Spectroscopic characterization of a primordial S-type family in the inner Main Belt. J. Bourdelle de Micas[1], S. Fornasier[1,2], M. Delbo[3], S. Ferrone[3], G. van Belle[4], and P. Ochner[5,6], [1]LESIA-Observatoire de Paris, Université PSL, CNRS, Université Paris Cité, Sorbonne Université, 92195 Meudon Principal Cedex, France, jules.bourdelledemicas@obspm.fr [2]Institut Universitaire de France (IUF), 1 rue Descartes, 75231 Paris Cedex 05, [3]Université Côte d'Azur, CNRS-Lagrange, Observatoire de la Côte d'Azur, CS 34229 - F 06304 NICE Cedex 4, France, [4]Lowell Observatory, 1400 West Mars Hill Road, Flagstaff, AZ 86001 (U.S.A), [5]INAF Osservatorio Astronomico di Padova, Vicolo dell'Osservatorio 5, 35122 Padova, Italy, [6]Dipartimento di Fisica e Astronomia G. Galilei, Universitá di Padova, Vicolo dell' Osservatorio 3, I-35122 Padova, Italy.

Introduction: Asteroids, along with all small bodies, are what is left of the original planetesimal formed 4.6 Gyr ago. However, not all the asteroids are survivor from the primordial times: a majority of them experienced collisionnal event that leads to the generation of asteroid families [1]. While the classical family identification methods (HCM, [2]) are well suited to detect families younger than 2 Gyr, they have problems to identify the very old ones, owing to the dispersion of the members of these type of famillies [3]. To overcome this limitation, a novel method, called the V-shape family identification [3] [4] [5] [6], has been developed. Recently, a new family has been detected in the inner Main Belt with an estimated age of 4.4 +/- 1.7 Gyr [6]. The vertex of the V-shape of this family is located at about 2.38 AU. Preliminary analysis indicate that this family might be predominantly composed by S-type asteroids [6].

Objective: In this work, we aim at constraining the potential members list of this old S-type family and to characterize its composition.

Method: The initial members list has been generated by Ferrone et al. [6]. In addition to that list, we add objects that are located in the core of the family. They are determined considering the two following criteria: 1) asteroids should have a diameter greater than 5 km; 2) their albedo should be greater than 10%. In total, thisprimordial, intended as very old, family has 216 potential members. We carried out a spectroscopic survey in the visible and near-infrared range of these potential members. In particular, we performed ground-based observations using different telescopes: the 1.82 m Copernico telescope (Asiago, Italy), the 4.20 m Lowell Discovery Telescope (Flagstaff, USA), and the 3.5 m Telescopio Nazionale Galileo (TNG, La Palma, Spain). To complete this survey, we also grab some spectra from the latest Gaia's data release (DR3, on June 2022) [7], as well as data published previously in literature. In total, we obtained new spectroscopic observations of 42 asteroids, 102 spectra from the literature and 122 from the Gaia asteroid catalogue. We performed taxonomical classification, following the Bus-DeMeo taxonomy, using the M4AST tool [8].

Results: We observed that 55% of the potential members belongs, as expected, to the S-complex. Thanks to the bands analysis, we observed that potential S-type members show a wide variety of mineralogy, ranging from S(I) to S(VII), according to the Gaffey classification scheme [9]. However, due to the lack of data in the near-infrared part, the number of objects with a detailed mineralogical characterization is limited. Moreover, we found that 20% of the objects belongs to the X-complex and 12 % to the V-type. The presence of these types among the potential members of that family raised the question of their membership because of the presence of X and V-type families near the primordial S-type one. To discriminate their membership, we compared their orbital location of the potential S-type family members with the ones of the Athor, Nysa, and Zita families [10] (for the X-complex) and with Vesta family (for the V-type). We found that the majority of the X-type (~ 63%) and V-type (~83%) orbital elements of the list of potential member of the primordial S-type family overlaps with those of the aforementioned X and V-type families in the inner Main Belt. Moreover, the spectral parameters of the V-type asteroids are indistinguishable compared to those of the Vesta family members. Therefore, we could reasonably exclude these objects from the membership list. Excluding the interlopers, the S-type primordial family include 141 members.

Conclusions: We performed a spectroscopic study of a newly discovered very old family in the inner Main Belt. We analyzed their spectra in order to characterize their composition, and to identify and to exclude potential interlopers. We found, after exclusion of interlopers, that the primordial S-type family is indeed dominated by the S-type asteroids (73%), as expected, and that it also includes 11% of X-complex and 9% of L-types asteroids. We found also some V-types that does not have a straightforward link with Vesta family. We measured a mean albedo of around 24% for that family.

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Copernico Telescope (Asiago, Italy) of the Istituto Nazionale di Astrofisica (INAF) – Osservatorio Astronomico di Padova, at the Italian Telescopio Nazionale Galileo (TNG) operated on the island of La Palma, Spain, by the Centro Galileo Galilei of INAF, and at the Lowell Discovery Telescope at Lowell Observatory. Lowell is a private, non-profit institution dedicated to astrophysical research and public appreciation of astronomy and operates the LDT in partnership with Boston University, the University of Maryland, the University of Toledo, Nothern Arizona University and Yale University. This work is based on data provided by the Minor Planet Physical Properties Catalogue (MP3C) of the Observatoire de la Côte d'Azur. This research has made use of the Small Bodies Data Ferret (http://sbn.psi.edu/ferret/), supported by the NASAPlanetary System. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grants agreement No 101004719 and No 730890.

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