Amateur data from Radio-Jove in the Virtual Observatory

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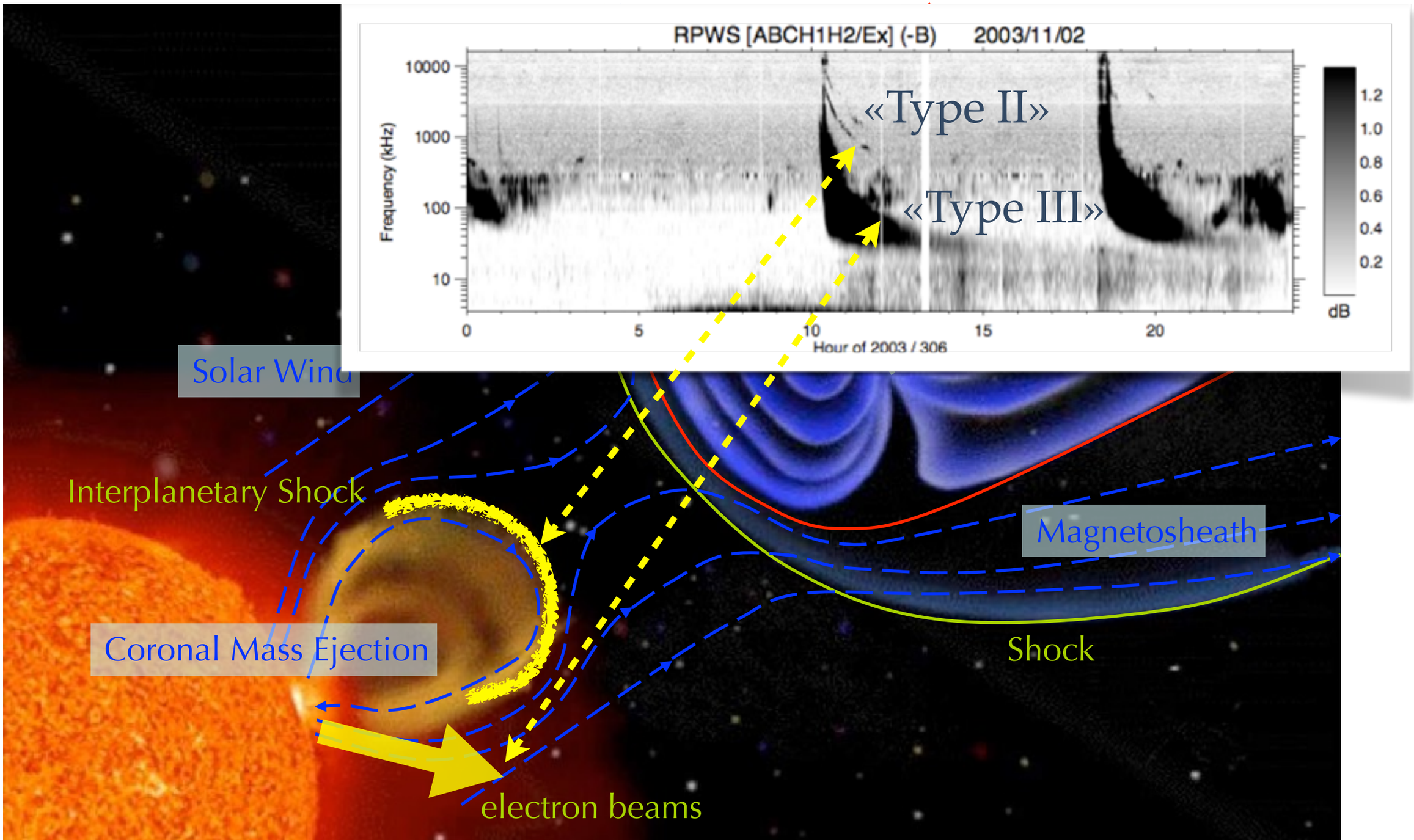
Epsc-2014, Cascais, Portugal

