Space Science Data at ESA

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ESA’S FLEET IN THE SOLAR SYSTEM

The Solar System is a natural laboratory that allows scientists to explore the nature of the Sun, the planets, and their moons, as well as comets and asteroids. ESA’s missions have transformed our view of the celestial neighbourhood, visiting Mars, Venus, and Saturn’s moon Titan, and providing new insight into how the Sun interacts with Earth and its neighbours. The Solar System is the result of 4.6 billion years of formation and evolution. Studying how it appears now allows us to unlock the mysteries of its past and to predict how the various bodies will change in the future.
Thanks to cutting edge technology, astronomy is unveiling a new world around us. With ESA's fleet of spacecraft, we can explore the full spectrum of light and probe the fundamental physics that underlies our entire Universe. From cool and dusty star formation revealed only at infrared wavelengths, to hot and violent high-energy phenomena, ESA missions are charting our cosmos and even looking back to the dawn of time to discover more about our place in space.
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)
- [http://archives.esac.esa.int/](http://archives.esac.esa.int/)

Different Users:
- Scientific Community (public access)
- Instrument teams and observers (controlled access)
- Science Operations Team (privileged access)
Science Archives at ESAC

Enable maximum **scientific exploitation** of data sets

Enable efficient **long-term preservation** of data, software and knowledge, using modern technology

Enable cost-effective archive production by **integration in, and across, projects**
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 made available to the scientific community through Internet
   Through a standard web browser and through scriptable APIs
   Search, preview, select and download
ESA main Astronomy Archives

Many scientists are already enjoying @ESAGaia 1st release: 11,000 users downloading 22TB of #GaiaDR1 data in 24hrs!

@ESAGaia archive has reached 1K users downloading 22TB of data in just 24 hours! archives.esa.int/gaia

@#GaiaDR1

herschel

Planck Legacy Archive
New Planetary Science Archive – psa.esa.int
ESA Heliophysics Archives
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
Long term preservation of data processing capabilities (ongoing)

- 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, ...)

ESA UNCLASSIFIED - For Official Use
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
Towards multi wavelengths Science data exploitation

**Goal**: to facilitate data discovery and archival science for ALL users

- Multi-wavelength
- Project agnostic
- Exploration

Interface “on top of” all ESA astronomy archives

**ESASky** – sky.esa.int
ESASky Concept: Explore, compare, select, download

Try it: sky.esa.int!
See the sky with different “eyes”

- XMM EPIC - X-Ray - SN 1006
- Planck - Radio - Full sky
- HST - Visible - M 51
- Herschel - IR - cygnus X
See the sky with different “eyes”
Collaboration is key – ESASky

Dedicated Python module to ESASky

HiPS
SAMP
TAP
ObsCoreDM, MOC

XMM-Newton and Chandra

JWST Footprints
Need for a new archive usage paradigm

New ways required to access the Gaia catalogue and associated data
• Powerful query mechanism, asynchronicity of results
• One “query interface” for all archive services and VO services

User can not download all catalogue and all data
• Need to have user workspaces IN the Archive
  • User database space, user disk space
• User workspace shareable amongst various users

Bring user code to the data
• Part of the user workspace in the archive
• Share code with other users

The user works with the data WHERE the data is

=> Archive 2.0 concept
Conclusions

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

Visualization of big data : ESASky
Archives 2.0 concept : bring the code to the data

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