Io and Enceladus volcanisms; meteor impacts: A study of material ejections in weightlessness

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Abstract

Plumes and material ejections take place on different objects in our solar system. Our experiment -in phase with current events in physics (discoveries of Galileo and Cassini spacecrafts)- is general enough to concern several facts: extraterrestrial volcanism and cryovolcanism, asteroid impacts in low gravity. We propose to project particles at high speed to observe their behaviour.

Summary

Plumes and material ejections take place on different objects in our solar system. As far as plumes are concerned, associated to active volcanism or cryovolcanism, they occur on Earth of course, as well on moons such as Io or Enceladus. Material ejections occur when an asteroid strikes objects of the solar system.

If those phenomena are well understood and interpreted on Earth, which is large compared with Io or Enceladus and whose temperature and pressure conditions are well known, it is not the case of those observed outside of our planet.

The purpose would therefore be to study material ejections in low gravity whether it concerns plumes due to active volcanism of cryovolcanism, or ejections due to meteor impact.

How can plumes reach such heights in low gravity? What is the importance of buoyancy or temperature of the ejected material? How are aggregates formed, what is their importance on these material ejections phenomena?

Many things are interesting for the concerned fields of research. This experiment is general enough to concern several facts: extraterrestrial volcanism and cryovolcanism, study of asteroid impacts in low gravity. So, interests are multiple: understanding of mechanisms coming into play in low gravity, low temperature, and low or non-existent pressure, studying particles dispersion on low gravity, studying forming and effect of aggregates.

It would allow us to confront simple models -numerically tested- to experimental data, to understand more subtly these processes on the other active objects in our solar system, and to hope finding totally original phenomena.

Moreover, it will be an experiment in phase with current events in physics: on the one hand it could help us understand the phenomenon taking place on Enceladus, discovered last year by the Cassini spacecraft, on the other hand it could bring several pieces of information about volcanism on Io, observed by the Voyager 1 and 2 spacecrafts and by the Galileo spacecraft as well, in the middle of the '90s.

It is interesting to carry out these experiments on the International Space Station because of the lack of gravity there. Advantages would be numerous: on the one hand, it would allow us to observe ejections more easily, the speed of their particles being not so much faster than the speed of the laboratory experiments' particles. On the other hand, it would be possible to simulate these phenomenons with similar conditions than those observed on low gravity objects as far as temperature and pressure condition are concerned.

The experiment we propose would be to project particles -like silicates- at high speed and to observe their behaviour. The interesting observable quantities will be the speed of the particles, jet temperature, and the size of aggregates.

In order to measure the particles speed, we can use an high-speed camera. It would allow to follow very precisely the plume evolution. If optical domain is interesting to follow particles taken as a whole, we can contemplate to use other measure methods (Doppler effect, etc.).

The temperature could be easily measured.

We can hope studying aggregates when the experiment is over, getting them back. We could contemplate to bring aggregates back to Earth to be studied.