Plasmas in the Solar System
Solar Wind & Magnetized Planets



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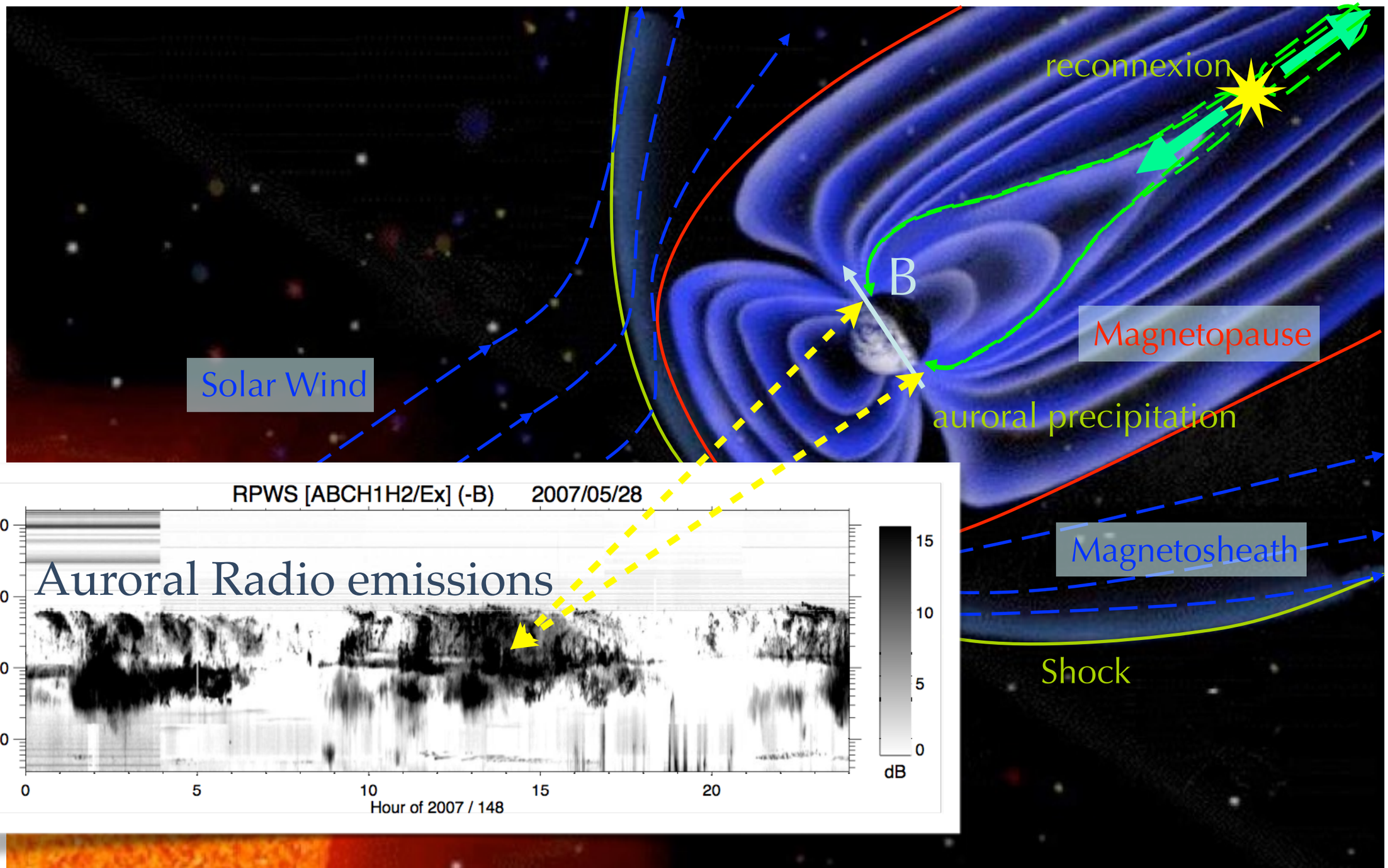
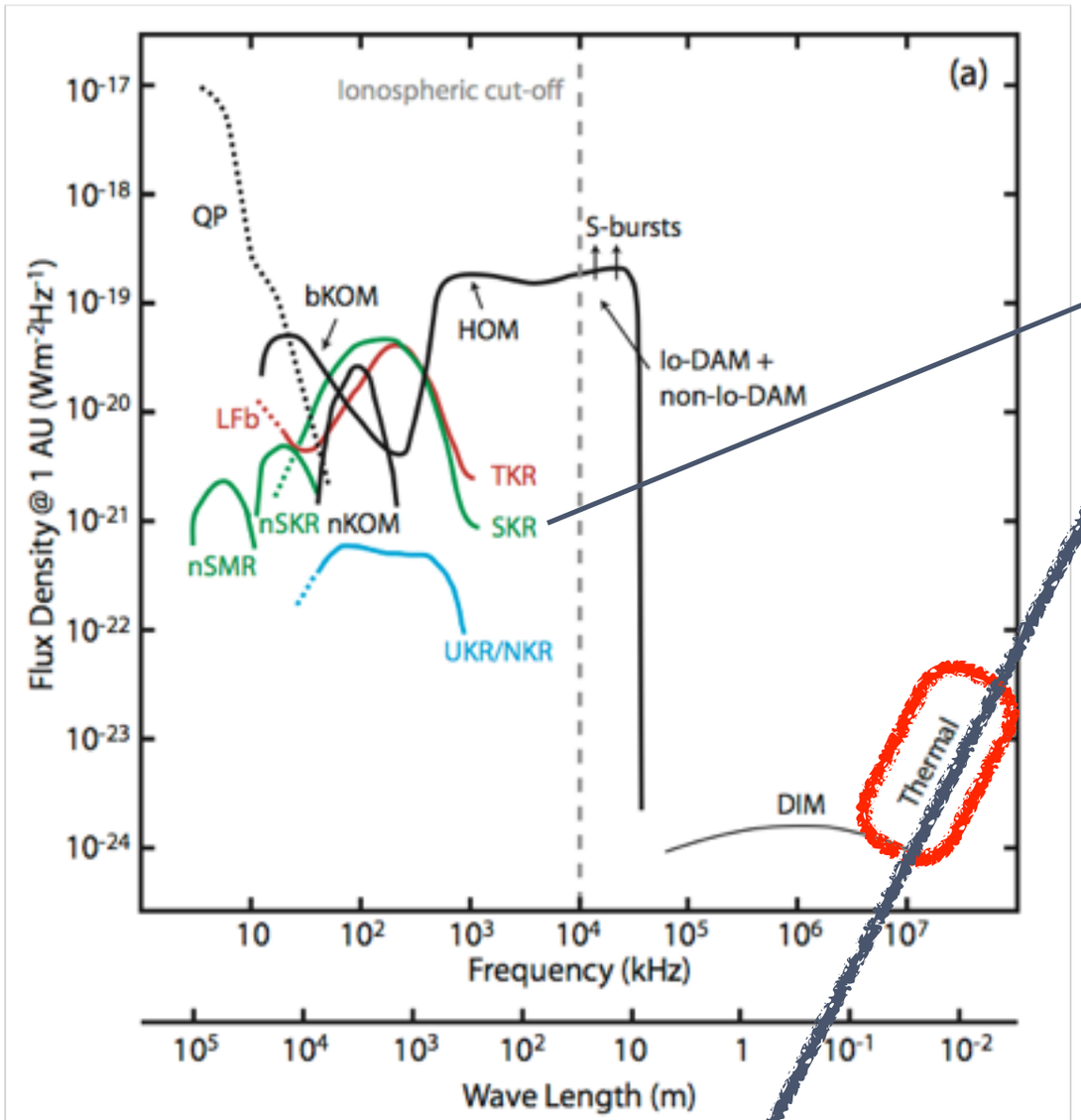
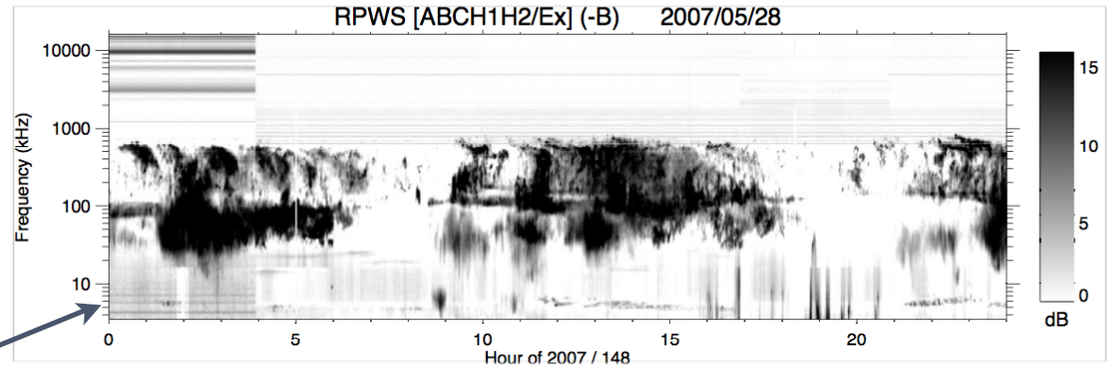


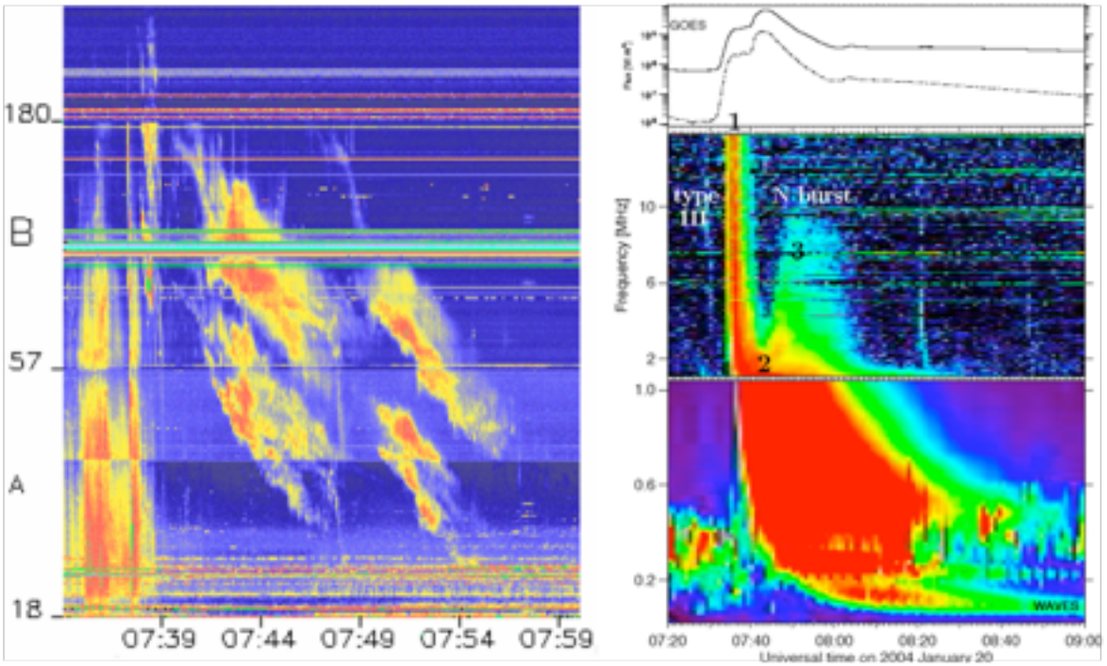
Low Frequency Spectrum in the solar system

