TRAPPIST monitoring of comet C/2012 F6 (Lemmon)

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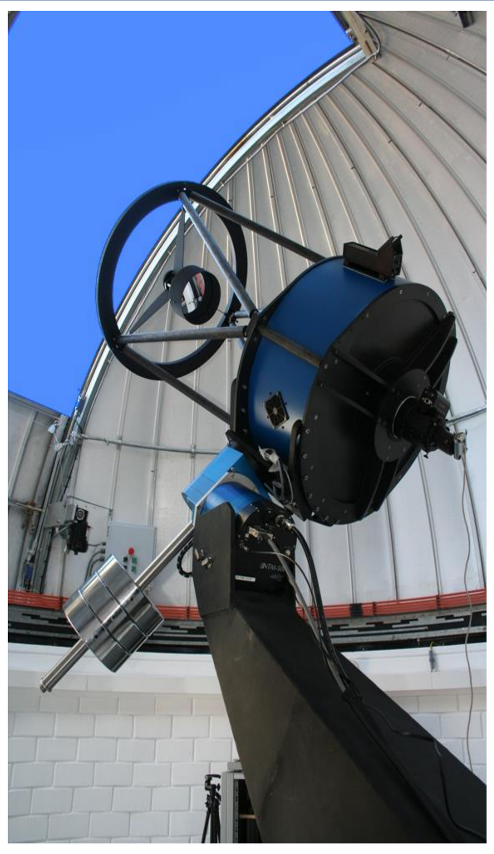
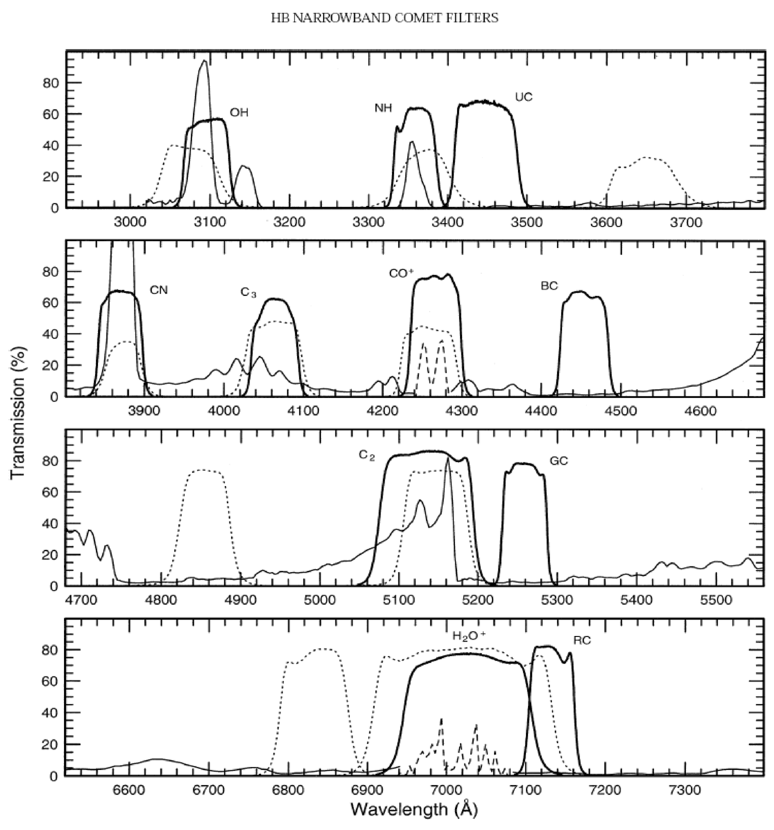


Instrument and Observations

TRAPPIST (TRAnsiting Planets and Planetesimals Small Telescope) is a 0.6-m robotic telescope installed by the Liège University at La Silla observatory (ESO, Chile) [1]. TRAPPIST is fully devoted to the study of exoplanets and small bodies of the solar system.

