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CO_2 as the driving force of comet Hartley 2's activity

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Abstract

The EPOXI mission found that CO_2 is the major driving force of the activity of Comet 103P/Hartley 2. In our experimental study we observed massive ice grain ejection, driven by CO_2 release, which was measured and filmed, during the ice sample heating process.

1. Introduction

CO_2 is the major driving force of the activity of Comet 103P/Hartley 2 (Fig 1). The active nucleus area is ~2%, but that there is a large halo of icy grains emanating from it that contributes more than 90% to the total water production rate at perihelion [1-2]. In our experimental study CO_2 was trapped underneath "cometary" amorphous water ice. During the heating process, massive ice grains driven by CO_2 jets were measured, during several temperature ranges.

2. Experimental results

Layers of CO_2 and amorphous water ice of 100 μm thick were deposited on a 17 cm^2 rectangular gold coated copper plate, cooled cryogenically in the vacuum chamber to 40-50K [3]. CO_2 is trapped in low temperature "cometary" amorphous water ice, about 4 orders of magnitude more efficient than gases such as CO, CH_4 and Ar. The plate was then warmed up and the gases, water vapor and grains were recorded by a quadrupole mass filter. Fast ice grains, having speed at least 1.67 m sec^{-1}, could reach the ion source and were recorded during the heating process. The frozen CO_2 sublimated and flowed outward, carrying with it a large flux of CO_2, water vapor and ice grains. The ice grains sizes from 1-150 μm [4] was measured by a mass filter with a time resolution of milliseconds at a rate of 0.25 sec^{-1} (Fig. 2). The heating process was filmed with a microscope camera (Fig. 3). The individual grains are seen as streaks for 33 msec (Fig 3a), forming "craters" (Fig 3b, c).

3. Figures

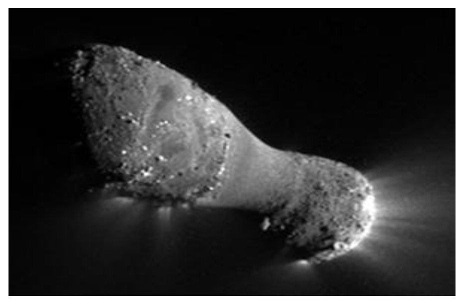


Figure 1: Jets from the surface of Comet Hartley 2 (NASA's EPOXI mission).

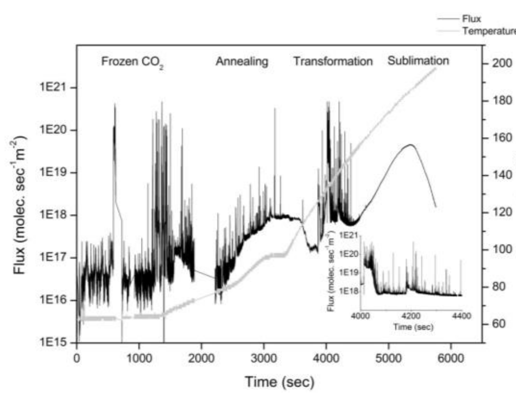
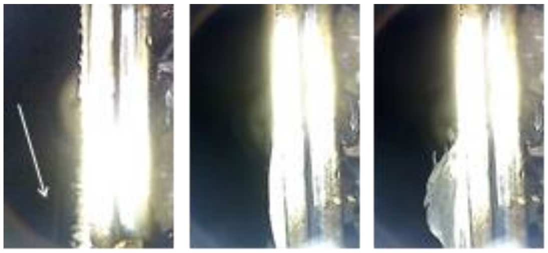


Figure 2: Ice grain ejection from thin ice samples: 2 layers were formed: a ~100 μm layer of frozen CO_2 covered by a ~100 μm layer of amorphous ice. In the insert, an extended time scale shows wide water peaks along with narrow ones.



(a) (b) (c)

Figure 3: Ice grains are seen to be ejected by CO_2 from a 100 µm gas-laden amorphous ice upon its heating. (a) the individual grains are seen as streaks, because the pass the entire frame during 33 msec; (b) swelling of the ice layer and (c) its detachment from the ice surface.

4. Summary and Conclusions

The EPOXI mission to Comet 103P/Hartley 2 found strong activity in water grains release driven by CO_2 jets. Our experimental findings can explain the comet nucleus activity and surface chances and show correlations between CO_2 jets and ice grains upon heating.

Acknowledgements

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