Planetary Radio Emissions



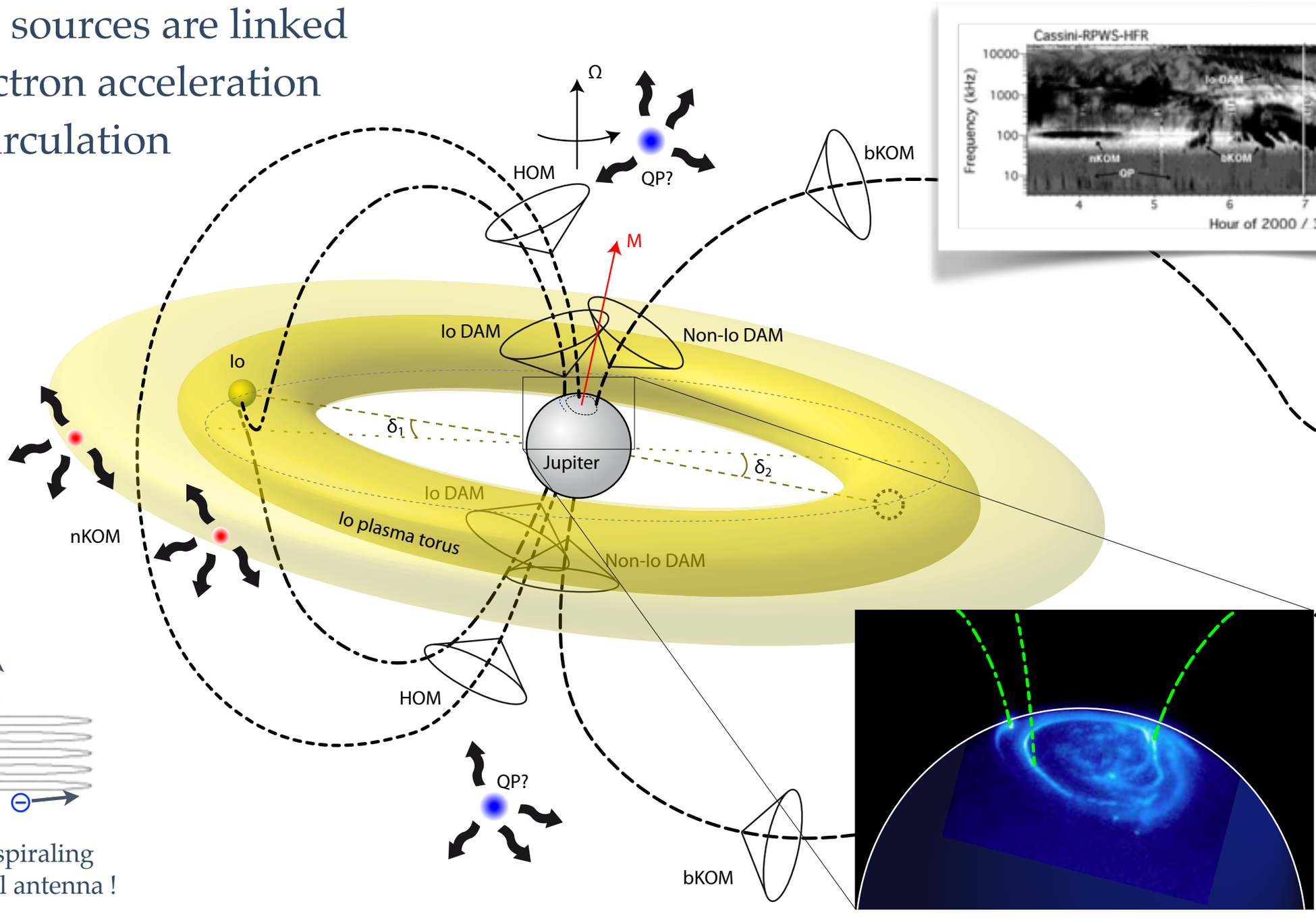


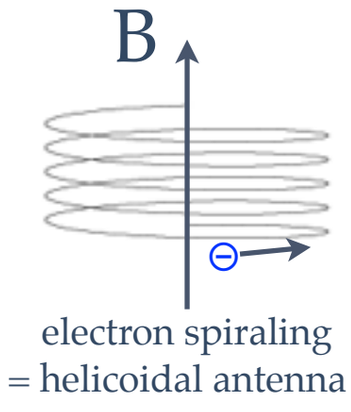
and solar



Radio sources at Jupiter

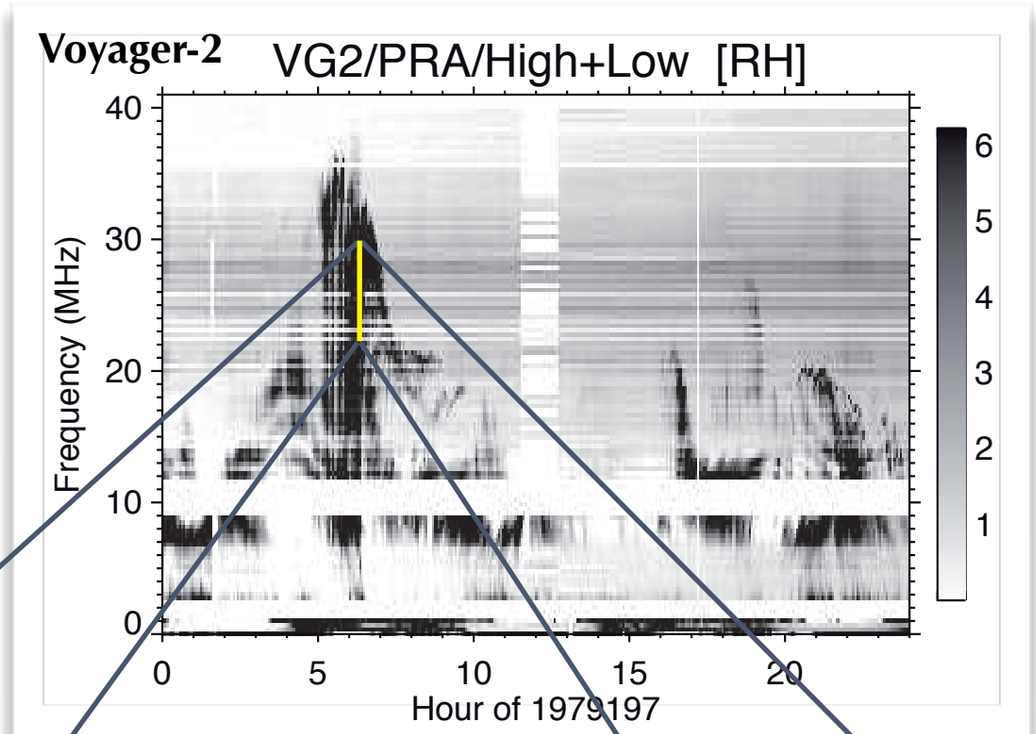
Radio sources are linked
to electron acceleration
and circulation

