COSIMA

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Dust under the microscope

ÖAW AUSTRIAN ACADEMY OF SCIENCES

IWF SPACE RESEARCH INSTITUTE

INAF ISTITUTO NAZIONALE DI ASTROFISICA OSSERVATORIO ASTRONOMICO DI CAPODIMONTE

asi

INSTITUTO de ASTROFISICA de ANDALUCIA IAA

CSIC CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS

FINMECCANICA

esa European Space Agency

Rosetta

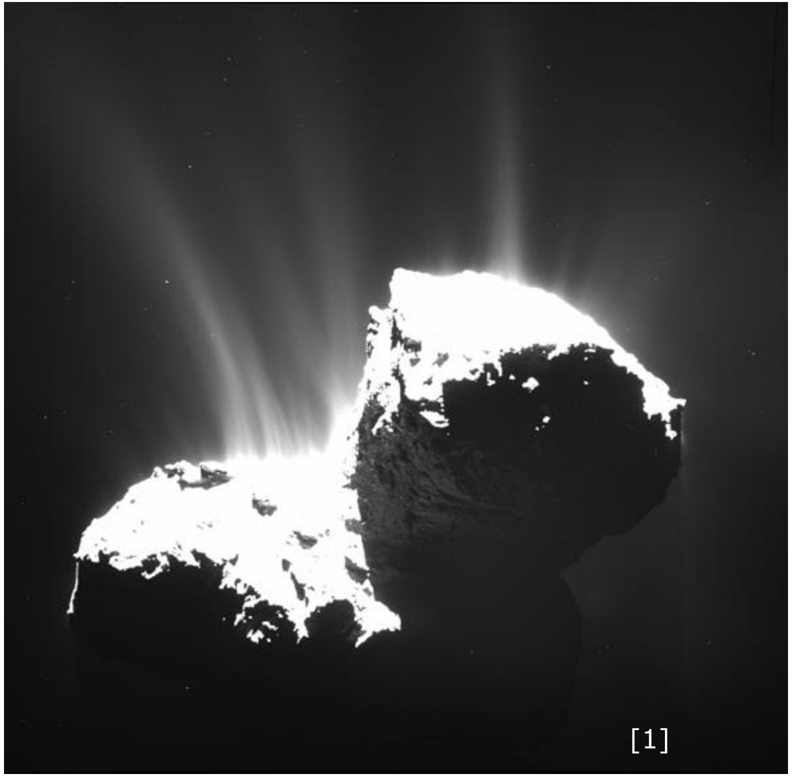
Unprecedented collection of the least altered cometary dust:

- Slowest relative velocities to a comet ever flown
- Closest approach ever to a comet
- First time to accompany a comet around Sun