- •ASTELCO Ritchey-Chretien telescope Ø=60cm at F/8
- •German-equatorial direct-drive mount : slewing 30˚ /s, 4 min tracking without guiding
- •FLI Back-illuminated 2kx2k CCD camera, thermoelectric cooling (-50˚ C), FOV=22'x22' and pixel scale of 0.65"
- •Dual Apogee filter wheel (2x10 positions): Broad band filters: BVRcIcz + I+z + blue-blocking and **NASA HB narrow band cometary filters** [2]: OH,NH,UC,CN,C_3,CO^+,BC,C_2,GC,RC and NaI permanently loaded.

Figure 1: The robotic 0.6-m TRAPPIST telescope installed by the Liège University at La Silla observatory (ESO, Chile).



Comet C/2012 F6 (Lemmon)

Comet C/2012 F6 (Lemmon) is a long period comet that reached perihelion on March 23, 2013 at 0.73 AU.

We observed the comet with TRAPPIST from December 11, 2012 to March 4, 2013 (before perihelion) and from April 29, 2013 to June 11, 2013 (after perihelion). The comet was observed several times a week with both BVRI and narrow band filters. We have collected **1358 frames on 49 nights.** In February we observed the comet continuously during several hours to detect the nucleus rotation.[7]

Figure 2: Transmission profiles of NASA HB cometary filters in bold [2]. The dashed line represents a cometary spectrum. The bandpass of previously used IHW filters is shown by the dotted line.

Determination of gas and dust production rates

From the images in narrow band filters we derive OH, NH, CN, C_3 an C_2 production rates by fitting a Haser model [3] on the measured radial profiles. The scale lengths used for the Haser model are those from A'Hearn et al., 1995 [4]. We also computed Afρ values [5] in the 4 continuum filters UC, BC, GC and RC.

The **average production rates obtained on March 3** (when *r*=0.85 AU) are: log Q(OH) = 29.36; log Q(NH) = 27.05; log Q(CN) = 26.96; log Q(C_3) = 26.50; log Q(C_2) = 27.20. The Afρ values are similar in the four continuum filters, for the same date: Afρ(UC) = 7200 cm; Afρ(BC) = 6380 cm; Afρ(GC) = 6330 cm; Afρ(RC) = 7340 cm [6].

