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SSHADE: an European Database Infrastructure in Solid Spectroscopy

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Abstract

SSHADE (http://blog.sshade.eu) is an European project of a set of databases to provide the community with a large number of reference spectra of solids (ices, minerals, organics, cosmo-materials, …) of astrophysical and terrestrial interests in the X-ray, UV, visible, infrared and mm ranges. The SSHADE consortium has currently 20 partner groups in 18 laboratories from 8 different European countries. This project is developed as part of the VESPA activity within the Europlanet 2020-RI project of the Horizon 2020 program.

1. Introduction

Spectroscopy and spectro-imagery are increasingly used in space missions (e.g. VIMS/Cassini, OMEGA/Mars Express, CRISM/MRO, VIRTIS/Rosetta, RALPH/New Horizons, MAJIS/JUICE, …) to study the solid phases (icy, mineral or organic surfaces and grains, dust particles, aerosols…) of the objects of the solar system. Infrared, Raman, fluorescence and X-rays micro-spectroscopies are also used to study meteorites and cometary dusts in the laboratory and onboard some space missions (landers, rovers) for *in situ* measurements. A major contribution to the analysis of these observations is the measurement in the laboratory of UV, Visible, IR, sub-mm, Raman and XANES spectra of a variety of materials (ices, minerals, organics, …) expected to be present at the surface of the bodies of the solar system or in their ejected grains (e.g. comets, asteroids, TNO, icy satellites, Pluto, Mars, …).

A large number of laboratories in Europe have developed experiments to measure and study the spectroscopic properties of a variety of solid materials of astrophysical interest, either natural (terrestrial or extra-terrestrial) or synthetics, as a function of various compositional, structural, textural or environmental (T, P, irradiations…) parameters. The amount of data collected is huge (several tens of thousands) and many of these laboratories boast leading-edge expertise in some solid spectroscopy fields. However most of the published data (but not all by far) are very difficult to access in a usable form (i.e. electronic) to compare with observations or to use in radiative transfer codes.

We thus decided in the frame of the Europlanet 2020-RI project (09/2015-08/2019) to extend our Solid Spectroscopy Data Model (SSDM) to the needs of all spectroscopy laboratories and to convert and expand the GhoSST database structure in a database infrastructure, called SSHADE, able to gather and distribute the spectroscopic data of most of the European laboratories working on solids of any types, with astrophysical and terrestrial applications.

2. What is SSHADE?

SSHADE ("Solid Spectroscopy Hosting Architecture of Databases and Expertise") is a project of a set of databases on solid spectroscopy that started its development in September 2015 and should be publicly available early in 2018, with hopefully a public demonstrator in September 2017.

The SSHADE databases cover laboratory, field, airborne as well as simulated and theoretical spectral data including various levels of products (ex: transmission, absorbance, absorption coefficient, optical constants, band list) for many different types of solids: ices, snows and molecular solids, minerals, rocks, inorganic solids, natural and synthetics organic and carbonaceous matters, meteorites, IDPs and other cosmo-materials,… They come from a wide range of measurement technics: transmission, bidirectional reflection, Raman, fluorescence, … and over a wide

range of wavelengths: from X-rays, through UV, visible, infrared to millimeter wavelengths

It is based on the GhoSST database developments (Europlanet + VAMDC 2009-2012). The SSHADE database infrastructure is hosted at the OSUG Data Center (Université Grenoble Alpes, France). The SSHADE development is part of the VESPA activity [1] within the European Europlanet-RI project of the Horizon 2020 program (09/2015-08/2019).

The SSHADE consortium has currently 20 partner groups in 18 laboratories from 8 different European countries (F, UK, I, D, E, HU, PL, CH). News about this project can be followed on the SSHADE blog (http://blog.sshade.eu).

3. SSHADE infrastructure

The SSHADE infrastructure has:

- A common data model: SSDM
- A common 'solid spectroscopy' interface
- A common data Import / Search / Visualization / Export engine
- A common fundamental database (species, publications, objects, …)
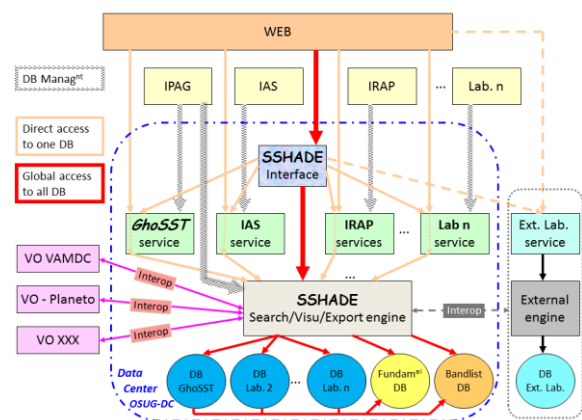- A set of spectral databases: one per group/laboratory (GhoSST is one of them)

Figure 1: Schematic structure of SSHADE infrastructure

It is possible to search spectral data either with an 'Elastic Search' tool (à la Google) based on the content of a selected set of key words, or with various filters (spectrum type, species or material type or name, database, …), or from different points of view (spectra, band lists, publications, objects, …).

SSHADE will be also a service for Virtual Observatories (VESPA, VAMDC, ...). In particular part of the SSHADE databases will be accessible via the EPN-TAP protocol [2], which will allow comparison with observational data and mass processing in the VESPA environment through a series of dedicated spectroscopy plotting and analysing tools [3].

4. Databases implementation

We are progressively implementing in the SSHADE infrastructure the databases of each of the 20 partners of the SSHADE consortium. For each database the 'scientific manager' (responsible of the scientific content of its database and its quality) and the 'database manager' (responsible of the ingestion of the data in its database) are trained to the tools developed for data preparation, validation, import and management. They are in charge, with the help of contributors (experimentalists who produce data) to progressively develop the content of their database. They will also contribute to the future common 'band list' database of molecular solids by providing band parameters data or critical reviews of published data.

Tutorials on the use of the database infrastructure will be organized mostly during major planetary sciences and astrophysics conferences. The SSHADE web site will contain all documentation on the SSDM data model, tutorials and user case on the use of the SSHADE database, as well as on the experimental systems and cells used to record the spectra contained in SSHADE.

References
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[3] Erard et al (2017) Spectroscopy of planetary surfaces in a VO context (VESPA), EPSC2017