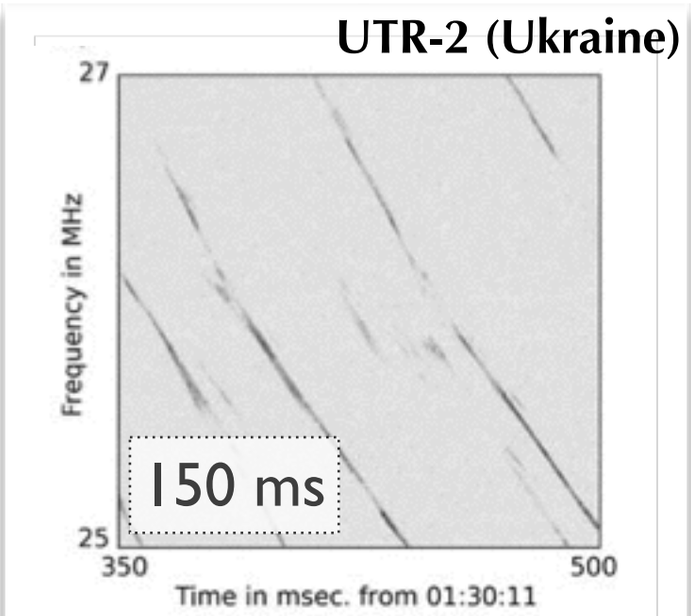


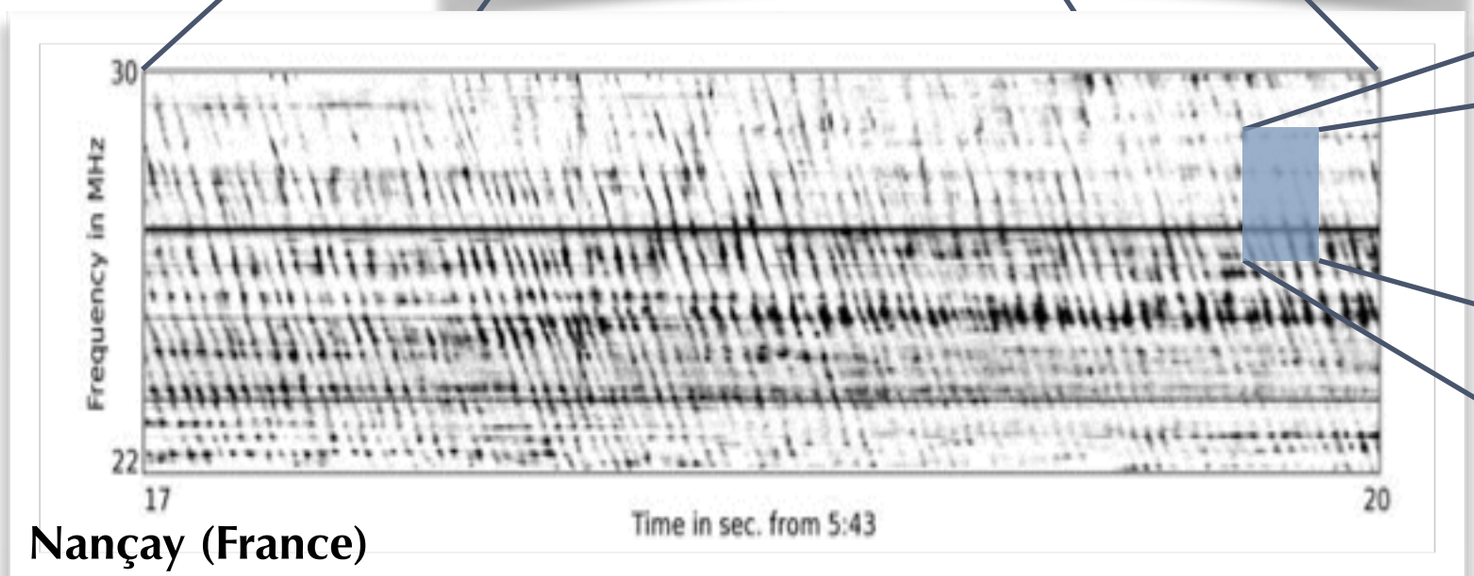


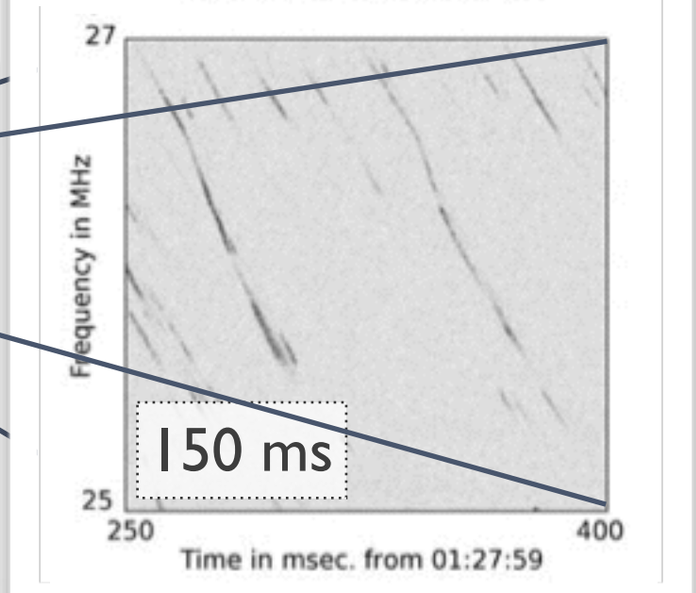
Jovian radio emissions

- Frequency: 0-40 MHz
- Multi scale structure (a few ms to a few hr)
- Sporadic
- Very dynamic
- S-bursts [short-bursts] [=millisecond bursts]









Why Sharing Jovian Radio Emissions Data ?

- Occurrence can be **predicted in a statistical manner** but they are intrinsically **sporadic**.

- Enlarging the temporal coverage of the jovian radio emission is a key aspect of the understanding of this sporadicity.

- In addition to the temporal variability of the emission, a larger spatial and temporal coverage will provide informations on the temporal width of each burst (radio arc), the **short term variability** of the arc shape...

- This may provide key information on the radio source properties, as well as on the radio source environment.

How to efficiently share data?

- Provide **calibrated data**, or data include enough pieces of information to calibrate the data.

- Provide data in a **standard format** commonly used by scientists.

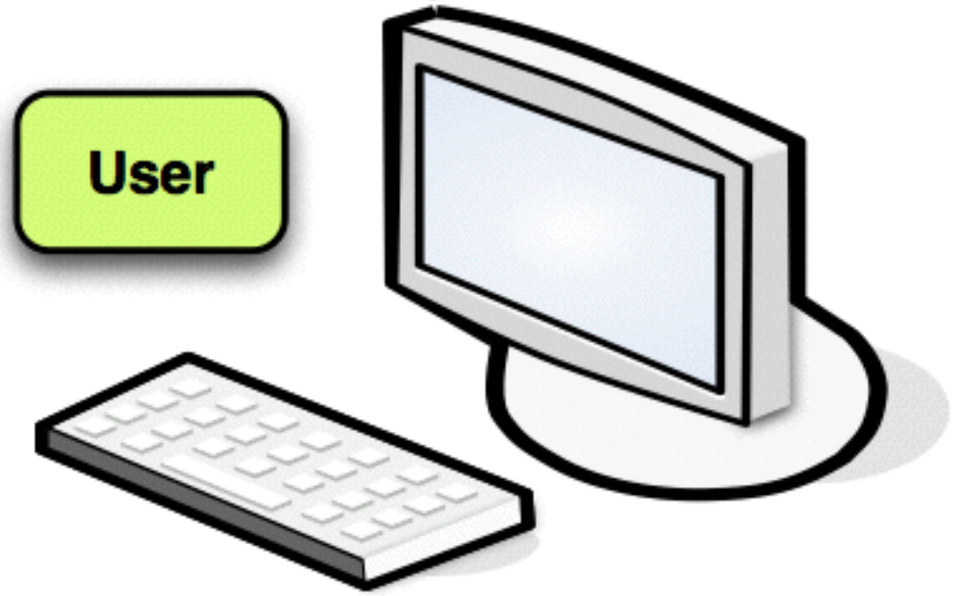
- Provide data with observation «**metadata**» (location of observer, accurate time of observation in UT, observation target name...) using a standard set of keywords.

- Make it available to a database network (a.k.a. «**virtual observatory**») used by scientists

What is a Virtual Observatory?