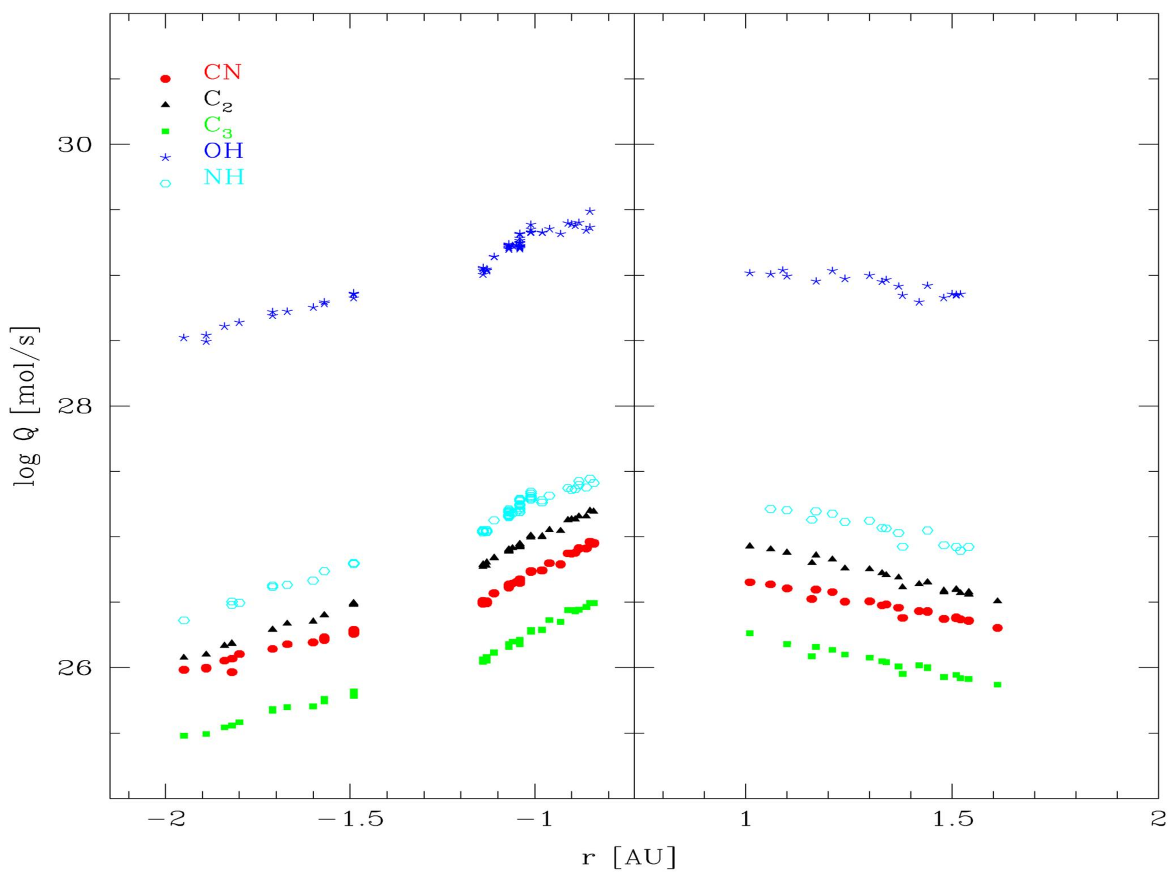


Figure 3: F6 (Lemmon) production rates of five gaseous species (OH, NH, CN, C_3 and C_2) as a function of the heliocentric distance (AU) before (left) and after (right) perihelion.

