

# Space Science Data at ESA

Christophe Arviset Head of Data and Engineering Division ESA-ESAC, Directorate of Science

Christophe.Arviset@esa.int

Open Universe Workshop, Vienna, 20-22 Nov 2017

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**European Space Agency** 

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**bepicolombo** Exploring Mercury proba-2 Observing coronal dynamics and solar eruptions



Uenus express Studying Venus' atmosphere (2005-2014) **giotto** Close encounter with comet Halley (1986-1992)

> **juice** Studying Jupiter's icy moons

**exomars** Europe's new era of Mars exploration (2015-)

smart-1 Exploring our Moon (2003-2006)

**ulysses** Watching over the Sun's poles (1990-2009)

solar orbiter The Sun up close mars express Investigating the Red Planet (2003-)

cluster Measuring Farth

Measuring Earth's magnetic shield (2000-)

### rosetta Chasing and landing on a comet

5 in Operations 3 in Develop. 1 in Post-Ops

1 in Post-Ops 4 in Legacy

# → ESA'S FLEET IN THE SOLAR SYSTEM

**cassini-huygens** Studying the Saturnian system and landing on Titan (1997-2017)

# → ESA'S FLEET ACROSS THE SPECTRUM



### lisa pathfinder Testing the technology for gravitational wave detection [2015-2017]

herschel Unveiling the cool and dusty Universe (2009-2013)



planck Looking back at the dawn of time [2009-2013]

www.esa.int

Chemical analysis of celestial objects [1995-1998]

iust Observing the first light



hipparcos The first astrometry satellite (1989-1993)

> cheops Sizing and first characterisation of exoplanets

> > gamma rays

euclid Exploring the dark Universe



Surveying a billion stars of exoplanets [2013-]



Expanding the frontiers of the visible Universe [1990-]

> exosat X-ray survey of high-energy phenomena (1983-1986)



5 in Operations 2 in Develop. 2 in Post-Ops 6 in Legacy

Analysing ultraviolet light from stars (1978-1996)

> cos-h Surveying the high energy Galaxy (1975-1982)

xmm-newton Seeing deeply into the hot and violent Universe [1999-]

> integra Seeking out the extremes of the Universe [2002-]

> > European Space Agency

## ESAC Science Data Centre The Digital Library of the Universe

At ESA's European Space Astronomy Centre near Madrid

Science Archives from >15 space missions:

- Astronomy, Planetary, Heliophysics
- From all phases (development, operations, post-ops, legacy)
- <u>http://archives.esac.esa.int/</u>

**Different Users:** 

- Scientific Community (public access)
- Instrument teams and observers (controlled access)
- Science Operations Team (privileged access)







### ESA Space Science Open Data Policy

Proprietary period for all science data (~1 year) To instrument teams when data is being produced by instrument teams To observer for observatory missions

Data then enter the public domain Freely accessible worldwide Being sometimes replicated in non ESA site (European / US data centres)

Data is on-line, available to the scientific community and other Through a standard web browser and through scriptable APIs Search, preview, select and download







## ESA main Astronomy Archives





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## New Planetary Science Archive – psa.esa.int



### **Planetary Science Archive**

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### → ONE ARCHIVE, MANY MISSIONS

### What is the PSA?

The European Space Agency's [ESA] Planetary Science Archive, or PSA, is the central repository for all scientific and engineering data returned by the agency's space science missions that have been exploring planets, monos, and small bodies in the Solar System.

The interface is designed for scientists who use observations from ESA's planetary missions for their research, but should be reasonably intuitive also for non-experts.



	Mission	Main targets							
	ExoMars 2016	Mars							
i.	Giotto	Comet 1P/Halley							
73	Huygens	Titan							
7	Mars Express	Mars; Phobos; Deimos							
	Rosetta	Comet 67P/Churyumov-Gerasim Asteroids 21 Lutetia and 2867 S							
	SMART-1	Moon							
p	Venus Express	Venus							





What can you find in the archive?

The PSA rontains science-ready data that have been calibrated by the instrument teams and peer reviewed by independent experts in the scientific community. The observations are compliant with the Planetary Data System (PDS) standards to ensure the long-term preservation of the dataset.

The archive encompasses over three decades of ESA's exploration of the Solar System, including data from missions that are currently operation, in the nost-operations phase, or completed as well as ground-based observations of comets. These data - about 10 million individual observations so far, amounting to almost 50 terabytes in volume - are now available to the scientific community from one single interface.

