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The CoPhyLab

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1 The CoPhyLab

Laboratory experiments are of major importance to understand the activity of comets and to support future space missions. However, past comet simulation experiments were performed under the assumption that comets are mainly composed of water ice with only a limited amount of dust. In the past years, however, the Rosetta mission has shown that cometary nuclei consist primarily of dust and less volatile materials are present than previously thought. Hence, it is high time to set up a new series of laboratory experiments with the aim to investigate the physics of realistic cometary analogue materials. This task is currently addressed by the CoPhyLab (Comet Physics Laboratory) which is a joint project among the Universität Bern, the Institut für Weltraumforschung Graz, the Deutsche Zentrum für Luft- und Raumfahrt, the Max-Planck-Institut für Sonnensystemforschung, the University of Stirling and the Technische Universität Braunschweig. This laboratory aims at studying the physics of cometary analogue materials. This task is approached by first investigating isolated physical properties in so-called small experiments (e.g., the thermal conductivity, or the gas permeability of analogue materials). In a next step, the experiment's complexity is increased step-by-step by either adding further components to the sample, or by studying several physical properties under different conditions (large experiments). Therefore, a novel large experiment chamber will be set up in the laboratory. Additionally, the laboratory experiments are supported by thermophysical modelling. This presentation will provide an overview on ongoing as well as on planned CoPhyLab experiments.

2 Ongoing Small Experiments

2.1 Dust Emission

One of our first experiments was the investigation of how dust aggregates are ejected from a sublimating ice surface. Therefore, we prepared solid, pure ice samples and poured dust aggregates on top of the ice surface. The temporal evolution of the sample's surface in vacuum and the dust ejection were observed by two cameras. Fig. 1 shows the trajectories of the dust aggregates with respect to the sample's surface. It is interesting to note the non-zero starting velocity of the aggregates. We are currently working on improving the experiment by installing an high-speed camera.

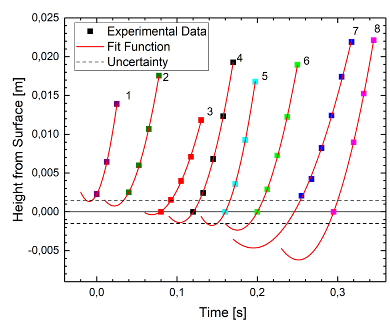

Figure 1: Aggregate trajectories measured in one of our small experiments [1].

2.2 Tensile Strength

In addition, we have studied the tensile strength of analogue materials (see Fig. 2) and found that the tensile strength depends on the grain size and on the volume filling factor of the material [2]. During the conference we will present new data on organic analogue materials (see also D. Bischoff EPSC contribution: Measurement of the tensile strength of organic materials) as well as on ice-dust mixtures.

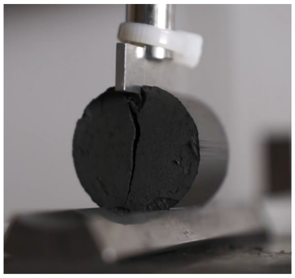

Figure 2: The tensile strength experiment: a bar is pressed from top onto a cylinder, which consists of graphite particles, until the sample breaks.

2.3 Thermal Conductivity

With this small experiment we are aiming at setting up a non-invasive method to measure the thermal conductivity of comet analogue materials and meteoritic samples. This setup consists of a vacuum chamber, an infrared camera and a solar simulator. The thermal conductivity can be derived by comparing the experimentally measured temperature distribution with thermophysical model calculations (see Fig. 3).

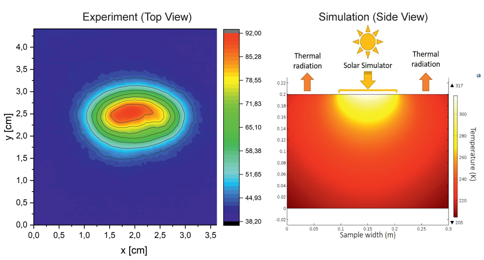

Figure 3: Typical temperature distribution of a test material that is illuminated by the solar simulator: experiment (left) versus simulation (right).

2.4 Spectral Reflectance

In Bern, the current activities within the CoPhyLab project focusses on the measurements of the reflectance of ice and dust mixtures and the comparison with reflectance models. The dependence of the visible reflectance on the incidence, emission and phase angle will be presented by C. Feller at the EPSC: Photometric measurements and calibrations in view of the CoPhyLab experiments. The spectral reflectance of the same mixtures are currently being measured. These results will later serve as a calibration to retrieve the composition of the surfaces from spectra during sublimation experiments.

3 Planned Large Experiments

In parallel to the small experiments we are currently installing a large simulation chamber with 14 different instruments (e.g., mass balance, mass spectrometer, temperature sensors, thermoneedles, penetrometer, infrared camera, highspeed camera, radiometer, hyperspectral imaging system, etc.) which will be able to investigate the evolution of cometary analogue samples. Details of the large-chamber design are presented by C. Kreuzig: The CoPhyLab L-Experiments.

4 Thermophysical Support

The experiments are supported by thermophysical modelling in order to better understand the different channels of heat dissipation in our systems. In addition, we will utilize our experiments to calibrate a thermophysical model which will be used for data interpretation of spacecraft instruments. Fig. 3 presents a first model simulation of the thermal conductivity experiment. In this case, the simulation is needed to derive the thermal conductivity from the experiment data. A. Lethuillier-Letoquin will present the latest results of the CoPhylab thermophysical model during the EPSC: Thermal modeling of cometary analogs with CoPhyLab.

5 Public Outreach

Please follow our Twitter and our YouTube channel for updates on the CoPhyLab project.

Acknowledgements

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References

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