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Abstract: The SSHADE infrastructure in experimental solid spectroscopy is mostly based on a set of spectral databases of partners of the SSHADE consortium, a VESPA sub-network. This deliverable of the Europlanet 2024 RI program concerns the training of a series of new partners to teach them how to prepare and import data in their database and manage it. Eleven new partners were trained and nine of them already started to put online various sets of spectra of ices, minerals, organics, meteorites, etc, for the planetary sciences and astronomical/astrophysical user communities to help them interpret VUV to far-IR spectroscopic observations of planets and small body surfaces, aerosols and grains. The SSHADE consortium now has twenty-five European contributor groups (eleven countries) and five non-European (IN, TW, CN, TR, CA).

1 Introduction and aims

1.1 The SSHADE project

SSHADE (lead: IPAG, consortium of contributor partners: <https://wiki.sshade.eu/doku.php?id=sshade:databases>) is a multi-database infrastructure in experimental solid spectroscopy for a VESPA sub-network of European and non-European contributor groups.

At the beginning of the program, we pre-selected nine groups interested in being partners of the SSHADE infrastructure and willing to get a database to put online their spectroscopic laboratory or field data on solid samples for the planetary sciences and astronomical/astrophysical user communities to help interpret VUV to far-IR spectroscopic observations of planets and small body surfaces, aerosols and grains.

1.2 The new partner training

We started to train six of these groups online at the beginning of the COVID-19 pandemic but were unable to provide them with the second part of the training in-person immediately after, as we delivered successfully during the Europlanet 2020 RI programme. When we were able to restart in-person training, the researchers of two of them moved to another laboratory or were on sabbatical, so we were not able to provide them with the complementary training and their database did not start yet. We then delivered the complementary training for other four groups and delivered complete training to five other groups; two of them were additionally selected from a waiting list of groups interested in SSHADE.

At the time of writing, we have thus far been able to add nine new partners with already fully-active databases or starting to put online various sets of spectra of ices, minerals, organics and meteorites; two other partners have had initial training but have not yet started filling their databases.

These groups and their databases are listed in detail in Section 2 and complemented with a waiting list of groups interested to join the consortium in the short or medium term.

The SSHADE consortium team now consists of thirty different groups in sixteen different countries. The groups and their databases are listed in the SSHADE wiki: <https://wiki.sshade.eu/doku.php?id=sshade:databases>.

1.3 The training program

The initial training lasted between two and three days, and the complementary training between one and two days, depending on the complexity of the data of the group and the number of attendants. These training sessions were attended by one to six people, including Master's and PhD students and postdocs. A total of 31 people from 13 different groups in 7 different countries (CA, CN, FI, FR, GR, IT, TR) people attended the training sessions. Among them, 9 people from 3 different groups in 3 different countries (CA, CN, TR) are outside Europe.

Some statistics (total 31):

- Gender:
 - o 13 F (42%)
 - o 18 M (48%)
- Career:
 - o PhD + Post-Doc : 16 (52%)
 - o Young Researcher : 5 (16%)

Senior Researcher : 10 (32%)

The **initial training** consists of:

1) Teaching of:

- The organisation of the SSHADE infrastructure and consortium
- The user interfaces: Search / Visualisation / Export / Dashboard
- The organisation and content of the SSHADE Wiki
- Solid Spectroscopy Data Model (SSDM) and its various components:
 - o Sample (with matters, phases & species)
 - o Experiment & spectra
 - o Instrument
 - o Database & laboratory
 - o Experimentalists
 - o Publications
- The XML template files and language
- The provider tools to prepare, import, verify and manage their data
- The DOI and the data reference
- The managers tools to manage their database and their data.

2) Practicals of preparation and importing of data and metadata in XML files of:

- Instrument & experimentalists
- Database & laboratory
- Publications
- Sample (with matters, phases & species)
- Experiment & spectra.

