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Imaging Spectroscopy in lab: a tool supporting the interpretation of remotely sensed data

E. Ammannito (1), A. Boccaccini (1), A. Coradini (1), M.C. De Sanctis (2), and G. Piccioni (2)
(1) INAF, IFSI, Rome, Italy , (2) INAF, IASF, Rome, Italy

A new experimental set-up has been implemented to provide spectral reflectance measurements of various samples in the visible and near infrared range. This activity was done to support the scientific interpretation of the hyper-spectral data produced by imaging spectrometers for planetary investigations. Using suitable laboratory equipments, we can study terrestrial rocks and meteorites, considered analogs of planetary surface, in order to extract information from reflectance spectra that will be acquired during the space missions to bodies of the Solar System.

The experimental set-up is based upon an imaging spectrometer. Such spectrometer has the same optical design of VIRTIS and VIR-MS (two imaging spectrometers flying on board of Rosetta and Dawn missions respectively space mission) but a slightly different mechanical layout. These changes were necessary in order to improve the use of the new spectrometer in the laboratory. The most relevant changes are the absence in the former of the IRFPA (InfraRed Focal Plane Array) and a different scanning motor for the primary mirror of the telescope.

The experimental set-up is made of two different systems, the DM which is the spectrometer and the optical bench.

The DM is actually composed by two sub-systems: a Shafer telescope, coupled with an Offner grating spectrometer. The telescope is an optical element used to focus the light on the slit of the spectrometer that is the core of the DM. As the instrument uses a bi-dimensional focal plane aligned with the spectrometer's slit axis, the acquisition of a hyper-spectral cube is performed through a push broom acquisition mode by moving the scanning mirror of the telescope. The focal plane is a CCD of 288 spatial pixels and 384 spectral pixels. For further details about the characteristics of the DM and its optical design it is possible to refer to literature on VIR-MS as well as the one on VIRTIS and VIMS-V. The software used for the communication with the DM and for the acquisition of the detector data was developed in our institute and it was designed to handle hyper-spectral data.

The optical bench is a sub-system needed to collimate the light beam coming from the source before it arrives on the primary mirror of the telescope. In order to obtain this result it was studied an optical system of three elements. A target, that has the role to carry the sample to be measured; an off-axis parabolic mirror, that is the real collimating element and a folding mirror that it is used to deviate the collimated beam in order to get the best alignment with respect to the DM. The folding mirror is not critical from the optical point of view because at that point the beam is collimated, on the other side, the parabolic mirror and the target need to be aligned in order to get a collimating system. The idea using such elements is that a parabolic off-axis mirror collimate the light coming from its focus. It means that we need to put the target exactly on the focus of the mirror. The procedure performed to align the two elements is based on the use of an interferometer.

The set-up was calibrated trough a dedicated measurement campaign. Imaging spectrometers aboard of space missions required a detailed calibration procedure. In the case of an experiment for laboratory purpose the procedure is much more easy especially because, using an adequate reference target, it is not necessary a radiometric calibration to get reflectance spectra. Thus, the aim of the calibration procedure is essentially to provide the spectral and geometrical properties of the system. From spectral point of view it was found a range of 450-900nm and a spectral sampling of (1.20 ± 0.20)nm and a spectral resolution of (2.10 ± 0.20)nm. From geometrical point of view, it was found a spatial resolution on the target of (0.250 ± 0.25)mm in both directions, along the slit and along the scanning, and the Field of View of the system to be roughly (40x40)mm.

The first results obtained by measuring different samples will be discussed.