	0.933	29.0	227.3
July 22	1.664	0.838	29.0	222.4
July 30	1.585	0.725	29.2	215.2
August 20	1.406	0.500	31.1	195.1
August 25	1.366	0.453	32.1	190.1
Sept. 2	1.304	0.384	34.2	188.8
Sept. 13	1.219	0.293	38.2	175.1
Oct. 15	1.074	0.127	49.8	235.5
Oct. 18	1.068	0.122	51.4	247.9
Oct. 19	1.068	0.122	51.4	247.9
Oct. 22	1.062	0.121	53.8	261.0
Oct. 25	1.059	0.124	55.6	268.6
Oct. 29	1.058	0.127	57.5	275.5
Nov. 5	1.064	0.158	58.8	284.5
Nov. 15	1.087	0.205	58.8	284.5
Dec. 26	1.323	0.420	31.2	338.0

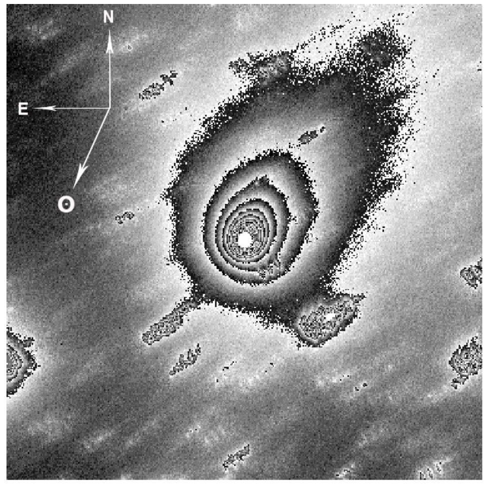

Figure 1: Image of comet 103P/Hartley 2 on December 26, 2010, acquired with the R Johnson filter. The FOV is $1.88' \times 1.88'$, meaning 34230×34230 km at the comet distance.

Acknowledgements

This research has been supported by the Spanish Ministerio de Ciencia e Innovación under contract AyA 2009-08011. Z.-Y. Lin acknowledges a grant by the Junta de Andalucia under the project JA2007-TIC2744. L.M. Lara also acknowledges J.M. Bacaicoa for his help in editing the images.

References

[1] A'Hearn, M., et al. : Deep Impact: Excavating Comet Tempel 1, Science 310, 258-264, 2005.

[2] Haser, L., Distribution d'intensite dans la tete d'une comete, Bulletin de la Societe Royale des Sciences de Liege, 43, 740-750, 1957.

[3] Lara, L.M. and Schulz, R. and Stüwe, J. A. and Tozzi, G. P.: Activity of Comet Tabur (C/1996 Q1) during September 12-17, 1996, Icarus, 150, 124-139, 2001.

[4] Lin, Z.-Y., Lin, C.-S., Ip, W.-H. and Lara, L. M.: The Outburst of Comet 17p/Holmes, AJ, 138, 625-632, 2009.

[5] Lara, L.M., Lin, Z.-Y. and Meech, K.: Comet 103P/Hartley 2 at perihelion: gas and dust activity, A&A, in press, 2011.

[6] Meech, K. et al.: EPOXI: Comet 103P/Hartley 2 Observations from a Worldwide Campaign, ApJ 734, L1-L8, 2011.