The **complementary training** consists of:

- Preparing specialized XML file templates for each type of matter, samples and experiment/spectra of each group
- Preparing and importing several sets of data

2 The Partner Databases

2.1 New databases

In this part, we list the groups that are new partners of the SSHADE consortium, that have been trained during the Europlanet 2024 RI programme and that have already started to feed their databases (fully active or starting databases).

- **BOREALIS:** dataBase fOR matErial And pLanetary science Spectroscopy

Division of Atomic and Molecular Physics, Department of Physics. Faculty of Science - Ege University, Izmir, Turkey

Scientific Manager: Ozan Unsalan
Database Manager: Ozan Unsalan

BOREALIS is a database intended for Raman and Infrared spectroscopic experimental data on material and planetary science.

- **CHIPS:** Canadian Hyperspectral Integrated Planetary Spectroscopy

Centre for Terrestrial and Planetary Exploration (C-TAPE) / University of Winnipeg, Winnipeg, Manitoba, Canada

Scientific Manager: Sandra Potin
Database Managers: Sébastien Manigand
Other data Providers: Edward Cloutis, Daniel Applin

The CHIPS database contains spectroscopic experiments of several types, such as reflectance, Raman and transmission, with spectral ranges covering from the UV to the near-infrared. The studied samples are either natural geological samples, field sites, meteorites or synthetic components.

- **DB-GEOPS:** GEOsciences Paris-Saclay database

GEOsciences Paris-Saclay (GEOPS) / Géomorphologie et Géochronologie des surfaces Planétaires et Volcaniques team - CNRS / Université Paris Sud Orsay / OSUPS, Orsay, France

Scientific Manager: Frédéric Schmidt
Database Managers: François Andrieu

The DB-GEOPS database contains NIR reflectance spectra of layered compact and granular materials of varying thickness and grain sizes used to validate codes of radiative transfer models of planetary surfaces.

- **FGI_RefLib:** Finnish Geospatial Research Institute Reflectance Library

Space Geodesy Group of Finnish Geospatial Research Institute FGI, National Land Survey of Finland, Masala, Finland

Scientific Manager: Jouni Peltoniemi
Database Manager: Jouni Peltoniemi

The FGI_RefLib database will provide electronic access to several sets of original laboratory bidirectional reflectance spectra (and elaborated products) of snow, planetary analogues, meteorites, sand, gravel, etc. recorded in our laboratory at 350–2500 nm, with polarization, and that have been published in peer-reviewed scientific papers.

- **LPRS:** Library of Planetary Remote Sensing

Laboratory of Planetary Remote Sensing (LPRS), Planetary Science Institute, School of Earth Sciences, China University of Geosciences, Wuhan, China

Scientific Manager: Hao Zhang
Database Manager: Hao Zhang
Data Providers: Te Jiang, Yeming Liu, Changhao Ni, Zichen Wei, Yan Zhuang

LPRS is a laboratory database on the spectral and photometric bidirectional distribution functions of various planetary materials for the Moon and asteroid studies: Moon and asteroid soil analogues, evolution under space weathering processes and samples collected by space missions.

- **Mirabelle:** "CRPG" database

Centre de Recherche Pétrographiques et Géochimiques (CRPG) / 'Formation et Evolution du Système Solaire et des Planètes' team - CNRS / Université de Lorraine, OSU OTELo, Nancy, France

Scientific Manager: Jessica Flahaut

Database Manager: Gen Ito

Data Providers: Marie Barthez, PhD students

The Mirabelle database is specialized in VNIR spectroscopy of Mars, the Moon and terrestrial analog locations and is focusing on the VNIR (0.5-2.5 microns) properties of both sedimentary (e.g., evaporites) and magmatic natural, rock samples. VNIR reflectance spectra of such samples were previously collected on the field with a ASDinc Fieldspec4 and/or Terraspec 4 at various Mars analog location including : the Atacama desert salars and Andean volcanoes (Chile), the Azorean hydrothermal fields (Portugal), the Solfatara crater (Italy). Reflectance spectra are also often re-measured in the laboratory under more controlled parameters (e.g., fixed geometry). They will be contributed to the Mirabelle database in SSSHADE and may serve future planetary studies.

