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Spectroscopy of planetary surfaces in a VO context (VESPA)

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Introduction

The VESPA data access system developed in the Europlanet-2020 program focuses on applying Virtual Observatory (VO) techniques and tools to Planetary Science [1]. A specific theme in this activity is related to spectroscopy in solid phase, with applications to the observation of the surfaces of planets, satellites, and small bodies, and is now being implemented. A first aspect consists in providing observational databases in an interoperable form; this currently includes observations of terrestrial planets and asteroids, and will develop in the next two years. A second aspect is to make experimental databases available and searchable in this context. A third aspect is to adapt existing VO tools to handle spectra of solid phases and make comparisons with observations possible. All data and tools will be available from the VESPA search interface (http://vespa.obspm.fr).

1. Solid spectroscopy in VESPA

VESPA actions related to experimental data include on one hand the evolution of the GhoSST database into a much larger infrastructure called SSHADE; on the other hand a unified access to several existing databases of mineral spectra.

SSHADE (Solid Spectroscopy Hosting Architecture of Databases and Expertise) is a sub-network of 20 European contributors from 8 different countries [2]. It will extend the existing GhoSST (Grenoble astropHysics and planetOlogy Solid Spectroscopy and Thermodynamics) database [3] to a large set of contributor databases in the field of solid spectroscopy, including major ones. The on-going implementation phase will be followed by a phase of data documentation and validation, to ensure consistency and data quality. The resulting service will not only help extend the spectral databases of ices, minerals and organic materials, but will also make the state-of-the-art laboratory data readily available as references to interpret observations of planets and small bodies, in particular from spacecraft. SSHADE includes a dedicated environment with visualization and processing tools for specialists; the databases will include measured spectra as well as derived data such as band lists and optical constants, relying on the very complete Solid Spectroscopy Data Model defined for this service. A first public interface will be available early in 2018. The databases will also be accessible via the simpler EPN-TAP protocol [4], which is intended to speed up comparison with observational data and to allow for mass processing in the VESPA environment (Fig. 1).

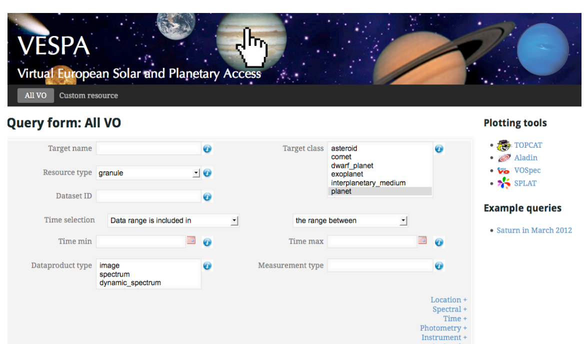

Fig 1: The VESPA user interface: http://vespa.obspm.fr

Other databases of mineral reflectance spectra have been regularly populated in the past 20 years and are routinely used to interpret observations of planetary surfaces, e. g., on Mars, the Moon, or small bodies. An important project is therefore to extend EPN-TAP to define parameters describing samples of interest in terms of mineralogical composition, origin, grains size, mixing, possible processing, etc, as well as measurement technique and physical quantity. The current design phase is based on several spectral libraries, in particular the Berlin Rosetta Spectral library (minerals and meteorites in reflectance) and the CRISM spectral library [5] that is currently searchable from a web form at the PDS Geosciences Node (http://speclib.rsl.wustl.edu/). The Berlin Emissivity Database at DLR, which is supported in other Europlanet activities, is another possible candidate to make an EPN-TAP data service. With such descriptions available, the spectral libraries will be readily accessible by spectral fitting tools, but also by planetary GIS environments connected to VESPA.

2. Plotting and analyzing tools

A more technical but important action in this science theme is to adapt astronomical standards and tools to Planetary Science needs, where many spectral observations are acquired in reflected light and on extended objects. Current VO data models do not include the descriptors (*UCD*s and *UTypes*) identifying the corresponding physical quantities (radiance, I/F ratio, many sorts of reflectance, albedos and emissivities, etc), nor the usual physical units in the field. More generally, the various existing VO tools do not seem to handle our spectral data similarly at present, probably because of incomplete requirements provided by the standards. CASSIS [6] is the tool of choice to assess the consistency of standards extension, since it is partly supported by VESPA (Fig. 2).

3. Use case

A simple use case consists in searching spectra of asteroid Vesta in M4ast and comparing them with basaltic meteorites measured in reflectance from spectral libraries. The main issue is to search for samples in the experimental databases, and to retrieve spectra that are sufficiently documented for later processing. The availability of spectral thumbnails in the VESPA search interface appears important to quickly identify data of interest.

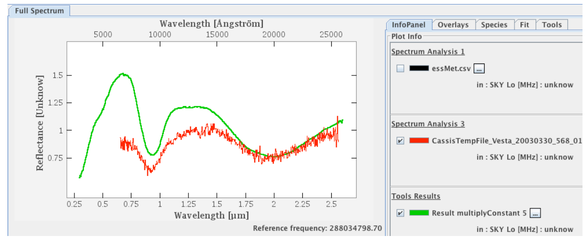

Figure 2: Comparison between spectra of asteroid Vesta from the M4ast service and the ALH84001 SNC meteorite extracted from the PDS spectral library, in CASSIS.

The PDS spectral library uses a description with 8 different levels (global type, class, subclass, group, species…), while the Berlin one uses only 4 such levels, some with multiple values. In practice, it is difficult for the user to identify what keyword is expected to contain what descriptor, and it appears that existing databases do not always use fully consistent descriptions. The simple solution currently under assessment in EPN-TAP is to concatenate all available descriptors in a single list where substrings related to composition will be searched, e. g. “phyllosilicate” or “meteorite” as well as “kaolinite” or “CV3”. Many tests are on going to converge towards a satisfying description common to all data services, but fully efficient implementations will require some level of reprocessing of the compositional information. In addition, a dedicated form may be required to address this level of complexity in the main search interface.

References

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