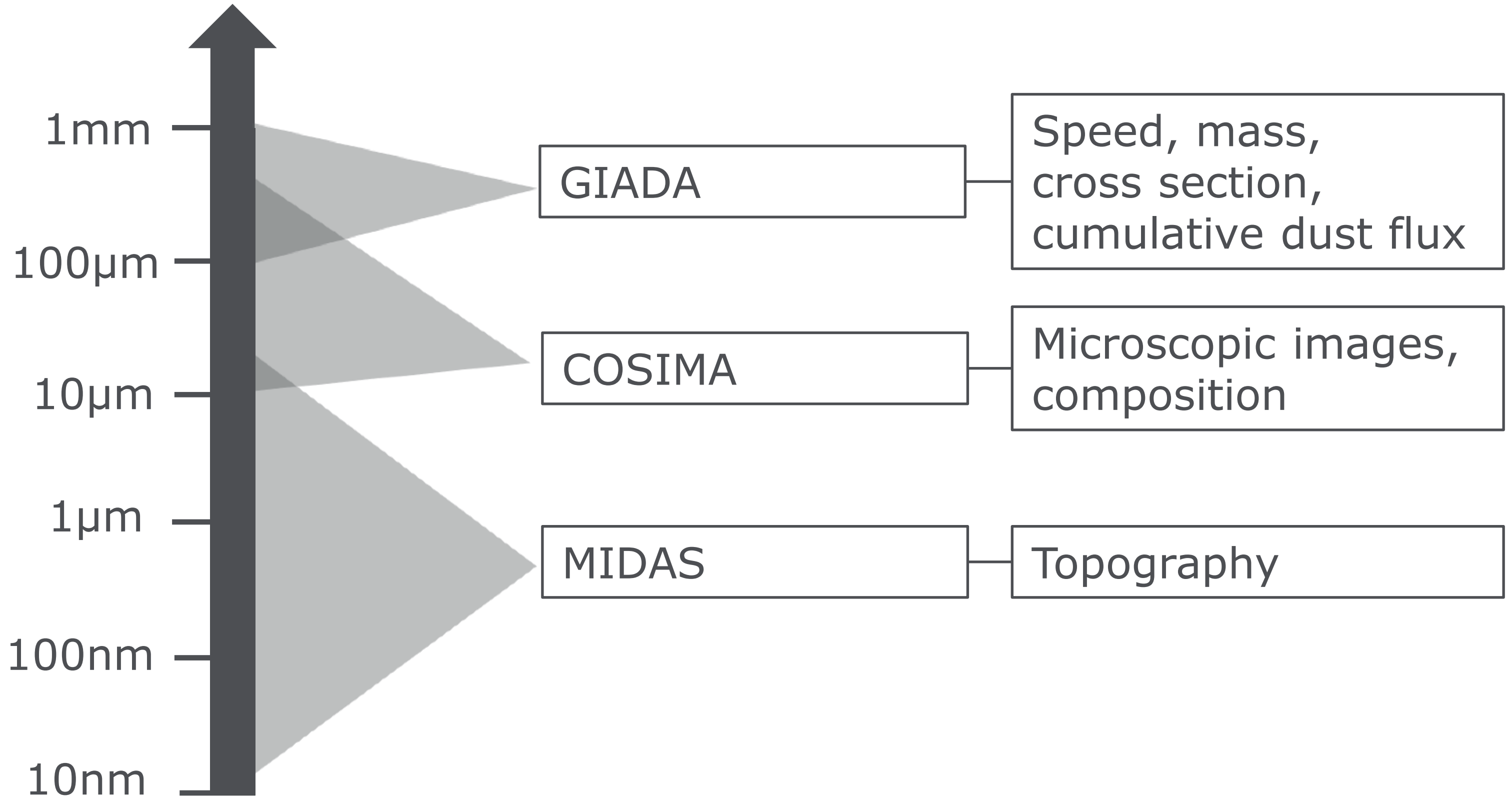
What have we learned?

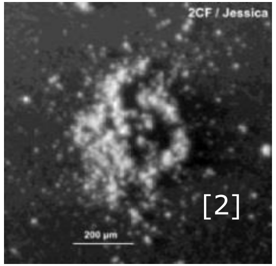
1) Dust morphology
2) Dust composition
3) Nucleus properties

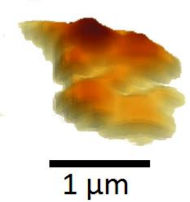
→ Early solar system



Main instruments







[3]

