VNIR Spectral Characterization of brachinites and ungrouped brachinites-like in comparison with S-Type parental bodies, in support of the HERA mission. C. Carli[1], A. Migliorini[1], E. Bruschini[1], T. Cuppone[2], S. Stefani[1], G. Pratesi[2], A. Stephant[1], F. La Forgia[3], M. Lazzarin[3] [1]INAF-IAPS Istituto di Astrofisica e Planetologia Spaziali, Via Fosso del Cavaliere 100, 00133, Roma, Italia (cristian.carli@inaf.it), [2]Dipartimento di Scienze della Terra, Università di Firenze, Via G.La Pira 4, 50121, Firenze, Italia, [3]Università degli Studi di Padova, Vicolo dell'Osservatorio 5, 35122, Padova, Italia..

Introduction: Sample return missions are at present one of the primary goals of the Solar System exploration. Different missions addressing that goal are ongoing. Nevertheless, meteorites are a natural sampling of our Solar System bodies as they provide important information about their parent bodies, spanning from the most primitive, associated with the origin of our Solar System, to the most evolved ones.

The parent bodies are often observed in the Visible Near Infrared (VNIR) from Earth or spacecraft, addressing the capability to detect the main mineralogy. Some of these objects are mainly characterized by absorptions attributable to mafic mineralogies and in particular due to the presence of olivine or pyroxene. Those mineral phases are mainly identified by the crystal field absorptions attributed to Fe^{2+} in octahedral coordination. The variation of their spectra depends on the different mineral assemblages, mainly by the different composition of pyroxene and olivine, their relative abundances, the presence of other phases (e.g. plagioclase, opaque minerals, amorphous), or textural variations (e.g. crystal sizes, spinifex) (e.g. [1,2,3]).

Among the asteroids,the S-types are characterized by spectral properties that span from low-Ca pyroxene, up to high-Ca pyroxene and olivine, with possible different abundances of those phases [4]. Different potential types of meteorites can overlap this field as suggested in different works [e.g. 5,6 and references therein]. In particular, high interest is generally attributed to those objects with spectral properties that are in between pyroxene and olivine composition to better understand the potential detection limit of olivine and so clarify the olivine-paradox.

The Didymos-Dimorphos binary system, target of the DART mission that successfully impacted the small moon Dimorphous in September 2022, is classified as an S-type asteroid [7]. In this respect, it shows spectral properties that well fit with the regions that are closer to high olivine abundances [7, 8, 9, 10]. Further investigation of the Didymos-Dimorphous system will be performed with the HERA mission, to be launched in October 2024.

Here, we investigate the spectral properties of 12 brachinites and ungrouped achondrites brachinite-like (UBAs), that have relatively high abundance of olivine with some minor variation in mineral association, abundance and composition [11]. We study the Visible to Near Infrared (VNIR) reflectance properties to evidence how they change in a spectral range suitable to investigate S-types and compare with Didymos spectral properties.

Set-Up and Data set: Meteorite spectra were measured using the Fieldspec Pro spectrophotometer mounted on the goniometer present at the S.LAB. laboratory, at "Institute for Space Astrophysics and Planetology," IAPS-INAF, Rome. The goniometer setup permits acquisitions in bidirectional reflectance mode. The data cover the spectral range of 0.35–2.5 μm with a spectral resolution of 3 nm in the VIS and 10–12 nm in the NIR and at fixed illumination and viewing angles of 30° and 0°, respectively.

The source used was a quartz tungsten halogen lamp and the spot illuminated had a diameter of about 6 mm. The standard reference calibration was performed with a Spectralon optical standard 99% (registered trademark of Labsphere, Inc.). Spectra are an average of 100 acquisitions; moreover, for all the powders, we averaged three different spectra acquired after filling and emptying the cup each time to avoid systematic errors related to the way the cup is filled.

The meteorites have been characterized from a mineralogical and petrographical point of view by SEM and EPMA at MEMA – Department of Earth Sciences of Florence [8].

Preliminary Results and Implications: In the VNIR spectral range these samples clearly show systematic trend between the Band Center at 1 μm (BCI) and the Band Area Ratio (B.A.R.) that correlate with the olivine abundance and slightly with Fe content on olivine (Figure 1). In fact, meteorites with high olivine amounts but a very low Fa content (i.e. low iron) have positions of the absorptions coherent with the associated pyroxene [see also 3]. Clearly the samples investigated in this work moved from the portion of S (III) type defined by [4] with higher BCI up to the region defined by the S (I) type, with VNIR mainly dominated by olivine. We can notice how Didymos nicely fit within this domain defined by brachinites-UBAs and it is slightly out from the OC boot defined by the S (IV) type indicated by [4].