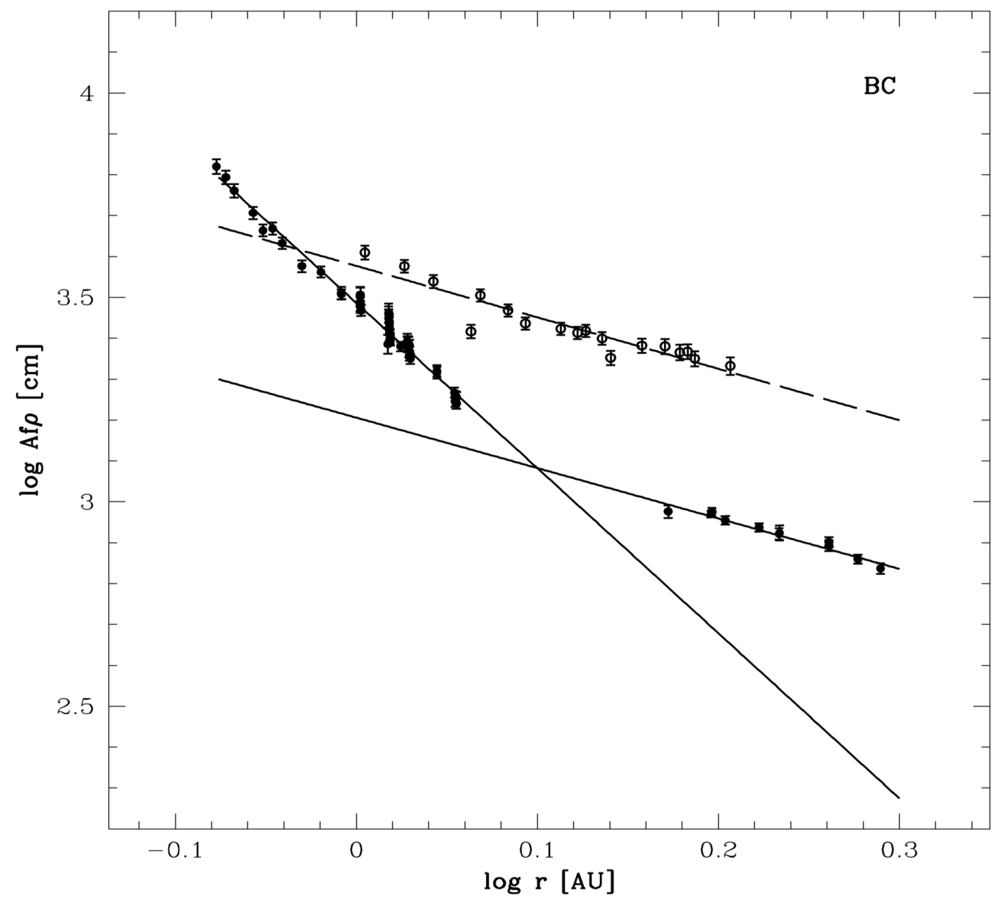


Figure 4: Logarithm of Afρ from BC filter as a function of the logarithm of the heliocentric distance (AU) before (filled dots) and after (empty dots) perihelion. The x-axis origin is perihelion distance. A **sudden change of the heliocentric dependency** happened in early February. This was correlated with changes in dust radial profile slopes.

Follow-up of C/2012 F6 activity

We monitored the evolution of the gas and dust production rates from December 11, 2012 to June 11, 2013 (Figures 3 and 4). The comet activity rises steeply while approaching the Sun, e.g. Q(CN) was multiplied by a factor 10 between December and March. The heliocentric evolution of the five gaseous species was similar and an **asymmetry about perihelion** was noted.

Evolution of the chemical composition

We followed the evolution of C/2012 F6 (Lemmon) coma chemical composition during several months. Comet Lemmon is a gas rich comet that has a **typical** chemical composition in terms of **carbon chain** species [4]. The **C_2 to CN ratio was changing** with the heliocentric distance when the comet was beyond 1.4 AU (maximum variation by a factor 2). The variation of C_2 to CN ratio could be due to heliocentric **scaling effects on Haser scalelengths**. The C_3 to CN production rates ratio was not displaying any variation with the heliocentric distance.