1) Dust morphology - COSIMA

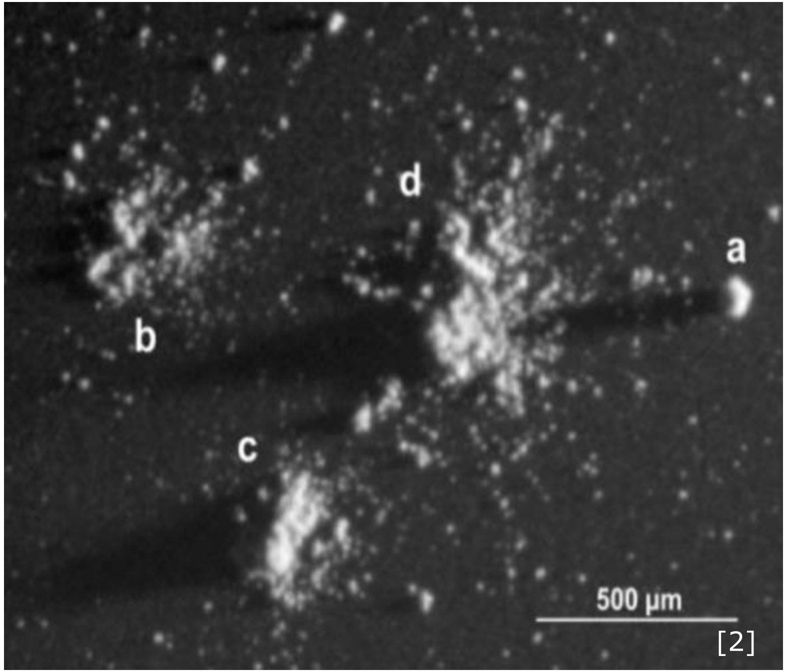
Compact particles

- Well-defined shape
- Pristine, no fragmentation
- Relatively bright: High mineral content?

Clusters

- Glued clusters rather dark: Carbonaceous matrix?
- Fragmentation
  - Depends on impact velocity & strength: Very fragile material
  - Pre-existing sub-units ~ 10 µm

[2][8][9]

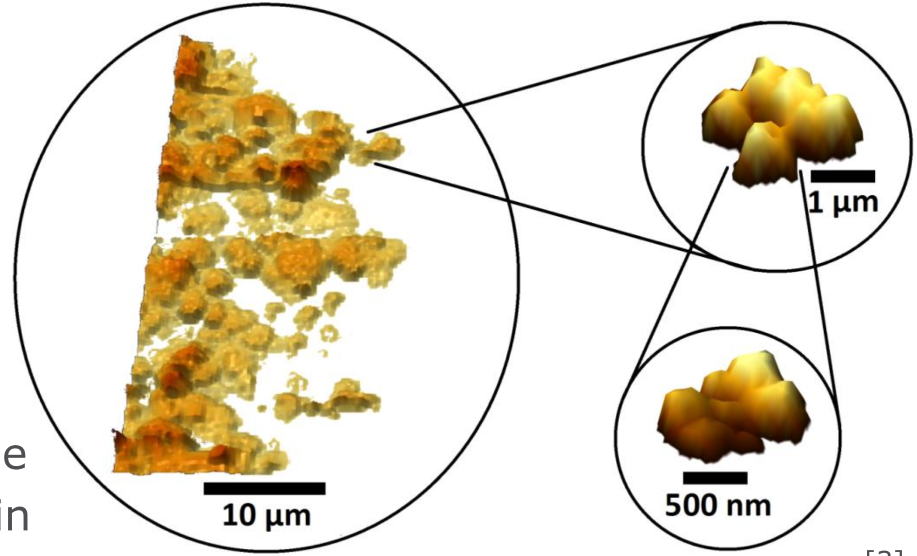


a) Compact
b) Shattered cluster
c) Glued cluster
d) Rubble piles

1) Dust morphology - MIDAS

Agglomerates with well-defined sub-units

- Hierarchical construction:
  Sub-units at distinct size scales
- Packing of sub-units:
  Compact to porous
- 1 especially porous particle
  - Fractal structure: similar to a sponge
  - Pristine: Information about growth in early solar system



[3]

