

**PSYCHE: STATE OF KNOWLEDGE FROM GROUND-BASED OBSERVATIONS.**

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**Introduction:** Main belt asteroid (16) Psyche is interesting because is thought to be the remnant metallic core of a planetesimal. Ground-based radar and near infrared observations have suggested the presence of significant metal with small amount of silicates in the regolith. These observations have also suggested that the metal to silicate ratio varies with rotation. While Psyche has been the subject of periodic ground-based campaigns, no multi-wavelength comprehensive study has been attempted so far to geologically characterize the object. In this abstract we summarize the results of a multi-year characterization study involving near-mid IR and radar observations of Psyche.

**Observations:** NIR spectra (0.7-2.5  $\mu\text{m}$ ) of asteroid (16) Psyche obtained with the SpeX instrument [1] on NASA Infrared Telescope Facility on Mauna Kea, Hawai'i [2]. Simultaneously we obtained 3  $\mu\text{m}$  data using the long-wavelength cross-dispersed (LXD: 1.9–4.2  $\mu\text{m}$ ) mode of the SpeX [3]. The IRTF observations were carried out over two nights in December 2015. We also observed Psyche with Arecibo radar in the S-band over a 11-day period in 2015 [4].

**Near-IR Results:** We combined the spectral data with the radar shape model to link them to specific longitudes on the asteroid. The spectra show a weak absorption band centered between 0.92-0.94  $\mu\text{m}$  due to the presence of the mineral pyroxene. We estimated the pyroxene chemistry using these band centers to be  $\text{Fe}_{30}\text{En}_{65}\text{Wo}_5$ . The depth of this weak pyroxene band also varies (1.0 to 1.5%) with rotation along with the spectral slope. We created a new lab spectral calibration and estimated an average orthopyroxene content of the regolith to be  $6\pm 1\%$ . The NIR observations also showed a possible anti-correlation between band depth and radar albedo. The region with highest radar albedo also shows highest spectral slope and the lowest band depth suggesting an area of high metal content.

**3- $\mu\text{m}$  Results:** We detected a 3- $\mu\text{m}$  feature that suggests Psyche's regolith contains water or hydroxyl. This absorption feature is similar to the hydration features found on the surfaces of water-rich asteroids, attributed to OH- and/or  $\text{H}_2\text{O}$ -bearing phases (phyllosilicates). The detection of a 3- $\mu\text{m}$  hydration absorption band on Psyche suggests that the object might be impacted by carbonaceous material over the past 4.5 Gyr. The Dawn mission has detected similar exogenic impactor material on large main belt asteroids such as Vesta.

**Radar Results:** Based on our radar data our Psyche shape model has dimensions  $279 \times 232 \times 189$  km ( $\pm 10\%$ ),  $D_{\text{eff}} = 226 \pm 23$  km, and is 6% larger than, but within the uncertainties of, the most recently published size and shape model generated from the inversion of lightcurves [5]. Although Psyche is roughly ellipsoidal, it has a mass-deficit over a region around 90 ° of longitude. We also found evidence for two  $\sim 50$ –70 km wide depressions near its south pole. Using our new radar size and published masses, we estimate an overall bulk density of  $4500 \pm 1400$   $\text{kgm}^{-3}$ . Psyche's mean radar albedo of  $0.37 \pm 0.09$  is consistent with a regolith composed primarily of iron-nickel metal and a porosity of  $\sim 40\%$ . As seen in the NIR data, the radar reflectivity varies by a factor of 1.6 as the asteroid rotates, confirming the rotational variations in metal abundance. We also found evidence for visible albedo variations on the surface, which supports the exogenic impactor hypothesis.

**References:** [1] Rayner et al. (2003) PASP, 115, 362. [2] Sanchez et al. (2017) ApJ 153:29. [3] Takir et al. (2017) ApJ 153:1. [4] Shepard et al. (2017) Icarus 281, 388. [5] Hanus et al. (2013) Icarus 226:1045.

**Acknowledgement:** We wish to thank NASA IRTF staff for their assistance with the asteroid observations. NASA IRTF is operated by the University of Hawai'i under contract NNH14CK55B with NASA. Work by V.R. and J.A.S. was funded NASA Planetary Geology and Geophysics grants NNX14AN05G and NNX14AN35G. D.T.'s contribution to this work was funded by Eugene M. Shoemaker Postdoctoral Fellowship (NASA Planetary Geology and Geophysics Program). J.P. E.'s contribution to this work was funded by NASA Solar System Observing grant NNX16AE91G. The Arecibo Observatory is operated by SRI International under a cooperative agreement with the National Science Foundation (AST-1100968), and in alliance with Ana G. Méndez- Universidad Metropolitana, and the Universities Space Research Association. The Arecibo Planetary Radar Program is supported by the National Aeronautics and Space Administration under Grant No. NNX12AF24G issued through the Near Earth Object Observations program.