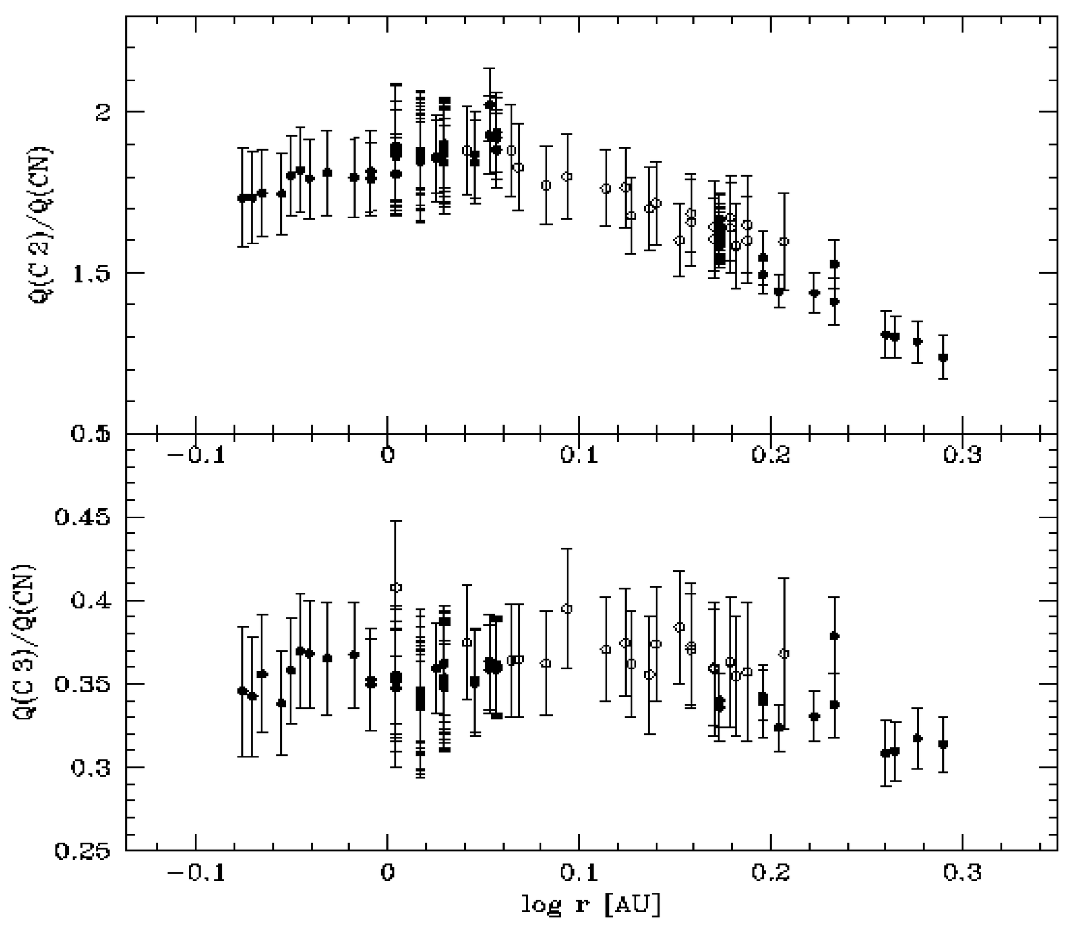
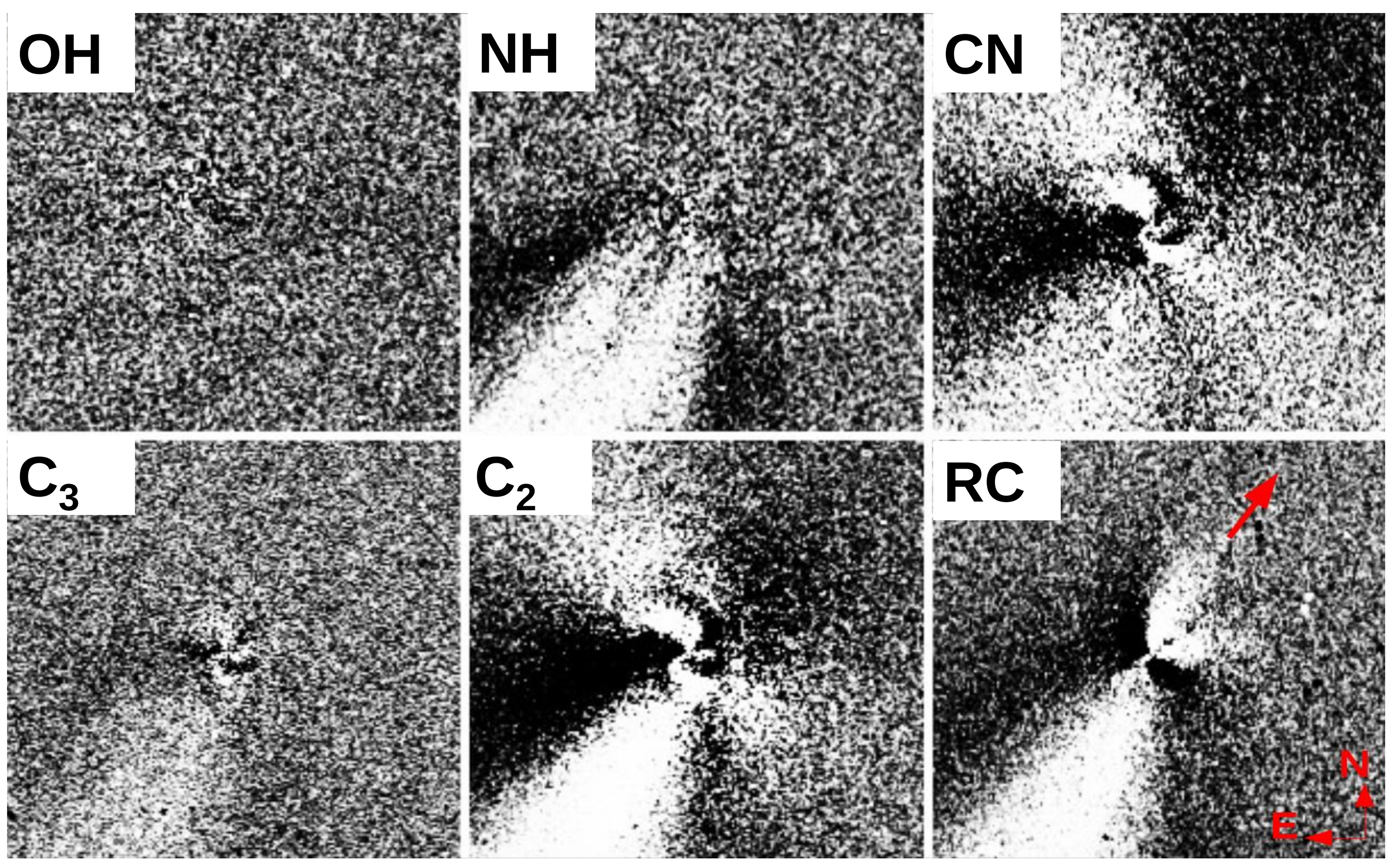