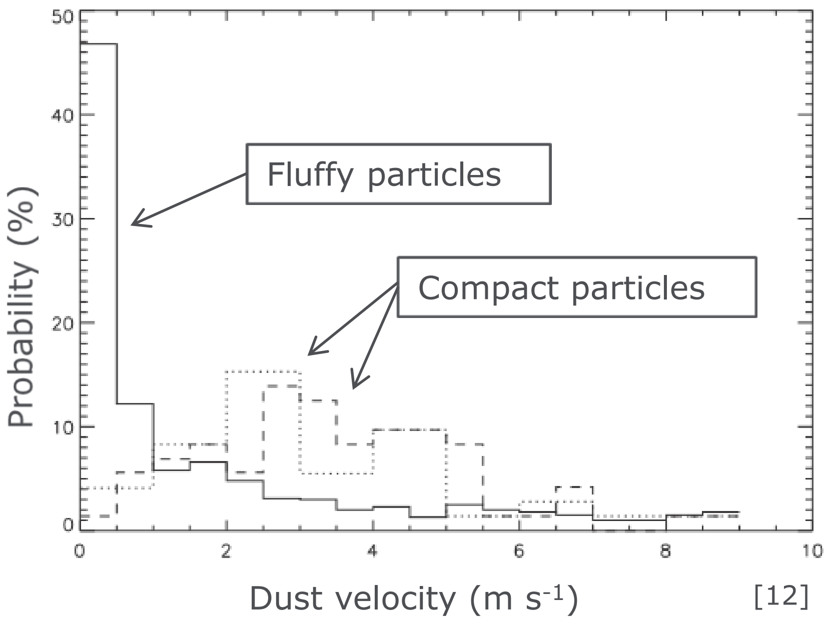
Porous Compact

[4][8][10]

1) Dust morphology - GIADA

Fluffy particles

- Lower velocity
- Detected as showers of small particles
- Parent particles:
  - mm-sized
  - Density less than air
  - Pristine fractal structure
  - ~ 15 volume percent of the dust



[12]

Compact particles

- Higher velocity and momentum
- Bulk densities $1200 \leq \rho \leq 4600$ kg m^{-3}

[6][11][12]

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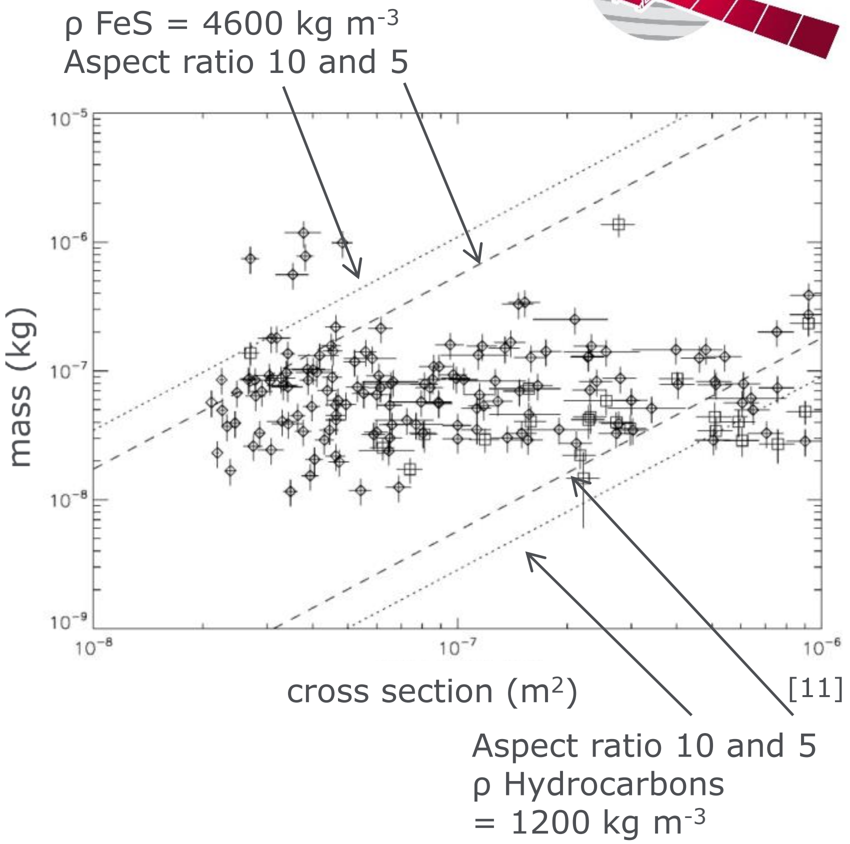
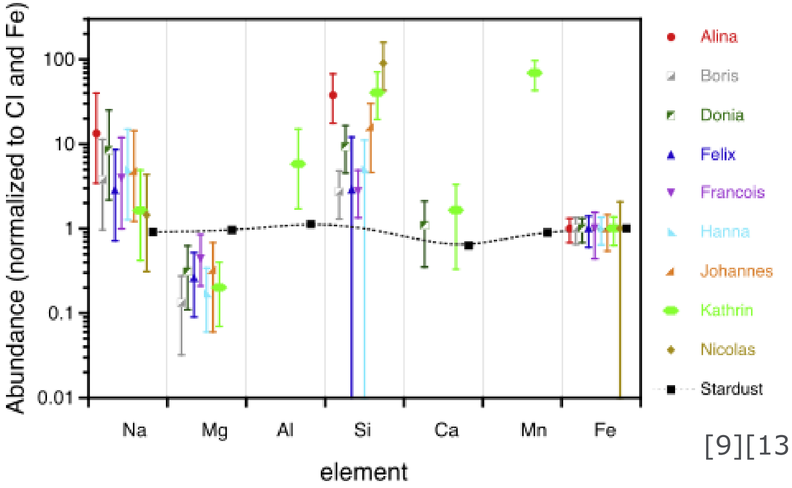


