UV-NIR REFLECTANCE SPECTRA OF ORDINARY CHONDRITES TO BETTER UNDERSTAND SPACE WEATHERING EFFECTS IN S-CLASS ASTEROIDS. J. Cortés-Comellas[1,*], J.M. Trigo-Rodríguez[1], J. Llorca[2], and C.E. Moyano-Cambero[1], [1]Meteorites, Minor Bodies and Planetary Science Group, Institute of Space Sciences (CSIC-IEEC). Campus UAB, Carrer de Can Magrans, s/n, 08193 Cerdanyola del Vallès (Barcelona), Spain. [2]Institute of Energy Technologies and Centre for Research in NanoEngineering. Technical University of Catalonia, Diagonal 647, 08028 Barcelona, Spain. [*]E-mail: jordicc88@gmail.com

Introduction: Comparing laboratory spectra of meteorites and remote reflectance spectra of asteroids is nowadays the most viable way to establish a connection between the samples recovered on Earth and the Solar System objects, although it's still a pretty difficult task. Narrow-band spectrophotometry programs initiated in the 1960s allowed the identification of absorption bands in asteroid spectra [1]. Such features were used later on to develop the first asteroid taxonomy [2]. Features determined from reflectance spectroscopy are commonly used for remote optical characterization of asteroids. Usually, the albedo, the position and particular strength of distinctive absorption bands, and the overall shape and slope of the spectra, are considered for a proper characterization. . Through reflectance spectroscopy we are able to distinguish a variety of features that allow us to identify the main minerals composing meteorites and the surface of asteroids.

In order to stablish a proper connection between meteorites an asteroids, we have to understand the effects that space weathering has on the spectra of any Solar System object too small to be protected by an atmosphere. This kind of weathering includes a mixture of physico-chemical processes: cosmic ray irradiation, elemental implantation and sputtering effects caused by solar wind high-energy particles [3], brecciation involving material mixing with projectiles, and regolith formation due to meteoritic bombardment [4]. Analyses of lunar regolith from the Apollo program lunar soil samples [5] and alteration experiments [6], identified the main processes and their typical alteration features. In addition, the influence of space weathering on asteroidal regolith was recognized in five 50-µm-sized grains of asteroid 25143 Itokawa recovered by Hayabusa, a sample-return mission from the Japanese Space Agency (JAXA)[7]. Meteorites penetrating Earth's atmosphere at hypervelocity suffer the ablation of about 95% of its mass, consequently losing their outher material and almost any trace of space weathering effects. Therefore, meteorites are naturally biased materials with reflectance properties that differe from their parent bodies surfaces.

On an ongoing study, we have been working with several meteorites in order to understand those spectral differences, and the physical processes promoting the them. Here, particularely, we compare the spectra of the most common asteroids in the inner regions of the Main-Belt, S-type asteroids, with several L and H ordinary chondrites (hereafter OCs).

Technical procedure: We have used a Shimadzu UV3600 Ultraviolet to Near-infrared (UV-Vis-NIR) spectrometer to obtain the reflectance spectra of thick sections from the 7 OCs listed in Table 1. The standard stage for the spectrometer is an Intregrating Sphere (ISR) with a working range of 0.2 to 2.6 µm, and operated under laboratory conditions (for more details see [8]). The sample beam interacts with the sections at a phase angle of 8º. A standard baseline was created for calibrating of the detector, using a conventional $BaSO_4$ substrate. The area sampled during the measurements correspond to a slot of ~2×1 cm^2.

Meteorite	Group	Collection
Gold Basin	L4	IEEC-CSIC
Kendleton	L4	IEEC-CSIC
North West Africa 778	H4	IEEC-CSIC
Gao Guenie	H5	IEEC-CSIC
Olmedilla de Alarcón	H5	Private collection
Bassikounou	H5	IEEC-CSIC
Nulles	H6	Private collection

Table 1: OCs selected for this study.