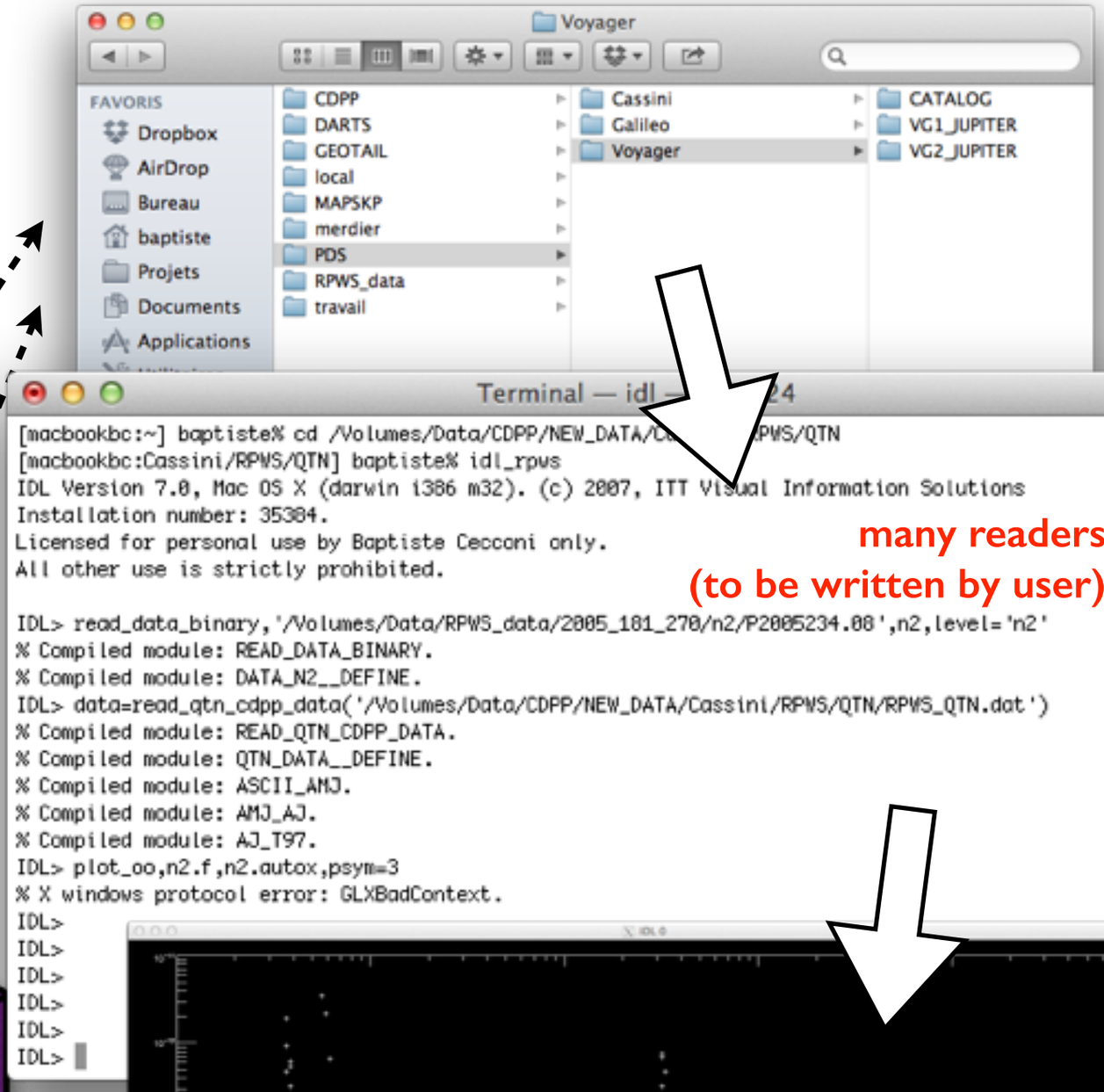
- A network of databases that all **speak a common language** to share their data. The user goes to a simple interface and searches for data, the portal is looking into remote databases and fetches results.
- Astronomical Virtual Observatory (VO) is the main one:
  - sharing images, spectra, catalogs, times series...
  - large data repositories and catalogs
  - searchable interfaces
  - plotting tools
  Everything is **freely available on the web**.
  US portal to Astronomical VO: http://www.usvao.org
  French portal to Astronomical VO: http://cdsweb.u-strasbg.fr
- **What about low frequency radio?**
  http://cdaweb.gsfc.nasa.gov *CDAWeb is providing free access to a lot of space borne data*
  http://vwo.gsfc.nasa.gov *VWO (Virtual Wave Observatory): access to many radio instrument (mostly space based)*
  http://amda.cdpp.eu *(Automated Multi Dataset Analysis tool) plotting tool with many space physics and planetary dataset included (free, but login required to keep user settings between connections)*

User's experience «classic»

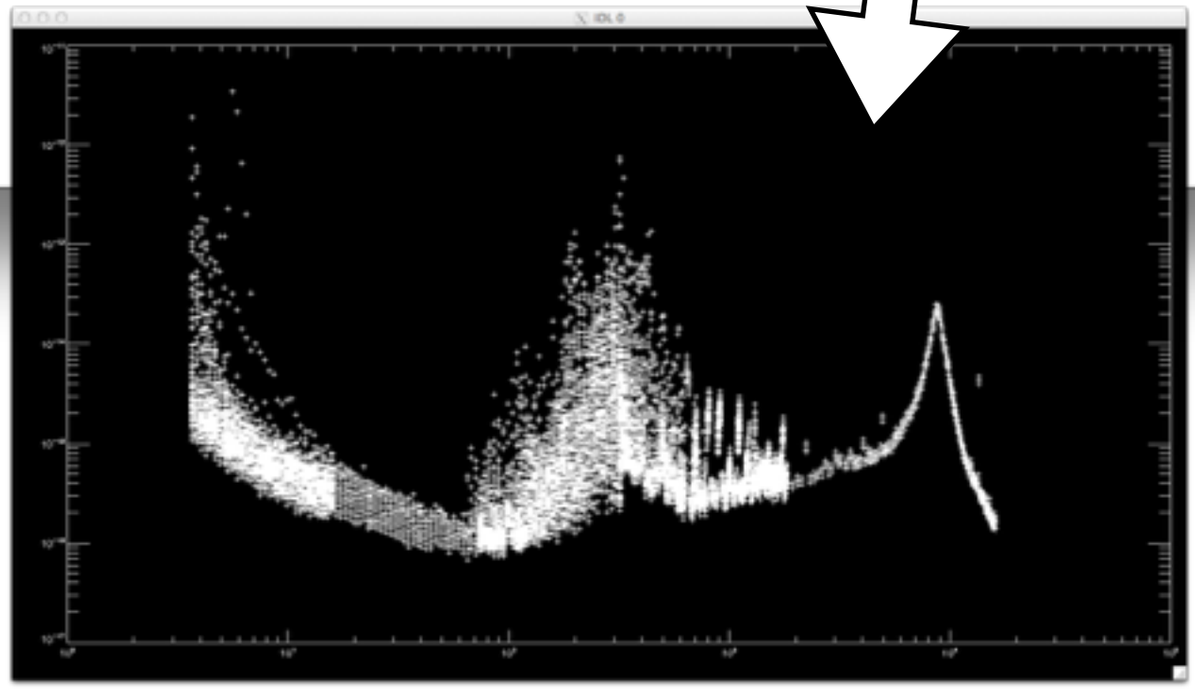


Search Data
(many interfaces)

Get Data
(many formats)



many readers
(to be written by user)