The PSA team is also preparing for ESA missions that are currently in the implementation phase such as Repif nombon FenMars 2020, and JUTCE, so that when observations are available in the future, they can be readily incorporated in the archive infrastructur





The PSA team welcomes feedback and suggestions for ways to improve the archive so that as many people as possible can make use of this extraordinary database. To contact the team, fill out th orm at: http://www.cos

Visit the other ESAC archives at: http://archives.esar.esa.in





### Index of ftp://psa.esac.esa.int/pub/mirror/

Do to higher level directory

Name	Size	Last Mo	dified
CASSINI-HUYGENS		16/10/07	00:00:00
EARTH		11/09/09	00:00:00
ExoMars2016		09/11/16	18:42:00
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INTERNATIONAL-ROSETTA-MISSION		14/10/16	03:00:00
MARS-EXPRESS		19/05/09	00:00:00
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SMALL-MISSIONS-FOR-ADVANCED-RESEARCH-AND-TECHNOLOGY		20/08/10	00:00:00
VENUS-EXPRESS		15/09/10	00:00:00



Space Astronomy Centre (ESAC) near Madrid, Spain. It has been developed as a collaboration between the ESAC Science Data Centre ESA's Planetary Science Ground Segment, and the instrument team The PSA team continues to develop new functionalities for the

archive responding to needs expressed by the scientific communit The team receives advice from the PSA User Group, an independe body that evaluates the services and tools provided by the archiv to the user community.

The PSA is an active member of the International Planetary Data Alliance [IPDA], a closely cooperating partnership to maintain the quality and performance of data [including data formats] from planetary research using instruments in space.



## **ESA Heliophysics Archives**





## Data Stewardship and Curation



ESA's Digital Agenda for Space commits us to data quality and accuracy

ESAC Science Data Centre mission:



Before transitioning mission data to Legacy Phase, ESDC curation includes:

- Working with consortia to ensure data quality and accuracy upon data delivery
- Collecting and organizing all knowledge specific to that mission (data, software, documentation)
- Linking data with research papers they generated (e.g. SAPS)
- Providing links and tools to compare legacy data and data from current missions to augment the research value of the data (e.g. ESASky, PSA, SEPP)
- Involvement in generation of high level science products by community

### Long Term Preservation Strategy - 1



Consolidation of all ESA Space Science Archives at ESAC, with strong re-use across projects, ensuring easier and cheaper long term data preservation

Hardware infrastructure

Software architecture and code, including technology migration Human technical and scientific expertise

Multi mission, multi instruments science exploitation

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### Long Term Preservation Strategy - 2



Long term preservation of data processing capabilities (on-going) Preserve software coming from various places Provide data processing capabilities as a "service" Bring the "user software to the data" instead of the "data to the user"

Sharing and preservation of knowledge, including international cooperation IVOA, IPDA





## Collaboration is key – IVOA in astronomy

Astronomy Science is now multi-wavelengths

Existing collaboration among VO partners worldwide Existing Virtual Observatory (VO) Framework

VO initially planned for space and ground based archive interoperability

layer on top of existing archives

VO now also used for data management infrastructure VO built-in archives at ESA (Gaia, Euclid, ...)







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## Collaboration is key – IPDA in Planetary Science

- Facilitate global access to, and exchange of, high quality scientific data products managed across international boundaries
- used between ESA, NASA, JAXA, ISRO planetary archives
- Definition of archiving data standards (PDS) and planetary archiving processes at international level, across space agencies
- used by ESA Planetary Science Archive

Sharing of expertise and standards between IVOA - IPDA



Member Agencies	
Aras	Armenian Astronomical Society Հայերեն աստղագիտական Հասարակություն
	China National Space Administration 國家娘天局
<b>@esa</b>	European Space Agency
	German Aerospace Center Deutsches Zentrum für Luft- und Raumfahrt e.V.
ल्याते विषक	Indian Space Research Organisation आरतीय अनुसंधान संगठन
CON-	Italian Space Agency Agenzia Spaziale taliana
LAXA	Japan Aerospace Exploration Agency 图立研究開発法人宇宙教空研究開発機構
Nasa	National Aeronautics and Space Administration
¢cnes	National Centre for Space Studies Centre national d'études spatiales
ИКИ	Russian Space Research Institute Институт Космических Исследований
وكالة الإمارات للفضاء UAE SPACE AGENCY	United Arab Emirates Space Agency وکانازمان تقصاء
UK SPACE	UK Space Agency

### Collaboration is key – ESASky





### Conclusions



Management of ESA Space Science Data Heterogeneity of missions and datasets Maximize Science Exploitation Ensure Long Term Preservation

ESASky, all sky visualization of big data Multi-missions, multi-wavelengths tool "If You want to go quickly Go alone If you want to go far Go together. " Atrican Proverb

Interoperability with other archives worldwide (Virtual Observatory) Collaboration between data centres is key International collaboration is key (IVOA, IPDA)

**European Space Agency**