DUST SPECTROSCOPY OF THE JOVIAN SATELLITES. Z. Sternovsky[1,2], E. Grün[1,3], M. Horanyi[1], S. Kempf[1], F. Postberg[4,5], J. Schmidt[6], ([1]LASP, University of Colorado, Boulder, CO; [2]Aerospace Eng. Sciences, University of Colorado, Boulder, CO; [3]MPI for Nuclear Physics, Heidelberg, Germnay; [4]Institute for Space Systems, University of Stuttgart, Germany; [5]Institute for Geosciences, University of Heidelberg, Germany; [6]Institute for Physics and Astronomy, University of Potsdam, Germany).

Introduction: The Galilean moons are enshrouded by dust clouds lifted from their surfaces by micrometeoroid bombardment. It is possible to analyze these particles as almost unaltered samples of planetary surfaces at flybys or from an orbiter. The proven technique of dust detection and compositional analysis through impact ionization allows both the qualitative and quantitative analysis of a large number of samples and thus combines the advantages of remote sensing and a lander. The detected particles can be traced back to their point of origin at the surface and mapping of the elemental and molecular composition can be acquired. For a Ganymede or Europa orbiter the main scientific output could be the compositional map from thousands of samples taken from a greater part of the surface. The approach has a ppm-level sensitivity to materials as salts and other inorganic and organic compounds embedded in the ice matrix. Regions which were subject to endogenic or exogenic alteration (resurfacing, radiation, old/young regions) could be distinguished and investigated. In particular, exchange processes with subsurface oceans could be determined with high quantitative precision.

The Cosmic Dust Analyzer (CDA) instrument onboard the Cassini spacecraft have analyzed the E-ring particles and the particles from the plumes of Enceladus. The data analysis combined with laboratory measurements resulted in a plethora of discoveries and the proof of a liquid ocean in contact with the rocky core beneath Enceladus's icy surface. Since the launch of the CDA instrument, better performance and lower mass instruments with high technical readiness level have been developed and tested in the laboratory.

Impact Ejecta Clouds: Impact ejecta clouds around all of the Galilean satellites have bee discovered by the dust detectors on board the Galileo spacecraft. The ejecta particles are released due to micrometeoroid impacts and can be sampled at distances of several times the moon's radius. Unfortunately, this dust detector was not equipped with chemical analysis capability.

CDA at Satrurn: One of the major excitements of the Cassini mission was the discover of Enceladus's plumes. The CDA instrument have measured the composition of the ions generated from the impact of these plume particles. The analysis of the spectra was aided by laboratory calibration measurements. The spectra (Fig. 1) show that although the particles are mostly composed of ice, the small salt content dominates the mass spectrum, which makes the method *extremely* sensitive to chemicals embedded in the icy matrix. The careful analysis of the spectra reveled the existence of subsurface salt water reservoir (ocean) [2] and the details of the dynamical operation of the plumes [3].

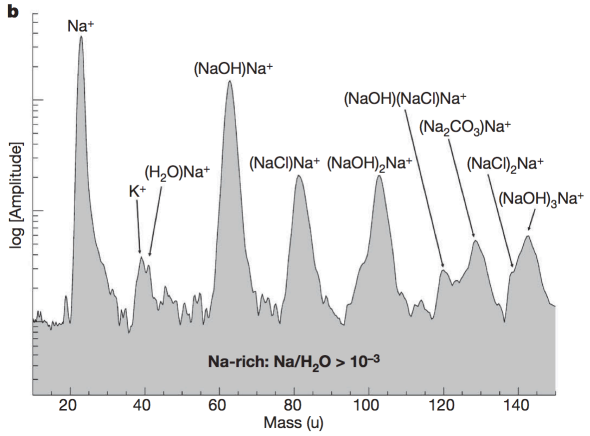

Fig. 1. The mass spectrum of icy plume particles is dominated by the traces of NaCl, Na_2CO_3 and KCL.

Science Capabilities: The operation of the chemical dust analyzer (dust spectrometer) around a Jovian satellite is illustrated in Fig. 2. The science capabilities of modern dust instruments operating on orbit or as fly-by include: (1) In-situ sampling of the surface material in form of micron and submicron sized ejecta particles. (2) The measurement of the salts, hydrated and unhydrated minerals and organic coumpounds embedded in he icy with *unprecedented* sensitivity to ppm-levels. (3) Compositional mapping of the surface with resolution of km or tens of km on the surface, depending on the orbit and/or instrument improvement options.

These measurements are imperative to the understanding of surface geology, the exchange process between the surface and subsurface oceans, space weathering and ultimately the habitability of the Jovian satellites.

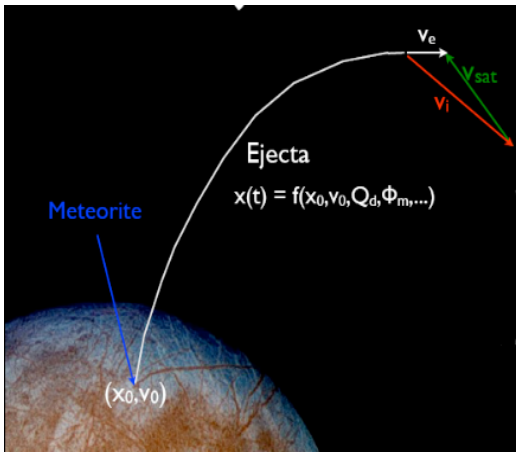

Fig. 2. The illustration of compositional mapping of the surface Europa.

Modern Dust Instrument: Modern dust instruments with much improved capabilites have been developed in the past decade (e.g. [4]). The new instrument concept utilizes a reflectron ions optics that improves the mass resolution of the CDA (m/dm = 20-50) to m/dm = 100-200. The improved mass resolution also allows higher dynamic range and thus better sensitivity. The mass estimate of a very capable dust instrument is approx. 5 kg.

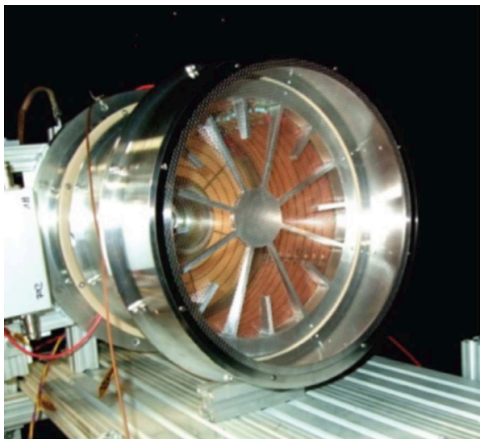

Fig. 3. The laboratory model of a modern, high resolution and low mass dust spectrometer instrument.

References: [1] Krüger et al., (1999) Detection of an impact generated dust cloud around Ganymede, Nature, 299 [2] Postberg et al., (2009) Sodium Salts in E Ring Ice Grains from an Ocean below the surface of Enceladus. Nature, 459. [3] Postberg et al., (2011) A saltwater reservoir as the source of a compositionally stratified plume on Enceladus. Nature, 474 [4] Sternovsky et al. Large area mass analyzer instrument for the chemical analysis of interstellar dust particles, Rev. Sci. Insrum. 78, 014501, 2007.