Prepare for Dust Sample Return

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May 2009, R. Srama
Where do we find dust?

* “Above” small bodies (moons, asteroids) – secondary ejecta of interplanetary dust impacts
* “Above” bodies with volcanoes/geysers (Enceladus, Europa?, Io, ..)
* Comets
* Interplanetary Dust
* Interstellar Dust
Dust: Messengers over time and space

H. Krüger

Streams of Dust Particles Coupled to Jupiter's Magnetic Field

Galileo

To Earth

FOV

DDS

Dust Streams Impact Direction

Io

Max-Planck-Institut für Kernphysik

May 2009, R. Srama

Prepare for Dust Sample Return
Dust Cloud around Ganymed: Moons as Dust Amplifiers

Link to surface and subsurface geology
GALILEO: Dust Cloud around Europa

Europa-flyby Galileo, Sremcevicz 2004

Prepare for Dust Sample Return
Stardust: Successful Sample Return
The Stardust Aerogel Collector

Combine with in-situ detection of impact time and location and speed and mass (composition not possible)
Example for collected dust particle (Stardust)

Comet dust particles

0.5 mm

Difficult to derive original dust grain properties, not impossible but...
TOF-SIMS Analyse einer Allendespuren in Aerogel (T. Stephan, Univ. Münster)

You do not need the grain, you can analyse the track!
Where are we?
Sample Return of Interstellar Matter
Proposal for Cosmic Vision 2015-2025
Preparation of Active Collector development

* Aerogel (10 times cleaner than Stardust) density gradient (2...20 mg/ml ?)
* Foils of „soft“ and „clean“ metals (aluminium)
* 7 Modules, each module is articulated individually to expose the collector during phases of interstellar dust detection.
* Each module has a collective area of 40 cm x 40 cm

One of 7 active collector modules:
The collector will be removed during parts of the SARIM orbits
Trajectory Sensor developed

Measurement of induced charge of particle primary charge

- **Dimension**: 40 cm x 40 cm
- **Depth**: 20 cm
- **Sensitive area**: 0.14 m²
- **FoV half cone**: 45°
- **Data rate**: 1500 bps
- **Mass**: < 5 kg
- **Power**: 8 W
- **Dust speed**: 1 .. 100 km/s
- **Dust charge**: 0.1 fC .. 100 fC
- **Dust mass**: 10e-15 .. 10e-8 g
- **Dust trajectory**: 1°
- **Dust composition**: N/A
We have tested a Small Dust Telescope
* Combine trajectory sensor and TOF spectrometer
* Dust origin AND dust properties (mass, composition, charge,...)
Univ. Colorado: Dune Mission Proposal (in-situ only)
New: Impact spectra of low-velocity impacts

Dust = Orthopyroxen, 2.5 km/s 0.6 µm
ToF Spectrometer: LAMA
New dust sample return mission - Increments on STARDUST

- 10 times sensitive area (collector 0.1 to 1 m²)
- 10 times sensitive area (spectrometer 0.01 to 0.1 m²)
- Collection/detection of interstellar dust possible
- Collection of dust grains in vicinity of small bodies (Hill sphere) – geyser or volcano activity provide a view below the surface
- Dust grains rich in alkali metals: proof of subsurface-ocean
- Determine impact time and location of individual impacts at the collector. Determine particle speed and mass of individual grains. We know where to look for particles in/at the collector.
- Combine with in-situ package (spectrometer/trajectory sensor)
- Separate interplanetary dust, interstellar dust, moon dust by trajectory analysis
Conclusion

* Targets: interstellar dust, interplanetary dust, dust from asteroid/moon surfaces, dust from moon interiors (detection of liquid water), cometary dust

* Combine dust collection with in-situ techniques, provides impact time and impact location (collector surface), grain mass, grain trajectory!

* Combine collector with in-situ compositional measurement (submicron or fast grains are problematic for collectors)
European Planetary Science Congress

EPSC 2009
September 13-18
Potsdam, Germany

Small Body Session
Sample return and its laboratory analysis

The Einstein Tower - An astrophysical observatory in the Albert Einstein Science Park