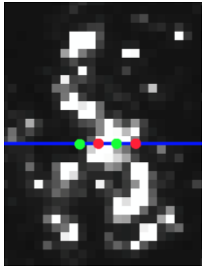
2) Dust elemental composition - COSIMA

- Dominated by primitive silicates – like rock on earth – and FeS
- Hints for material from hot inner solar system
- Very pristine components from early formation processes: High-molecular-weight organic material

[9][14]



[9][13]



[14]

3) Properties of the 67P nucleus - GIADA

- The dust bulk density measured by GIADA constrains the composition of 67P's nucleus
- Consistent with primitive materials of our solar system
- Dust of 67P matches predictions for building blocks of planetesimals

[11]

67P dust-to-ices mass ratio	8.5
Ices (+ porous, - compact)	15 ± 6 %vol
FeS (+ CI-chondritic, - solar)	5 ± 2 %vol
Mg,Fe-olivines and pyroxenes (+ CI-chondritic, - solar)	28 ± 5 %vol
Hydrocarbons (+Solar, - Cl-chondritic)	52 ± 12 %vol
Dust porosity	52 ± 8 %
Compacted dust bulk density	1660^{+2440}_{-360} kg m^{-3}

[11]

Conclusion

Rosetta and the early Solar System - The dust-instrument perspective

Dust of 67P

- Agglomerates with different morphologies [2][4][12]
- Composition:
  - Primitive silicates and FeS [9]
  - High-molecular-weight organics [15]
  - Inner-solar system material [14]
- Certain structures and materials preserved from the early solar system [8][10][11]

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Solar nebula

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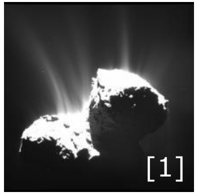
Solving the puzzle with Rosetta data

Comet 67P



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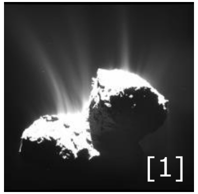
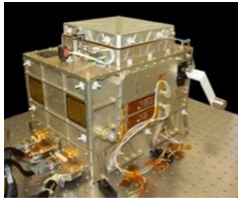


Some puzzle pieces

- Dust growth [4][8][10][11]
- Building blocks of planetesimals [11]
- From pebbles to comets - B. Davidsson

Acknowledgements



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