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IMPLICATIONS OF THE GRAVITY AND GEOPHYSICAL ENVIRONMENT OF (101955) BENNU FOR NEA EXPLORATION

Abstract

The OSIRIS-REx spacecraft's initial encounter with asteroid (101955) Bennu yielded its total mass, shape and spin state. The implications of these results for the exploration of near-Earth asteroids will be reviewed. The conference paper and presentation will combine and compare the models developed by multiple teams on the OSIRIS-REx mission, most specifically from the Radio Science Working Group (WG), the Flight Dynamics team, the Altimetry WG and the Regolith Development WG. The specific values for mass, density and other important parameters will be discussed at the IAC and will be based on published values (currently still in review). Many of these key parameters were estimated on arrival at Bennu, during the Preliminary Survey phase. The Bennu Preliminary Survey occurred between December 4 and 16, 2018, during which the OSIRIS-REx spacecraft performed five slow, hyperbolic flybys of the asteroid with closest approach distances of ~ 7 km and speeds of ~ 4 cm/s. The spacecraft was tracked during and around these flybys using the DSN, acquiring Doppler shift data that could detect the small deflection of the spacecraft velocity due to the asteroid's gravity, on the order of 3.5 cm/s. Based on these measurements the gravitational parameter of the asteroid was determined and when combined with the volume determined from the shape yields a bulk density consistent with that of asteroid (162173) Ryugu reported by the Hayabusa2 mission [1]. Comparisons with the analog meteorite types yields a porosity of up to 50% [2], establishing Bennu as a rubble pile asteroid. Our density estimateisalso consistent with the previous Bennudensity estimate (1260 ± 70 kg/m^3), which was based on the Yarkovsky effect rather than gravitational perturbations, thereby validating this novel approach to density estimation based on remote observations [3]. When the asteroid mass is combined with the Bennu shape and rotation rate the geophysical environment of Bennu can be evaluated under a constant density hypothesis. Doing so yields a range of important parameters that provide insight into the dynamical environment of this asteroid. This

is of importance for understanding and constraining its history and its current state, and places strong constraints on the development of future exploration missions. The paper will present and summarize these implications in detail.

References: [1] Yoshikawa et al. 2018. DPS Meeting. Abstract 501.01. [2] Walsh et al. 2019. 50th LPSC Meeting. [3] Chesley et al. 2014. Icarus 235: 5-22.