- **PIG:** Pigmentothèque Database

Laboratoire Environnements, DYnamiques et TErritoires de la Montagne (EDYTEM), Université Savoie Mont Blanc - CNRS, Archives environnementales : rétro-observation & modélisation Team, Le Bourget du Lac, France

Scientific Manager: Émilie Chalmin-Aljanabi

Database Manager: Bernard Schmitt, Hélène Salomon

Data Providers: Hélène Salomon, Claire Chanteraud, Aurelie Chassin De Kergommeaux

The PIG database contains Visible near-Infrared reflectance spectra (typically 0.4-4.2 μm) of a series of natural mineral pigments recorded either on raw blocks, on sieved powders or on polished plots. Spectra of simulated painting with these pigments on different substrates are also included. In the future spectra of archaeological paintings will be also included.

- **ROMA:** ROck reflectance for MArtian in situ exploration database

Laboratoire de Géologie de Lyon - Terre, Planètes, Environnement (LGL-TPE), Université Claude Bernard Lyon 1, Observatoire de Lyon - Lyon, FR

Institut de Planétologie et d'Astrophysique de Grenoble (IPAG), Université Grenoble Alpes - Grenoble, FR

Scientific Managers: Lucia Mandon (LESIA)

Database Managers: Lucia Mandon (LESIA)

Data Providers: Lucia Mandon (LESIA), Pierre Beck (IPAG)

The ROMA database provides the reflectance spectra between 0.4 μm and 3-4 μm of various terrestrial, Martian and synthetic samples, with a focus on intact rocks and Martian analogues. It includes higher-level data such as absorption band parameters, as well as sample mineralogy estimated by whole-rock X-ray diffraction analyses.

- **UH-ApS:** University of Helsinki Astrophysical Scattering and Spectroscopy Database

University of Helsinki Astrophysical Scattering and Spectroscopy Laboratory (UH-ApS), Planetary System Research group (PSR), Department of Physics, University of Helsinki, Helsinki, Finland

Scientific Manager: Karri Muinonen

Database Manager: Antti Penttilä

Data Providers: Tomas Kohout, Julia Martikainen

The UH laboratory will concentrate on solid and particulate materials with applications on planetary sciences. In particular, we are measuring in ambient atmospheric conditions and at room temperature, so mineral materials are mostly measured. The materials are natural but can be synthetically processed to, e.g., mimic space-weathering effects. We are particularly interested in measuring meteorites and similar materials.

2.2 Near-future databases

In this part we list the different groups that we already included as partners of the SSHADE database infrastructure in order to get their own database in SSHADE, and that we started to train during this programme but that have not yet effectively started to feed their databases.

- **phasma (ϕ asma):** Earth and Planetary Materials Laboratory Spectral Database

Planetary Sciences and Astrobiology, Laboratory of Mineralogy, Petrology and Economic Geology - National Technical University of Athens (NTUA), School of Mining and Metallurgical Engineering, Department of Geological Sciences, Athens, Greece

Scientific Manager: Elias Chatzitheodoridis

Database Manager: Elias Chatzitheodoridis

Data Providers: Eleftherios Profitis, Nikolas Tsakonas, Hector Stavrakakis, Andreas Kapagiannidis

ϕ asma (or phasma) is a database on Raman and FTIR spectra mainly acquired from Martian meteorites. In our collection, there is a rich selection of Martian meteorites.

We will enrich the database of spectra with acquisitions from Lunar meteorites and carbonaceous or other chondrites. For comparison, a selection of reference minerals is also provided from our rich inventory of minerals and rocks. All spectra are acquired with the instruments listed below, and for their precise interpretation we use proprietary software, the ramanSpace software that we have developed in our lab with all required functionality for background corrections and peak fitting, as well as an interactive database of minerals and phases composed from our own inventory of minerals (most to appear here as well) and from the literature.