SSODnet

GhoSST
KIDA

PSA

AMDA…

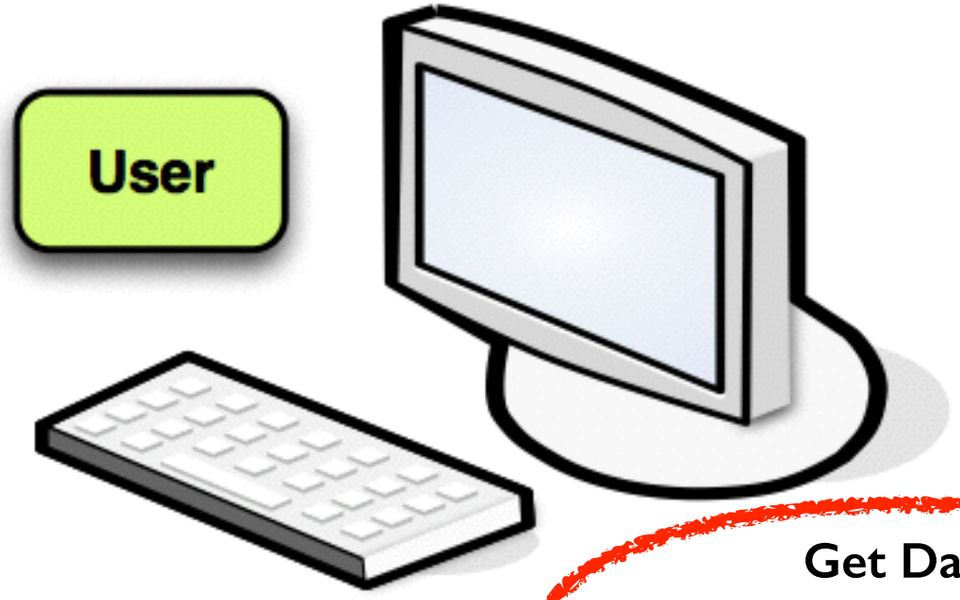
EPN

PDS

Data bases

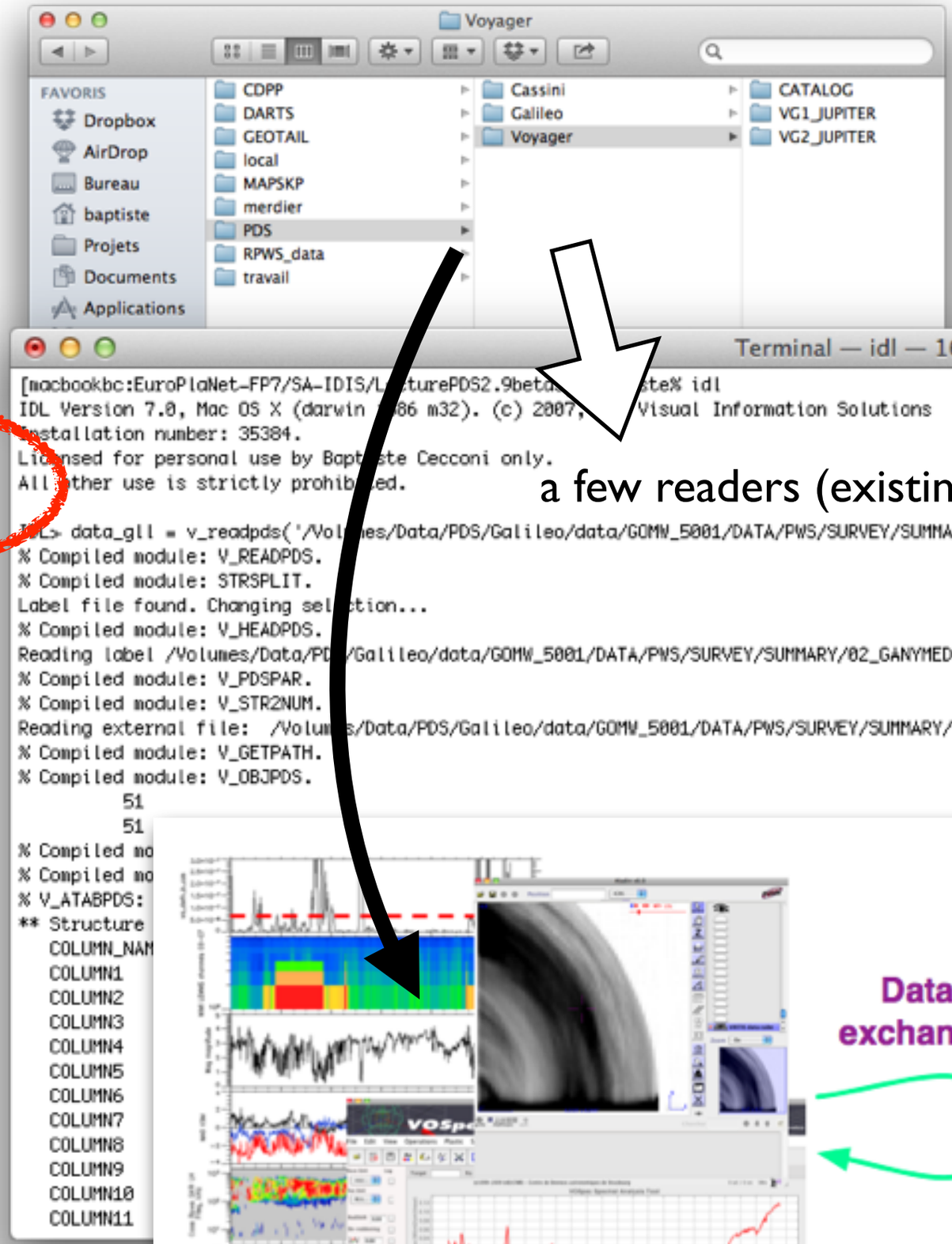
Space agency archives

User's experience «enhanced»



Search Data
(many interfaces)

Get Data
(Standard formats)
[FITS, CDF, VOTable...]



a few readers (existing!)

SSODnet

GhoSST
KIDA

PSA

AMDA...

EPN

PDS

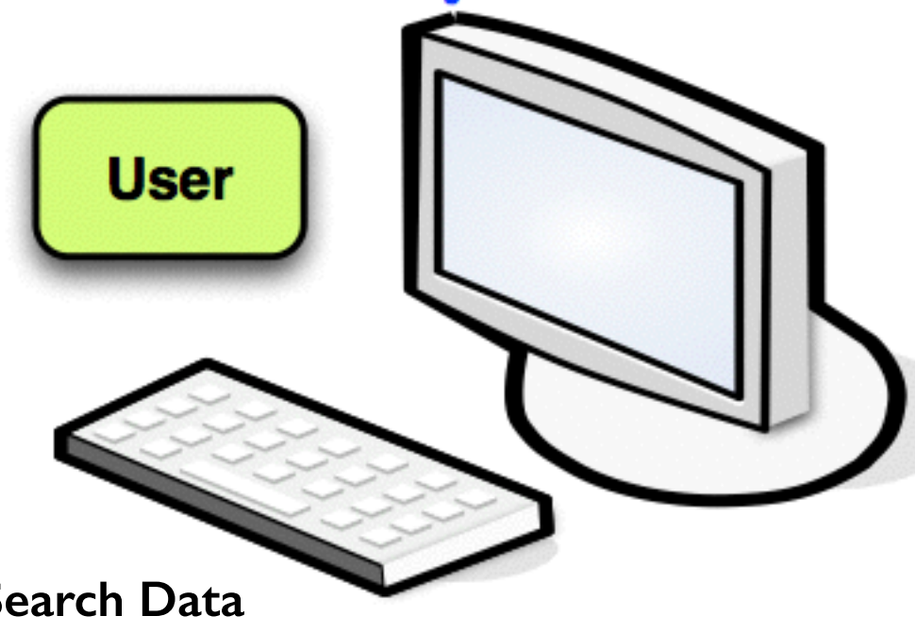
Data bases

Space agency archives

Data exchange

Visualization and other tools

User's experience «ultimate» (=Virtual Observ.)



User

Search Data (one simple interface)

list of Result

form

VO-client

Standard Query

Standard Answer

Automated Data Access

Catalogue / Registry

SSODnet

GhoSST KIDA

RadioJOVE

AMDA...

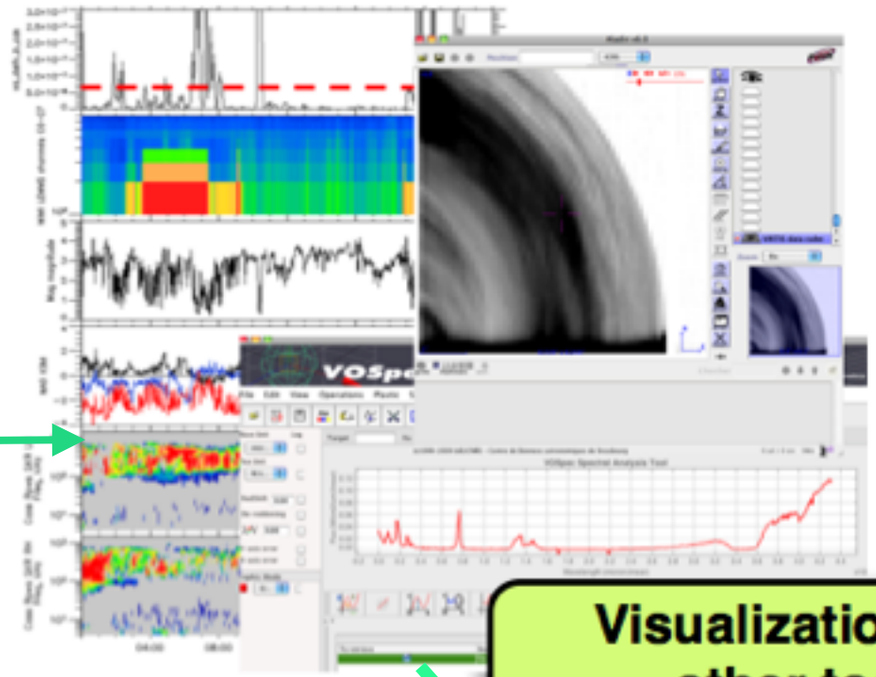
EPN

PSA

PDS

Data bases

Space agency archives



Data exchange

Visualization and other tools

Currently available data

- Nançay Decameter Array Routine Observations (France)
  - raw data file on Obs-Nancay website + quicklooks
  - available on VESPA network (Virtual Observatory access)

- Iitate Observatory (Japan)
  - FITS files + quicklooks
  - available on IUGONET network (Virtual Observatory access)

