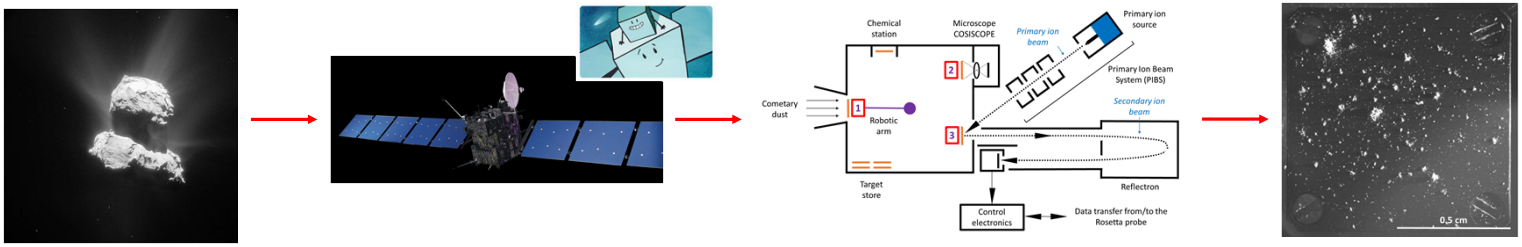
# Global Composition of Dust at Comet 67P/Churyumov-Gerasimenko as Measured by the COSIMA/Rosetta Mass Spectrometer

P23G-3520

Anaïs Bardyn[1*], D. Baklouti[2], H. Cottin[3], C. Briois[4], C. Engrand[5], H. Fischer[6], N. Fray[3], E. Gardner[7], K. Hornung[8], R. Isnard[3,4], Y. Langevin[2], H. Lehto[7], L. Le Roy[9], N. Ligier[2], S. Merouane[6], P. Modica[4], F.-R. Orthous-Daunay[10], J. Paquette[6], J. Rynö[11], R. Schulz[12], J. Silén[11], S. Siljeström[13], O. Stenzel[6], L. Thirkell[4], K. Varmuza[14], B. Zaprudin[7], J. Kissel[6] and M. Hilchenbach[6]

[1]DTM, Carnegie Institution of Washington, Washington, DC, USA, [2]IAS, Université Paris-Sud/CNRS, Orsay, France, [3]LISA, UMR CNRS 7583, Université Paris-Est Créteil et Université Paris Diderot, Institut Pierre Simon Laplace, Créteil, France, [4]LPC2E, CNRS/Université d'Orléans, Orléans, France, [5]CSNSM, CNRS/IN2P3/Université Paris-Sud, Orsay, France, [6]MPS, Göttingen, Germany, [7]University of Turku, Department of Physics and Astronomy, Tuorla Observatory, Piikkiö, Finland, [8]Universität der Bundeswehr, Neubiberg, Germany, [9]CSH, University of Bern, Bern, Switzerland, [10]IPAG, UMR 5274, Université Grenoble Alpes, CNRS, Grenoble, France, [11]FMI, Helsinki, Finland, [12]ESA, Noordwijk, The Netherlands, [13]RISE, Bioscience and Materials/Chemistry and Materials, Stockholm, Sweden, [14]Institute of Statistics and Mathematical Methods in Economics, Vienna University of Technology, Vienna, Austria

## 1. The Rosetta Mission: Comet 67P




**Comet 67P**
- Dimensions: ~ 4 km x 3 km x 2 km
- Orbital period: 6.44 yr
- Perihelion: 1.24 AU

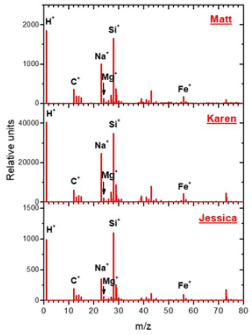
**The Rosetta Mission**
- Journey to the comet: 10 years
- At the comet: Aug. 2014 to Sept. 2016
- Rosetta orbiter (11 instruments)
- Philae lander (10 instruments)

**The COSIMA instrument**
- Time-of-flight mass spectrometer [1]
- On board the Rosetta orbiter
- Aim: Analysis of the chemical composition of 67P's dust
- Collect (1), Image (2) and Analyze (3)