Conclusions: Among all the achondrites and chondrites dominated by mafic minerals, brachinites, and UBAs, form a well defined group which shows a clear trend in composition from more reduced to more oxidized members [11].

Their spectral properties cluster in the region that expands the S (III) type, from [4], up to the

olivine-dominated material, based on BC1 and B.A.R relationship. Didymos spectral properties, as obtained from VNIR spectra [7], are compatible with this cluster. Hence, we proposed a comparison with the Brachinite and brachinite-like meteorite group to constraint the surface composition of Didymos, as well as a discussion with respect to other chondrites proposed as potential analogues which often plot within the S (IV) region.

Acknowledgements: This research was partially supported by ASI-INAF n.2018-16-HH.0 (Ol-BODIES project) and partially by ASI (agreement n. 2022-8-HH.0) for ESA's Hera mission.

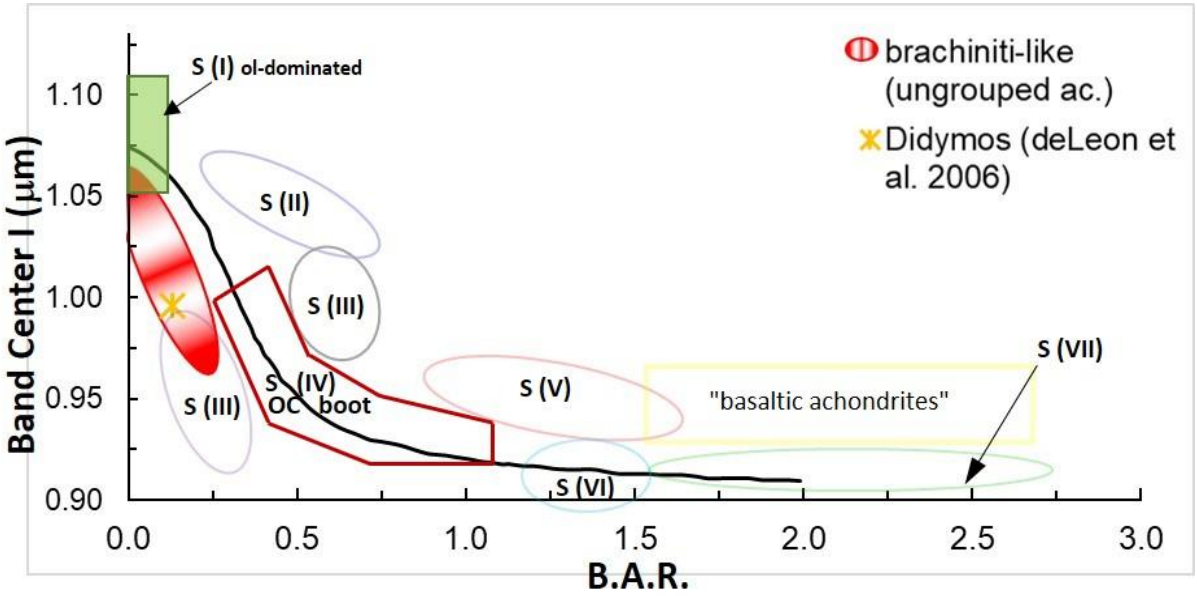

Figure 1 - Band Center I vs Band Area Ratio showing the domain of Brachinites and UBAs investigated in this work and the position of Didymos from [7].

References:

[1] Bruschini E., et al. 2022 EPSC abs#EPSC2022-349; [2] Carli C. et al. 2015, SGL Sp.Pub., 401; [3] Carli et al. 2013 LPSC abs#1923. [4] Gaffey et al. 1993, Icarus, 106. [5] Lucas et al. 2019, M&PS, 54. [6] Carli et al. 2023. M&PS 58; [7] De Leon et al. 2006, Adv. Space Res. 37, 178. [8] De Leon et al. 2010, A&A 517, 23; [9] Opitom et al. 2023, A&A, 671, L11; [10] Lazzarin et al. 2023, submitted to Nature Comm.; [11] Cuppone T., et al. 2023. CNSP Perugia abs#1061.