EPSC Abstracts
Vol. 14, EPSC2020-549, 2020
https://doi.org/10.5194/epsc2020-549
Europlanet Science Congress 2020

Spectral properties of 2020 AV2, the first known asteroid orbiting inside Venus orbit

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Recent numerical simulations (Greenstreet et al. 2012, Granvik et al. 2018) predicted the existence of a population of small bodies that is orbiting entirely inside Venus orbit. They could represent about 0.22 % of the steady-state near-Earth asteroids (NEAs). These asteroids are called Vatiras (by analog with the Atira-class NEAs) or Interior to Venus Orbit Objects. However, only at the beginning of this year (January 4, 2020) the first one was discovered by Zwicky Transient Facility (Bolin et al. 2020). It is called 2020 AV_2 and has the aphelion at 0.654 AU, and the perihelion at 0.457 AU.

The dynamical history of this object has been explored using *N*-body simulations (de la Fuente Marcos & de la Fuente Marcos 2020). It has been shown that 2020 AV_2 was a former Atira-class, and perhaps a former Aten-class asteroid, which reached the Vatira orbit relatively recently in astronomical terms, ☐10^5 yr (within 9σ confidence level). Similar results have also been reported by Greenstreet (2020).

The orbit of 2020 AV_2 makes it a peculiar case compared with those of the near-Earth asteroids. It is subjected to high temperature, strong solar wind irradiation, and close approaches to Mercury and (more distant) Venus. In this context, we carried out an observing run aimed at obtaining spectroscopic and photometric data for 2020 AV2. We used the 2.56 m Nordic Optical Telescope (NOT) and 4.2m William Herschel Telescope (WHT), both located at El Roque de los Muchachos Observatory in La Palma, Canary Islands (Spain). The observations were performed on the evenings of January 11, 13, and 14, 2020. They were challenging due to the low maximum elongation of this target (about 37 deg during our observations).

We obtained two visible spectra with the ACAM/WHT and with the ALFOSC/NOT instruments. The near-infrared part of the spectrum was obtained with the LIRIS/WHT instrument using the *lr-zj* prism. It covers the 0.9-1.5 μm wavelength range. The merged spectrum is shown in Fig. 1.

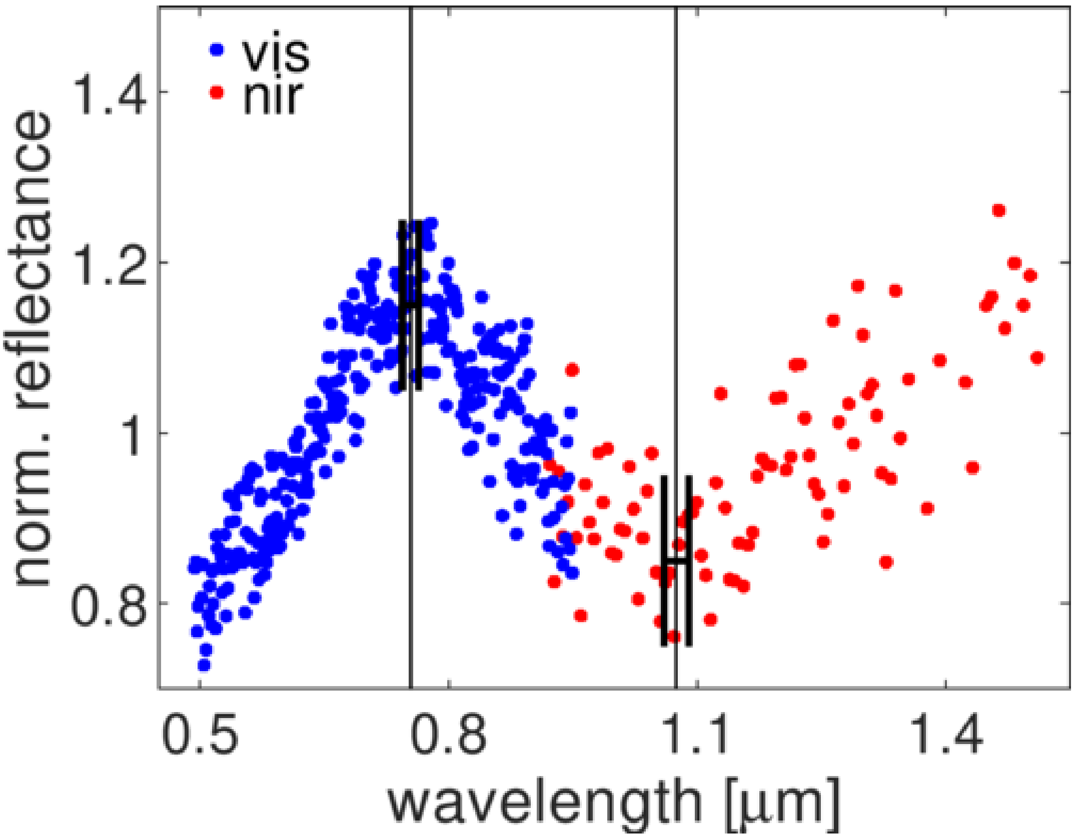

Fig.1 The combined visible - near infrared spectrum of 2020 AV2 (Popescu et al. 2020). The spectral curve is normalized to unity at 1.25 μm. The reflectance maximum at 0.745 μm and the band minimum at 1.075 μm are outlined by the two markers.

The merged spectrum, covering a wavelength interval between 0.5 and 1.5 μm, allowed us to classify 2020 AV2 as an Sa-type asteroid. The value estimated for the 1 μm band center, BIC = 1.08 ± 0.020 μm, points towards a composition similar to that of the S(I) subtype of asteroids with olivine-pyroxene mixtures, defined by Gaffey et al. (1993). This value of BIC is indicative of a ferroan olivine mineralogy similar to that of brachinite meteorites.

Last but no least, we derived the effective diameter of this Vatira to be $1.50^{+1.10}_{-0.65}$ km by considering the average albedo of A-type and S-complex asteroids ($p_V = 0.23_{-0.08}^{+0.11}$), and the absolute magnitude (H=16.40 ± 0.78 mag).

References: [1] Bolin et al. 2020, MPEC 2020-A99; [2] de la Fuente Marcos & de la Fuente Marcos, 2020, MNRAS, 494, L6; [3] Granvik et al. 2018, Icarus, 312, 181; [4] Greenstreet et al. 2012, Icarus, 217, 355; [5] Greenstreet 2020, MNRAS, 493, L129; [6] Popescu et al. 2020, MNRAS, paper accepted, https://doi.org/10.1093/mnras/staa1728

Acknowledgements: This work was developed in the framework of EURONEAR collaboration and of ESA P3NEOI projects. The work of M.P. was supported by a grant of the Romanian National Authority for Scientific Research - UEFISCDI, project number PN-III-P1-1.2-PCCDI-2017-0371. M.P., J.dL. and J.L. acknowledge support from the AYA2015-67772-R (MINECO, Spain), and from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870403 (project NEOROCKS).This work was partially supported by the Spanish MINECO under grant ESP2017-87813-R. Based on observations made with the William Herschel Telescope (operated by the Isaac Newton Group of Telescopes) and the Nordic Optical Telescope. The paper make use of data published by the following web-sites Minor Planet Center, JPL Small-Body Database Browser , SMASS - Planetary Spectroscopy at MIT.