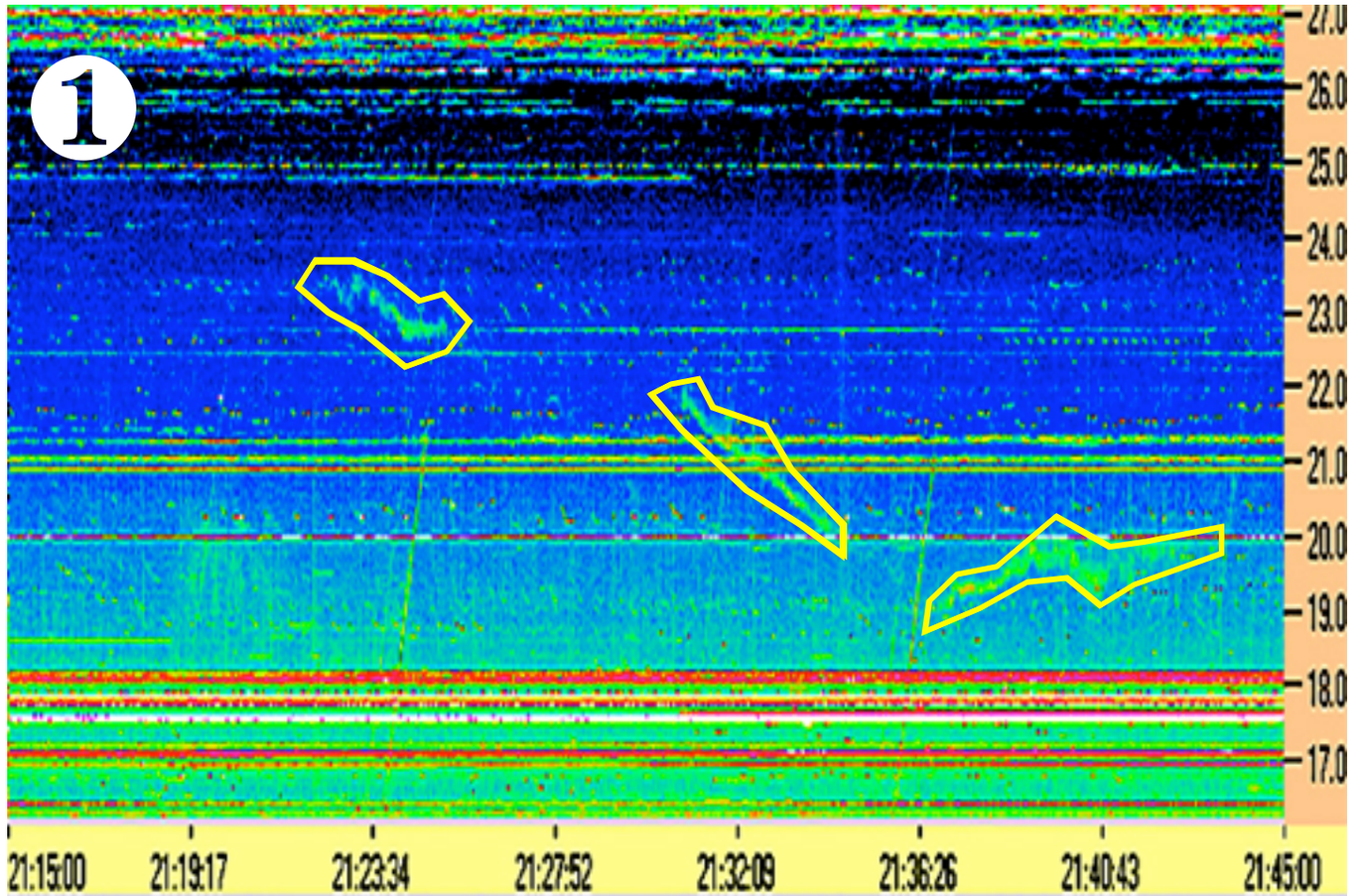
- Current RadioJove Archive website
  - quicklooks (very few data [wav files?])

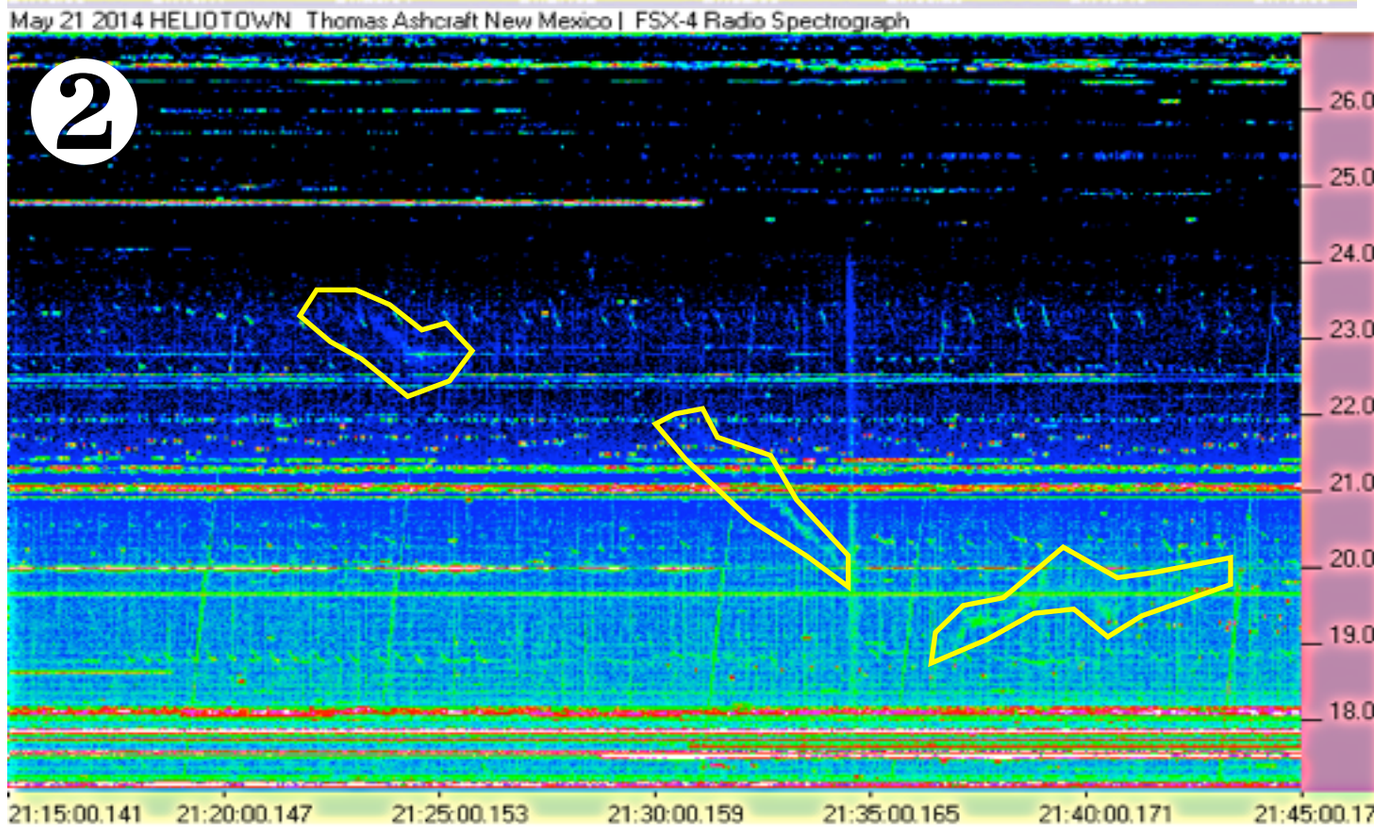
- Univ. of Florida data
  - available soon (C. Higgins, next year?)