**COSIMA target**
- 21 targets exposed
- > 35,000 particles [2]
- Size: ~10 to 1000 µm
- ~250 particles analyzed

# COSIMA: COmetary Secondary Ion Mass Analyzer

## 2. COSIMA analysis



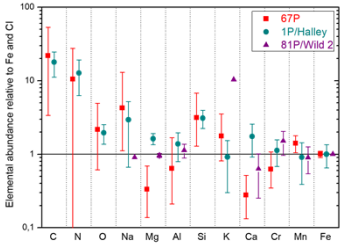

- Similar mass spectra signatures [3]
- Always a mixture of carbonaceous matter and mineral phases

(ion beam size: 30 x 50 µm²)

**Positive ion mass spectra**

*contribution from background has been removed*

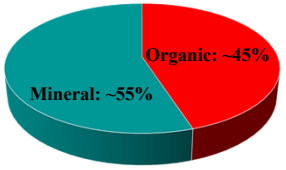
## 3. Global composition




**67P's dust compared to comets Halley and Wild 2**

*for references see Figure 6 in [3].*
- 67P's dust is chondritic within a factor of 3, C excepted
- Consistent with the composition of Halley and Wild 2

**Mass ratio of organic to mineral matter in 67P's dust**




- Based on the elements quantified in [3, 4] and H/C = 1.04 ± 0.16 [5]
- Assumptions:

(i) S/Fe = 0.5 (chondritic)
(ii) C, H and N in organic
(iii) O/Si = 4 in mineral ($SiO_4$) and the remaining O in the organic phase

## 4. Summary

- Dust particles are carbon-rich: ~45% organic matter in mass
- Macromolecular carbonaceous matter [6] is a major non-volatile component of 67P dust

**References**
[1] Kissel *et al.* (2007), [2] Merouane *et al.* (2017), [3] Bardyn *et al.* (2017), [4] Fray *et al.* (2017), [5] Isnard *et al.* (submitted), [6] Fray *et al.* (2016) | Credit images: ESA

*abardyn@carnegiescience.edu

CARNEGIE SCIENCE | DTM

AGU 100 | FALL MEETING | Washington, D.C. | 10-14 Dec 2018

# Global composition of dust at comet 67P/Churyumov-Gerasimenko as measured by the COSIMA/Rosetta mass spectrometer

A. Bardyn[1], D. Baklouti[2], H. Cottin[3], C. Briois[4], C. Engrand[5], H. Fischer[6], N. Fray[3], E. Gardner[7], K. Hornung[8], R. Isnard[3,4], Y. Langevin[2], H. Lehto[7], L. Le Roy[9], N. Ligier[2], S. Merouane[6], P. Modica[4], F.-R. Orthous-Daunay[10], J. Paquette[6], J. Rynö[11], R. Schulz[12], J. Silén[11], S. Siljeström[13], O. Stenzel[6], L. Thirkell[4], K. Varmuza[14], B. Zaprudin[7], J. Kissel[6] and M. Hilchenbach[6].

[1]DTM, Carnegie Institution of Washington, Washington, DC, USA
[2]Institut d'Astrophysique Spatiale, Université Paris-Sud/CNRS, Orsay, France
[3]LISA, UMR CNRS 7583, Université Paris-Est Créteil et Université Paris Diderot, Institut Pierre Simon Laplace, Créteil, France
[4]LPC2E, CNRS/Université d'Orléans, Orléans, France
[5]CSNSM, CNRS/IN2P3/Université Paris-Sud, Orsay, France
[6]Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany
[7]University of Turku, Department of Physics and Astronomy, Tuorla Observatory, Piikkiö, Finland
[8]Universität der Bundeswehr, Neubiberg, Germany
[9]Center for Space and Habitability, University of Bern, Bern, Switzerland
[10]IPAG, UMR 5274, Université Grenoble Alpes, CNRS, Grenoble, France
[11]Finnish Meteorological Institute, Helsinki, Finland
[12]European Space Agency, Noordwijk, The Netherlands
[13]RISE, Bioscience and Materials/Chemistry and Materials, Stockholm, Sweden
[14]Institute of Statistics and Mathematical Methods in Economics, Vienna University of Technology, Vienna, Austria.

COSIMA was a time-of-flight secondary ion mass spectrometer on board the Rosetta orbiter. From August 2014 to September 2016 the instrument performed *in situ* analysis of the dust particles ejected from comet 67P/Churyumov-Gerasimenko, before and after perihelion. COSIMA collected more than 35,000 particles at a low impact velocity (< 10 m/s) and analyzed about 250 of them with size ranging from ~50 to ~1000 µm.

