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New Experimental Studies of Ice Grain Ejection by Massive Gas Flow, Implications to Comets, Enceladus, Triton and Mars

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Abstract

Ice grains are ejected whenever gases are flowing from gas-laden amorphous ice upon its warming-up.

1. Experimental Results

New experimental studies on thin (up to 200 μm ice layers) confirmed our previous findings on ice grain ejection during the annealing of gas-laden amorphous ice and during its transformation into cubic ice. A massive gas flow from the interior, breaks the ice structure and carries with it ice grains from the walls of the gas flow channels. A new millisecond time resolution revealed a huge flux of tiny ice particles emanating from the ice. Yet, the sizes of the smallest ice grains are as found before in 1987 (1), 0.5 μm (figure1).

In large [20 cm diameter and a few cm thick] samples of gas-laden amorphous ice, a huge flux of ejected ice grains covers over the time the ice surface, as shown experimentally (figure 2).

Using our measured density of 250 kg m^{-3} (2), the sizes of the largest grains is 5.3 μm and the smallest is 0.53 μm (figure 3).

2. Figures

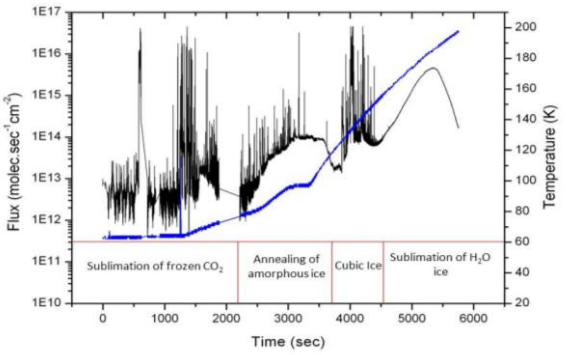

Figure 1: Ice grain ejection during the flow of CO_2 through an overlying 200 μm ice layer.

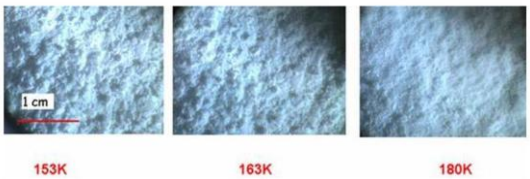

Figure 2: Coverage of the surface, by ejected ice grains of a large ice sample.

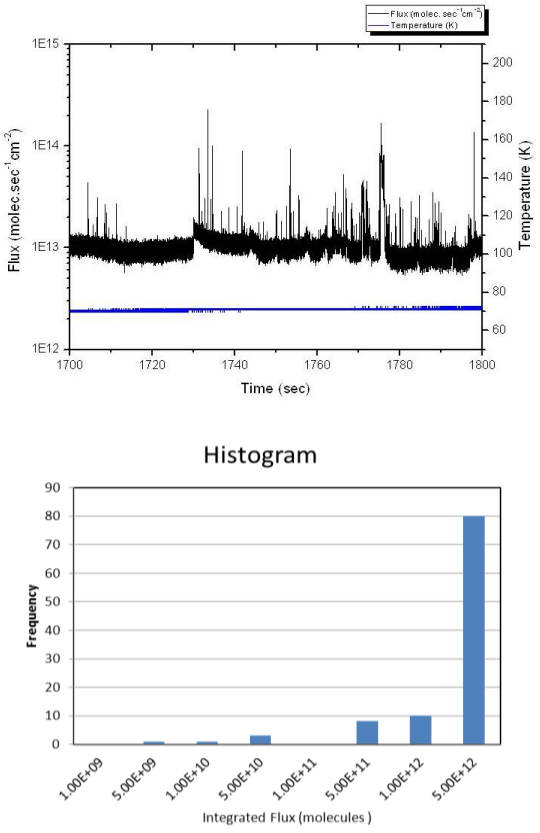

Figure 3: MS analysis of the ejected ice grains and their distribution.

3. Summary and Conclusions

These experimental findings can explain the ejection of ice grains from Enceladus' Tiger Stripes without invoking an eruption of liquid water from the underlying layers. It can also explain the plumes of dark material on Triton and the jets observed during the Martian polar spring when a layer of frozen CO_2 sublimates underneath a layer of ice.

Acknowledgements

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References

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[2] Laufer D., Pat-El I., Bar-Nun A., Experimental simulation of the formation of non-circular active depressions on Comet Wild-2 and of ice grain ejection from cometary surfaces, Icarus 178, 248–252, 2005.