Figure 5: Evolution of C_2 to CN and C_3 to CN production rates ratios as a function of the heliocentric distance (AU). Filled dots correspond to pre-perihelion values and empty dots correspond to post-perihelion values. The x-axis origin is perihelion distance.

Coma morphology and determination of the rotation period

We applied two enhancement techniques (Larson-Sekanina filtering and subtraction of an azimuthal median profile) on the F6 (Lemmon) narrow band images. Several gaseous jets coming out from the nucleus were detected in February and March 2013. We could not detect features in OH filter due to poor signal-to-noise ratio. NH filter is contaminated by dust and CO_2^+ ion. **Spiral-shaped features were detected in CN, C_2 and C_3 filters**. The **similarity between gaseous species** morphology indicates that they probably originate from the same active region(s). The **dust morphology** was different than that of the gas.



In February, we performed several long observing runs to detect changes in the coma morphology. We noticed that the position and shape of C_2 and CN jets were strongly varying with the **nucleus rotation**. The identification of 13 matching pairs of images allowed us to determine a **rotation period of 9.52 +/- 0.06 hours.**

Figure 6: Representative OH, NH, CN, C_3, C_2 and RC narrow band images from January 13 processed with Larson-Sekanina filter. The red arrow indicates the direction of the Sun. The field of view is 4.3'x4.3'.