Example: May 21st 2014

- ❶ Dave Typinsky [in Florida]
- ❷ Tom Ashcraft [in New Mexico]
- **Some fun maths:**

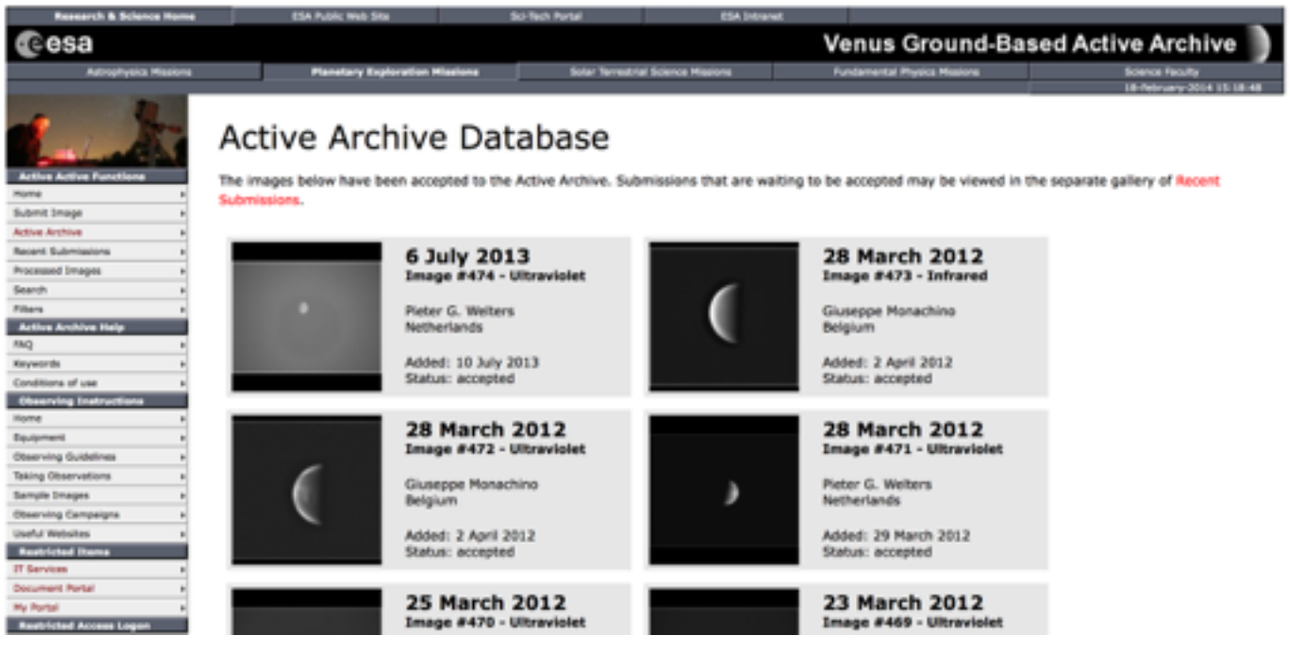
Distance between observers:
~ 2700 km [~ 1700 miles]
Earth-Jupiter Distance (at that time):
~ 880 10^6 km [~ 5.9 AU]
Rotation rate of jovian radio source:
~ 0.01 degree/sec [period= 9.92 hr]
Angle between two obs. seen from Jupiter:
~ 0.00017° = 0.6 '' [=*arctan*(2700/880 10^6)]
Time for beam to go from one obs to the other:
~ 17.6 msec
Speed of jovian beam spot on Earth:
~150 000 km/s ⇒ ½ speed of light !





Similar projects where Amateurs help Science

- Venus Active Archive
  http://www.rssd.esa.int/index.php?project=VENUS&page=Archive
  Amateur observations of Venus, in support of the Venus-Express mission



- Virtual Meteor Observatory
  http://www.rssd.esa.int/index.php?project=METEOR&page=vmo
  Amateur observations of meteor showers, with science tools

Project Description
Metadata («file header»)

- ***Additional metadata (not much) attached to archived records***

  - Location of observer (**GPS location** ?)
  - **UTC of observation** start (synchronized with GPS or NTP if possible)
  - **Spectral range**: min and max frequency
  - Data file format: cdf/FITS /votable/netcdf…
  - **Data** : Recorded file
  - **Quicklook**: in png format preferred
  - **Target** (Jupiter)
  - **Annotation**: type of emissions if known, description of hardware (radiojove kit/other)
  - **Observer's name / id / nickname**

- Metadata format: SPASE or IVOA (or both = simultaneous registration!)
  - SPASE: Space physics communities (Sun + Earth)
  - IVOA: Astronomy and Planetary sciences

  => *2 interfaces to the same database.*

Project Description
File Format

- Possible file formats: **CDF**, FITS, VOTable, *NetCDF, HDF5, wav...*

- Preferred data format: CDF (maintained by NASA/GSFC)
  CDF contains «Attributes» (= header keywords = metadata)

- What can be done with the RadioJove software?
  Jim Sky will study that with me

- Remarks:
  - «wav» file: *common file format for amateurs, but not for scientists*
  - other than «wav»: *metadata-rich formats*

Project Description
Infrastructure

- **SPASE or IVOA**, based on Europlanet developments, see here:
  http://voparis-europlanet.obspm.fr/docum.shtml
  Linking between the two worlds is possible *(under study within the european IMPEx project).*
- VO-RadioJove server would includes (may not be at the same place):
  - SQL database with all observation records
  - Access Protocols (e.g.: EPN-TAP, SPASE...)
  - Webservice (REST or SOAP) or just an upload form for data ingestion (with login?)
- VO-RadioJove **prototype server and database will be located in Paris** (VO Paris Data Center) The final server and database could be in Paris or Nançay (Radioastronomy facility in France).
  It could also be linked to the RadioJOVE current archive.
- Web-based interface for RadioJove participants to easily fill in events
  (**could be just a file upload** if file contains all information).
- Link with existing RadioJove software, which could produce a file with all information included that could be submitted directly to a webservice.
- Support staff available in Paris and/or Nançay if project is accepted.

Project Description
Next steps

- **Near future**
- July 2014 - January 2015:
  - decision on the data format and header content
  - setting up a test server in Paris for data upload, data validation, data distribution
- Need for beta-testers: **volunteers** ? (end of 2014)
  - size of data ? [24h or ±3h of meridian crossing]
  - testing upload of **spectrograms** and **single frequency**
- Discussion with Jim Sky to **include CDF output** in his software.
- **Further plans**
- Presentation of project at next «**Magnetosphere of Outer Planets**» conference, in Atlanta next year (June 1-5, 2015).
- Opening of the service to science community when everything is ready (end of 2015 or 2016?)

Summary

- Scientists can use your data !
- Standardized distribution of RadioJove observations
- Data format usable by scientist
- Take advantage of VO infrastructure
- Possible support from France for servers and databases (at least prototypes, then to be discussed).

Further Readings

- **BOOKS**
  - Kraus, 1966, **Radio Astronomy**. McGraw-Hill.
  - Dessler, 1983. **Physics of the Jovian Magnetosphere**, Cambridge Planetary Science Series, Vol.3., Cambridge University Press, New York.
  - Carr, Desch, and Alexander. 1983. **Phenomelogy of the Magnetospheric Radio Emissions**., Cambridge Planetary Science Series, Vol. 3. Cambridge Univ. Press, New York.

- **ARTICLES**
  - Zarka, Philippe. 1992. "**The Auroral Radio Emissions From Planetary Magnetospheres: What Do We Know, What Don'T We Know, What Do We Learn From Them?**" Adv. Space. Res. 12 (8): 99–115.
  - Zarka, Philippe. 2007. "P**lasma Interactions of Exoplanets with Their Parent Star and Associated Radio Emissions.**" Planet. Space Sci. 55: 598–617.
  - Cecconi, Baptiste (2010). **Goniopolarimetric techniques for low-frequency radio astronomy**. Observing Photons in Space. ISSI/ESA.
  - Zarka, Philippe. 2004. "**Fast Radio Imaging of Jupiter's Magnetosphere at Low-Frequencies with LOFAR**." Planet. Space Sci. 52: 1455–67. doi:10.1016/j.pss.2004.09.017.
  - Konovalenko, Kalinichenko, Rucker, Lecacheux, Fischer, Zarka, Zakharenko, et al. 2013. "**Earliest Recorded Ground-Based Decameter Wavelength Observations of Saturn's Lightning During the Giant E-Storm Detected by Cassini Spacecraft in Early 2006**." Icarus 224 (1). Elsevier Inc.: 14–23. doi:10.1016/j.icarus.2012.07.024.