Results and discussion: The S-type averaged spectra [8], ranging from 0.435 to 2.0 µm is compared with the different OCs (Fig. 1). Two common main absorption bands are noticeable close to 1 and 2 µm, showing manily the presence of olivine and pyroxene. Olivine presents a wide and very characteristic absorption band at about 1 µm, as the result of the superposition of three individual absorption bands associated with Fe^{2+} cations, while pyroxene shows absorption bands at 1 and 2 µm, related with the concentrations of Fe^{2+} and Ca^{2+}. Significant differences in the peaks of the L and H chondrites analysed are found (Fig. 1), as band depth, slope and relative position are clearly affected due to the mineralogical variations between these two groups of OCs.

Conclusions: As expected, the S-class averaged spectra show significant differences with the reflectance spectra of OCs (Fig. 1). The amplitude of the bands and the overall spectral slope in the asteroid spectrum exhibit the characteristic modifications produced by space weathering. The most important distinction is a noticeable increment of the slope (also called reddening) of the S-class spectrum. Such effect has been described before as a very common result of space weathering on asteroids. Indeed, a slope increment higher than 0.25 is a clear signature of space weathering, hence exemplifying the natural departure between the spectra of meteorites and its asteroidal parent bodies. It has to be taken into account that large impacts create fragmental asteroids and rubble piles [10] with different weathering exposures, which diversifies the spectral properties. Consequently, the scenario increases in complexity because the asteroidal spectra might span in a wider range depending on the time of exposition to weathering. End members of the S complex (Sq, Sv), and additionally even Q-type asteroids moving in near-Earth orbits, would fill this gap (see e.g. [11]). Indeed, the rare Q-type asteroids is represented by a small population of NEAs, with spectral differences recently explained as due to resurfacing of their regolith-covered surfaces during close approaches to Earth [12].

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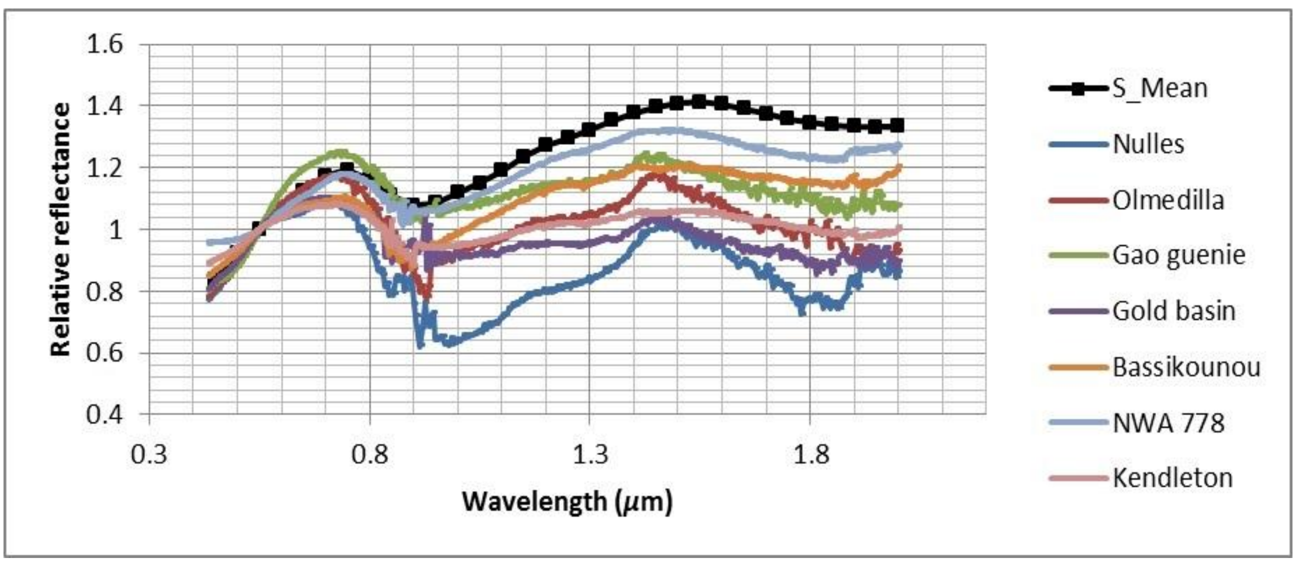

Figure 1. Reflectance spectra of the studied meteorites scaled and normalized to unity at 0.55 μm. For comparison it has been also added the S-class averaged spectrum taken from Bus-DeMeo taxonomy [9].