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New insights into comet activity from Earth-based observations of the EPOXI mission target, 103P/Hartley 2

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Abstract

Earth- and space-based observations provide synergistic information for space missions with data from instruments, at wavelengths and over timescales not possible during a fast flyby. A consortium of ~200 astronomers using 51 telescopes from 11 countries, and 9 space and airborne facilities combined to form a comprehensive overview of comet 103P/Hartley 2, the target of the EPOXI mission flyby on 4 Nov. 2010.

1. Introduction

Comets are left-over relicts of the early solar system and may have played a role in delivering water and organics to the prebiotic Earth (Mottl *et al.* 2007). Further, the record of the physical and chemical conditions of this era are better preserved in these bodies. Because of this they are the focus of several recent in-situ small body missions. The EPOXI fly by of the nucleus of comet 103P/Hartley 2 provided us with physical properties of the nucleus and clear evidence of chemical heterogeneity with CO_2-driven jets as a dominant volatile loss mechanism at perihelion compared to subsurface water-ice sublimation (A'Hearn *et al.* 2011). Comet 103P/Hartley 2 is a member of a class of "hyper active" comets which present an apparent active area that is a large fraction of the nucleus surface (compared to a few percent for most comets (A'Hearn *et al.*, 1995).

2. Earth Based Campaign

An international Earth-based observation campaign (Fig. 1) played a complementary role to the in-situ data, providing recovery images of the comet at large distances (Snodgrass *et al*., 2010), physical information about the nucleus size (Lisse *et al.* 2009), and from a coordinated multi-wavelength program nearly continuous coverage from Aug. 2010 through encounter (Meech *et al.*, 2011). From the Earth-based campaign it was clear that comet Hartley 2 had a small nucleus (0.57 km radius), with a rotation period near 16.4 hours prior to the onset of activity. As the activity developed the periodicity was found to change significantly over a period of months (Meech *et al*., 2011). The highly active nucleus had long- and short-term gas production variability with peak activity shortly after perihelion.

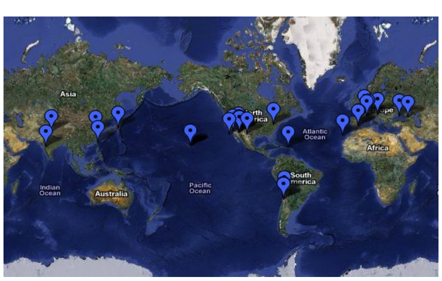

Figure 1. Distribution of EPOXI campaign observers.

3. The Heliocentric Light Curve

The comet's activity has been photometrically monitored (as scattered light from the dust coma) from the time of recovery to the present. We have developed a 4-component thermal ice sublimation model to estimate the dust grain flux from the surface driven by a gas flow. The model includes nucleus ices: H_2O, CO_2, CO and H_2O sublimating from the large chunks seen both from the EPOXI spacecraft and the Arecibo radar observations (Harmon *et al.* 2011). The model indicates that like other comets, water-ice sublimation began to create an observable dust coma near 4~4.4 AU as the comet approached the sun, but that near perihelion, strong CO_2 outgassing in the form of jets (as seen by the spacecraft) was responsible for lifting large ice/dust grains from the surface. CO_2 is likely a strong contributor to activity on the outbound leg of the orbit.

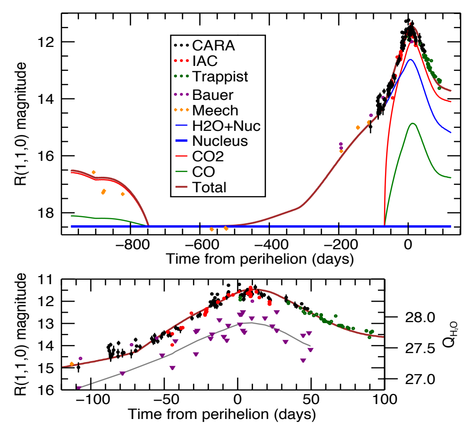

Figure 2: [Top] Composite photometric model of the comet brightness from the Earth-based campaign (dots). Models show that water-sublimation (blue line) controlled activity inbound from ~4.3-1.4 AU, at which point CO_2 (orange) and CO (green) outgassing were significant—out to beyond aphelion. [Dark blue = nucleus, brown = contribution from all 3 volatiles]. [Bottom] Expanded plot near perihelion showing that the peak is ~10 days post perihelion for both the optical photometry and water production (purple triangles).

4. Summary and Conclusions

Preliminary models of the data (see Fig. 2) up through the encounter show that the fractional active nucleus area is normal for water production and that at perihelion most of the water production is likely from the ice grain halo. Sublimation from deeper CO_2 reservoirs is likely an important driver of activity for this comet, including out to and beyond aphelion. Data obtained during 2011 until the comet moves into solar conjunction in June will be modeled and presented.

Acknowledgements

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References

[1] A'Hearn, M.F., Millis, R.L., Schleicher, D.G., Osip, D. J., Birch, P.V. (1995). "The ensemble properties of comets: Results from narrowband photometry of 85 comets (1976-1992)" *Icarus* **118**, 223.

[2] A'Hearn, M. F. *et al.* (2011): "EPOXI at Comet Hartley 2", *Science* in press.

[3] Harmon, J. K., Nolan, M.C., Howell, E.S., Giorgini, J.D. and Taylor, P.A. (2011). ``Radar Observations of comet 103P/Hartley 2", *ApJL* **734**, L2.

[4] Meech, K.J. *et al.* (2011). "EPOXI: 103P/Hartley 2 Observations form a Worldwide Campaign", *ApJL* **734**, L1.

[5] Motto, M., Glazer, B., Kaiser, R., Meech, K. (2007). "Water and Astrobiology", *Chemie der Erde—Geochem.* **57**:253-282.

[6] Snodgrass, C., Meech, K., Hainaut, O. (2010). "The Nucleus of 103P/Hartley 2, Target of the EPOXI Mission", *A&A* 516, L9.