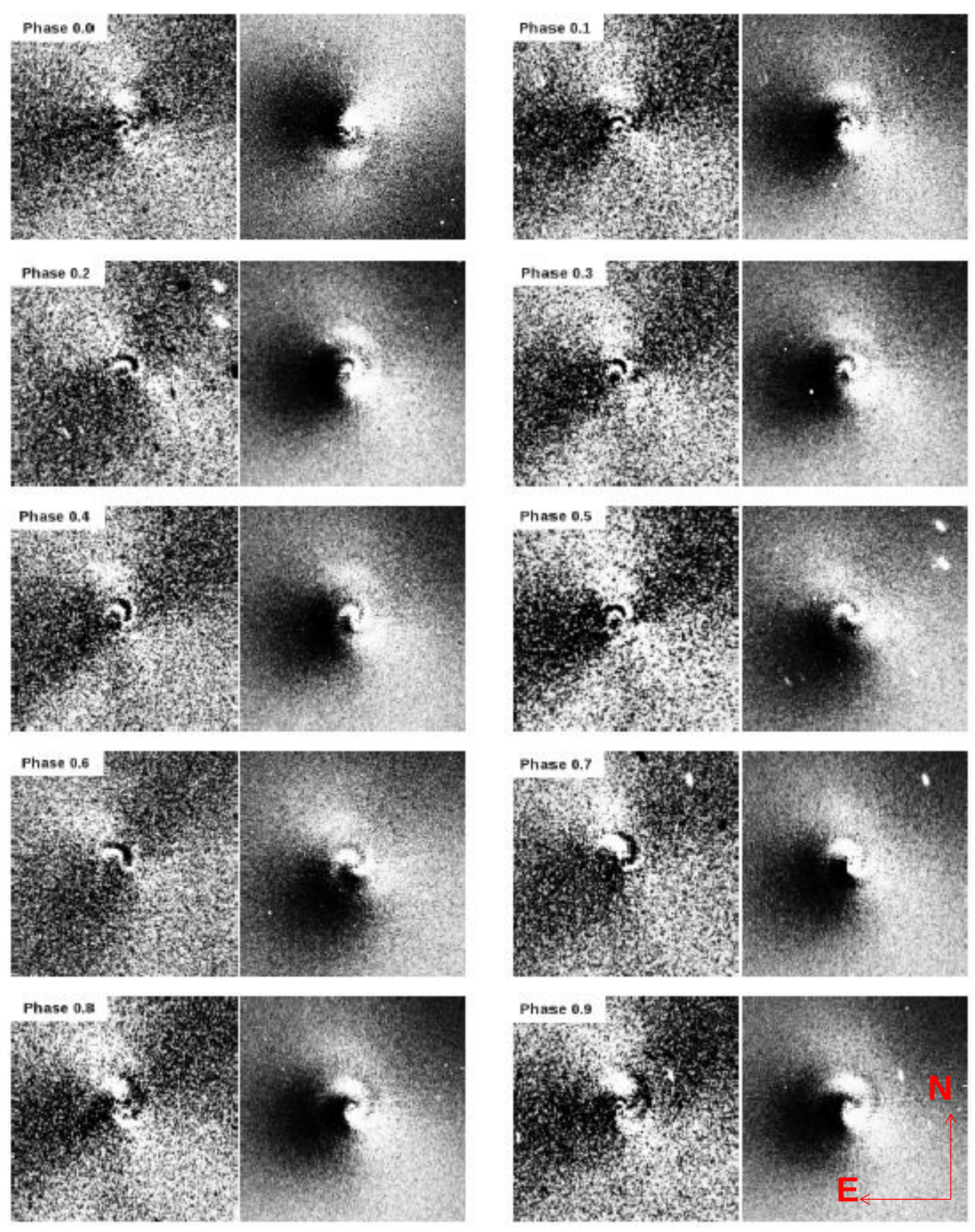


Figure 7: CN images processed with Larson-Sekanina filtering (left) and azimuthal median profile subtraction (right) acquired between February 7 and February 12, 2013. The images have been sorted by rotational phase assuming a rotation period of 9.52 h. The field of view is 4.3'x4.3'.

References

[1] Jehin et al. 2011, Messenger 145,2
[2] Farnham, T.L. et al. 2000, Icarus 147, 180
[3] Haser 1957, BSRSL 43, 740H
[4] A'Hearn et al. 1995, Icarus 118, 223A
[5] A'Hearn et al. 1984, AJ 89, 579A
[6] Opitom et al. 2013, CBET 3433, 1O
[7] Opitom et al. 2014, in prep

Links and Contact

http://www.astro.ulg.ac.be/Sci/Trappist
http://www.eso.org/public/news/eso1023
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