EPSC Abstracts
Vol. 8, EPSC2013-726, 2013
European Planetary Science Congress 2013

Sharing Planetary Radio Emission Dataset in the Virtual Observatory

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Abstract

In the double frame of the preparation of the ESA-led JUICE mission and the development of a planetary sciences virtual observatory (VO), we are proposing a new set of tools directed to data providers as well as users, in order to ease data sharing and discovery. We will focus on ground based planetary radio observations (thus mainly Jupiter radio emissions), trying for instance to enhance the temporal coverage of jovian decametric emission.

The data service we will be using is EPN-TAP, a planetary science data access protocol developed by Europlanet/IDIS (Integrated and Distributed Information Service). This protocol is derived from IVOA (International Virtual Observatory Alliance) standards. The Jupiter Routine Observations from the Nançay Decameter Array are already shared on the planetary science VO using this protocol.

We will first introduce the VO tools and concepts of interest for the planetary radioastronomy community. We will then present the various data formats now used for such data services, as well as their associated metadata. We will finally show various prototypical tools that make use of this shared datasets.

1 Low Frequency Radio Astronomy

The frequency band of low frequency radio astronomy covers the range between a few kHz to ≈50 MHz. The radio source in the vicinity of Earth are the magnetized planets, which radio emissions are linked to auroral phenomena, and the Sun. The data takes the form of time-varying spectrogram (also called dynamic spectra), which display information on the observed waves such as spectral flux density or polarization degree.

The radio emissions are sporadic and temporally variable. They are usually not isotropic. Their time-frequency shape is characteristic of the radio emission physics, contrarily to higher frequency radio astronomy where we observe fixed frequency lines depending on the emitting species.

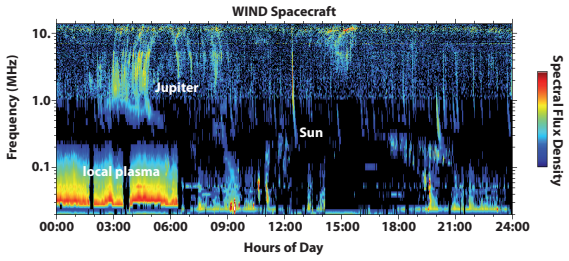

Figure 1: Radio emissions observed by the radio receiver onboard the WIND spacecraft on the Oct. 23rd, 2012. Jupiter and Solar radio emissions are visible.

2 Existing Databases

Various databases containing radio astronomy observations are disseminated around the world. The space agencies (NASA, ESA, JAXA, CNES) are giving access to radio data recorded on space missions (Voyager, Galileo, Cassini, WIND, STEREO, Ulysses, Cluster, Geotail, Interbal...). There are less databases available for ground based observations: the Nançay decameter array and the e-Callisto network are the two main databases. Each database has its own data format (text, binary, NetCDF, FITS, HDF5...) and metadata format (PDS3, PDS4, SPASE, CDPP...). They all propose HTTP access.

3 Europlanet Table Access Protocol

EPN-TAP is a VO data access protocol designed for Planetary Science data. It is intended to access data services of various content, including space-borne, ground-based, experimental (laboratory), and modeled data.

The EPN-TAP protocol is directly derived from IVOA's TAP, a protocol to access data organized in tables, here adapted to Planetary Science. EPN-TAP is an extension of TAP with extra characterization derived from a Data Model, as ObsTAP is an extension based on the Obscore Data Model.

Since EPN-TAP is IVOA TAP compliant, the discovery of all EPN-TAP services can be performed using an IVOA registry. A specific extension of IVOA registries to describe EPN-TAP services accurately will be defined elsewhere. The description of EPN-TAP compliant services must follow the rules defined by IVOA VOSI (Virtual Observatory Support Interface), which defines the capabilities of the services, as well as service availability.

4 Proposed framework

We propose a study of the various data formats available for radio astronomy, namely VOTable, FITS, NetCDF and HDF5. Each of these data format can be served through the EPN-TAP protocol, which includes enough metadata to provide efficient search and access to these databases. We use a software distribution developed by the GAVO (German Astronomical Virtual Observatory). A full tutorial is available from VOParis data center to set up a new service.

This framework has been implemented on the Nançay Decameter Array Routine observations database, as well as on the radio data available through the AMDA (Automated Multi-Dataset Analysis) tool from the CDPP (Toulouse). We plan to implement it soon on the Cassini/RPWS/HFR database at LESIA (Observatoire de Paris), and on the ExPRES (Exoplanetary and Planetary Radio Emission Simulation) tool from LATMOS and LESIA.

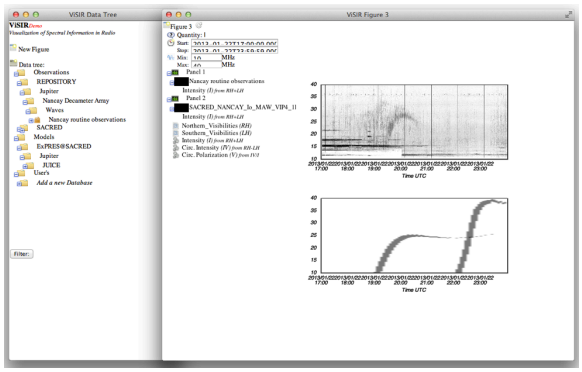

Figure 2: Prototype of a low frequency radioastronomy virtual observatory tool showing data from observations (top: Nançay data) and modeled data (bottom: from ExPRES database).