Photometric measurements of Solar System icy surface analogues

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Water has played a key role in the formation and evolution of most planets and small bodies and is still widespread at the surfaces of objects within both the inner and outer Solar System, mostly in its solid ice form. Disproportional to its importance as both an actor and a witness of many important processes, reference laboratory data on realistic macroscopic analogues for icy surfaces are relatively rare in the literature. Beyond the need to adapt accurate photometric instruments to work in cold conditions, the main challenge for such measurements is in the production of well-characterized and reproducible icy analogues, as water ice has a tendency to evolve rapidly in the laboratory (Fig. 1).

During the past few years, we have developed Setups for the Production of Icy Planetary Analogues (SPIPA) to address this issue. Using these setups, we can produce water ice with variable, but controlled, grain size (Fig. 1) and mix it with refractory contaminants following documented protocols that lead to reproducible mixed ice/dust samples. All the machines we have built to produce the samples can be transported on a trolley and/or by car so that samples can be produced and analyzed in different laboratories across Europe. This allows us to progressively collect a comprehensive dataset of relevant physical properties on a series of well-defined samples. Beyond our own interest in visible spectro-photometry that complements our instrument development (e.g. for BELA and CaSSIS) and data analysis activities, we are collaborating with different groups specialized in various techniques such as thermo-physical and mechanical properties (TU Braunschweig, IFP Graz), infrared spectroscopy (IPAG Grenoble), mass spectrometry and sputtering (PI/WP Bern) and microwave/sub-millimeter dielectric constant determination (IAP Bern).

At the workshop, we will present our analogues and review results obtained so far using techniques that involve radiative transfer at various wavelengths. We will then concentrate on two specific topics: the visible reflectance of pure micrometer-sized ice samples and the visible polarimetric phase curves of pure ice as well as mineral and organic dust samples. Both studies are of interest for the exploration of the icy surfaces of the moons of Jupiter and other gas giant planets.

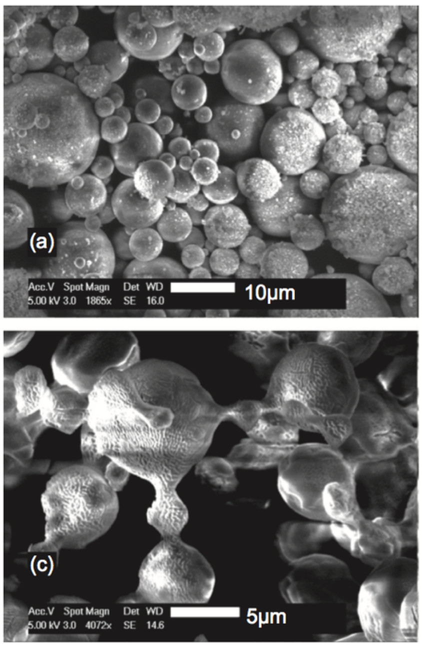

Figure 1: SEM pictures of (top) a fresh Sample of fine-grained H_2O ice produced with our SPIPA setup and (bottom) the same sample after 1 hour of storage in a freezer at -30°C.

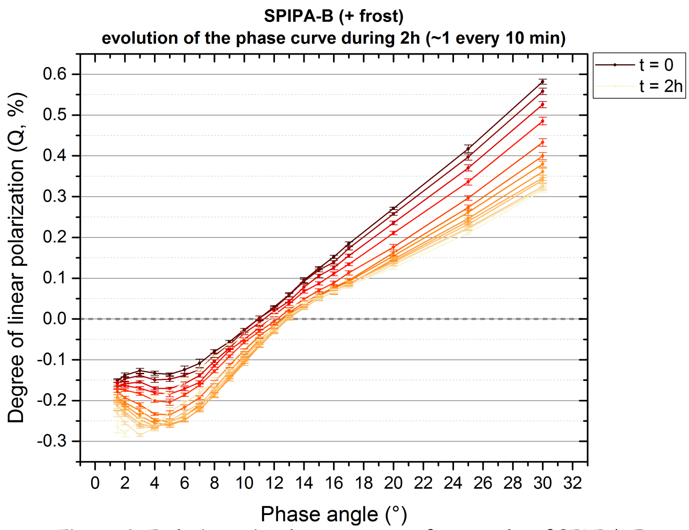

Figure 2: Polarimetric phase curves of a sample of SPIPA-B H_2O ice (70µm-diameter particles) recorded every ten minutes for a total duration of two hours. The modifications of the measured phase curves are due to the progressive dissipation of a cloud of crystals of water above the sample and the formation of frost on the larger ice grains with time. We have recently performed similar measurements with finer grained ice samples (see Fig. 1) as well as dust samples that also show strong spectral dependence of the polarimetric phase curves in the latter case.