- **PLUS:** Planetary Laboratory of University of Salento database

Astrophysics Laboratory, Dipartimento di Matematica e Fisica 'E. De Giorgi', Università del Salento, Lecce, Italy

Scientific Manager: Francesca Mancarella

Database Manager: Romolo Politi

Data Providers: Francesca Mancarella, Marcella D'Elia, Romolo Politi

The PLUS database contains spectroscopic data of various types of study of minerals of planetological and astrobiological interest. The Laboratory houses a collection of minerals and rocks that includes not only different species but also different classes and varieties and increase the collection continuously. The powdered samples are measured with various spectroscopic techniques from the UltraViolet to the Far-IR ranges (transmission, directional-hemispherical reflectance, specular reflection, etc.). It provides different levels of data from simple transmission or reflection spectra to optical constants. PLUS Laboratory is a part of the Department of Mathematics and Physics "E. De Giorgi" of University of Salento and a facility is a service of the INAF university section of Lecce.

2.3 Potential future SSHADE databases

In this part we list the different groups that contacted us to study their potential inclusion as partners of the SSHADE database consortium in order to get their own database in the SSHADE infrastructure, but that we did not yet included or started to train. They should be in future development programs of SSHADE.

- **LASA:** Laboratório de Astroquímica e Astrobiologia (LASA), Universidade do Vale do Paraíba (UNIVAP) – Instituto de Pesquisa & Desenvolvimento (IP&D), São Paulo, Brazil

Scientific Manager: Prof. Dr. Sergio Pilling

Data Providers: Dr. Fredson Vasconcelos, Dr. Will Rocha

- FTIR absorbance spectra of virgin and processed ices.

- thermal and energetic processing (UV Ly- α , electrons) of astrophysical ice analogues and their astrophysical implications in planetary or interstellar environments.
 - complex refractive index in the infrared by using the NKABS code,
- Tokyo University of Science, Faculty of Science Division I, Department of Physics, Japan

Scientific Manager: Tomoki Kimura

- Surface reflectance change on model material samples.
 - Space weathering on the icy moon surface driven by the space plasma irradiation based on the laboratory experiment.
 - Spectral libraries at UV-midIR to interpret experiment samples to constrain the real surface composition and space weathering process.
- SETI Institute, Carl Sagan Center, Astrobiology group, Mountain View USA
 - NASA AMES Research Center, Space Science & Astrobiology Division, Moffett Field, CA, USA

Scientific Manager: Janice Bishop

Data Providers: Melissa D. Lane,

- Low-temperature infrared spectroscopy of minerals to support their detection on planetary bodies: sulfates, carbonates, phyllosilicates, tectosilicates, chlorates and phosphates.
- Umeå universitet, Umeå, Sweden

Scientific Manager: Merve Yesilbas

Data Providers: Lucas Demaret, Trung Nguyen, Amanda Ekman

- Sulfates, salts and Martian analogues of mineral-water and ice interfacial chemistry and cryomineral formation using cryogenic vibrational spectroscopy techniques (Infrared and Raman spectra)
- Argonne National Laboratory, Lemont, IL, USA

Scientific Manager: Matthew G. Newville

- X-ray Absorption Spectroscopy (XAS, XANES, XAFS, EXAFS), X-ray Fluorescence (XRF) Spectroscopy and Imaging of various materials for Condensed Matter Physics, geochemistry, mineralogy and physical chemistry.

- ISTO – Orléans, France

Scientific Manager: Aneta Slodczyk

Data Providers: Rémi Champallier

- Infrared emission spectroscopy and Raman spectroscopy of volcanic rocks and minerals at high temperature (up to 1200°C) and high pressure (up to 2000 bar).

- IPGP, Sorbonne Univ., Paris, France

Scientific Manager: Daniel Neuville,

Data Providers: Daniele Antonangeli, Maxime Guillaumet

- XANES spectroscopy and Raman spectroscopy of volcanic glasses.