We will report the global composition of the cometary dust as deduced from COSIMA measurements. The average elemental composition measured for 67P's dust will be compared to previous results obtained from the Giotto and Vega missions for comet 1P/Halley and the Stardust mission for comet 81P/Wild 2, to the composition of Chondritic Porous Interplanetary Dust Particles (CP-IDPs) and to the CI chondrite composition.

**AGU Fall Meeting 2018 (**American Geophysical Union)
10-14 Dec 2018, Washington, DC, USA

https://fallmeeting.agu.org/2018/welcome/

https://fallmeeting.agu.org/2018/program-schedule/

Planetary Sciences

AGUfm18NEWS_Planetary-Sciences_Weekly.pdf

**P23G (CC) Hall A-C (Poster Hall)**

**Tuesday 1340h**

**The Origin, Evolution, and Fate of Comets: New Results from Rosetta, Other Missions, and Ground-Based Observations I Posters** *(joint with SH, SM)*

***Presiding:*** **Bonnie Buratti**, Jet Propulsion Laboratory; **Mathieu Choukroun**, Jet Propulsion Laboratory; **Matt Taylor**, European Space Agency;

1340h **P23G-3520** *POSTER* Global Composition of Dust at Comet 67P/Churyumov-Gerasimenko as Measured by the COSIMA/Rosetta Mass Spectrometer: **A Bardyn**, D Baklouti, H Cottin, C Briois, C Engrand, H Fischer, N Fray, E Gardner, K Hornung, R Isnard, Y Langevin, H Lehto, L Le Roy, N Ligier, S Merouane, P Modica, F R Orthous-Daunay, J A Paquette, J Rynö, R Schulz, J V Silen, S Siljeström, O Stenzel, L Thirkell, K Varmuza, B Zaprudin, J Kissel, M Hilchenbach

Abstract

# Global composition of dust at comet 67P/Churyumov-Gerasimenko as measured by the COSIMA/Rosetta mass spectrometer

A. Bardyn[1], D. Baklouti[2], H. Cottin[3], C. Briois[4], C. Engrand[5], H. Fischer[6], N. Fray[3], E. Gardner[7], K. Hornung[8], R. Isnard[3,4], Y. Langevin[2], H. Lehto[7], L. Le Roy[9], N. Ligier[2], S. Merouane[6], P. Modica[4], F.-R. Orthous-Daunay[10], J. Paquette[6], J. Rynö[11], R. Schulz[12], J. Silén[11], S. Siljeström[13], O. Stenzel[6], L. Thirkell[4], K. Varmuza[14], B. Zaprudin[7], J. Kissel[6] and M. Hilchenbach[6].

[1]DTM, Carnegie Institution of Washington, Washington, DC, USA
[2]Institut d'Astrophysique Spatiale, Université Paris-Sud/CNRS, Orsay, France
[3]LISA, UMR CNRS 7583, Université Paris-Est Créteil et Université Paris Diderot, Institut Pierre Simon Laplace, Créteil, France
[4]LPC2E, CNRS/Université d'Orléans, Orléans, France
[5]CSNSM, CNRS/IN2P3/Université Paris-Sud, Orsay, France
[6]Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany
[7]University of Turku, Department of Physics and Astronomy, Tuorla Observatory, Piikkiö, Finland
[8]Universität der Bundeswehr, Neubiberg, Germany
[9]Center for Space and Habitability, University of Bern, Bern, Switzerland
[10]IPAG, UMR 5274, Université Grenoble Alpes, CNRS, Grenoble, France
[11]Finnish Meteorological Institute, Helsinki, Finland
[12]European Space Agency, Noordwijk, The Netherlands
[13]RISE, Bioscience and Materials/Chemistry and Materials, Stockholm, Sweden
[14]Institute of Statistics and Mathematical Methods in Economics, Vienna University of Technology, Vienna, Austria.

COSIMA was a time-of-flight secondary ion mass spectrometer on board the Rosetta orbiter. From August 2014 to September 2016 the instrument performed *in situ* analysis of the dust particles ejected from comet 67P/Churyumov-Gerasimenko, before and after perihelion. COSIMA collected more than 35,000 particles at a low impact velocity (< 10 m/s) and analyzed about 250 of them with size ranging from ~50 to ~1000 µm.
We will report the global composition of the cometary dust as deduced from COSIMA measurements. The average elemental composition measured for 67P's dust will be compared to previous results obtained from the Giotto and Vega missions for comet 1P/Halley and the Stardust mission for comet 81P/Wild 2, to the composition of Chondritic Porous Interplanetary Dust Particles (CP-IDPs) and to the CI chondrite composition.