THE RECONNAISSANCE OF APOPHIS (RA) PICOSATELLITE MISSION CONCEPT. J.L. Noviello¹, X.Y. Ying², P.F. Wren³, B.L. Stinnett¹, Akshay R.T.², S. Karjigi², M.G. Ridge², P. Koganti², J.C. Castillo¹. ¹School of Earth and Space Exploration, Arizona State Univ. (PO Box 876004, Tempe, AZ 85287-6004, jnoviel@asu.edu), ²Ira A. Fulton School of Engineering, Arizona State Univ. (PO Box 879309, Tempe, AZ 85287-9309, skarjigi@asu.edu) ³Department of Space Studies, Univ. of North Dakota (Clifford Hall Room 512, 4149 University Ave Stop 9008, Grand Forks, ND, 58202, pwren@mars.asu.edu), ⁴The Jet Propulsion Laboratory, California Institute of Technology (4800 Oak Grove Drive, Pasadena, CA 91109, julie.c.castillo@jpl.nasa.gov).

Introduction: Obtaining a better understanding of primitive bodies such as asteroids is a primary goal in advancing the field of planetary science. Previous and upcoming missions [1, 2] focus on sample return objectives, but significant questions about asteroidal compositions, surface environments, and interior structure still remain. Some asteroids could pose a potential threat to Earth and are classified as potentially hazardous asteroids (PHAs). One such asteroid, 99942 Apophis, presents a unique opportunity to study a PHA up close due to its spectral characteristics, size, and proximity [3, 4]. Here we propose our preliminary mission concept of a picosatellite designed and built to explore the surface of Apophis and answer key questions for future asteroid lander missions: 1) What is the rate of dust accumulation on a foreign object on Apophis, a representative of the small bodies population? and 2) Is our system a feasible solution for mobility operations in a micro-gravity environment for a picosatellite without a propulsion system?

Science Objective: Dust collection on spacecraft poses a major hazard for future asteroid exploration missions. We want to study the dust (particles 2µm to 2 cm in diameter) accumulation rate in order to inform particulate damage mitigation strategies. This is also an opportunity to study the natural cohesion rates of particulates in a microgravity environment and potentially identify the mechanisms affecting their mobility [5]. To do this we plan to use a Raspberry Pi Cam [6] from SparkFun to directly photograph the dust accumulating on a non-refractive surface (NRS). We plan to photograph the NRS once every 20 minutes for 2.5 hours and then clean the surface using current carried through a transparent coating called the Electrodynamic Dust Shield (EDS). An algorithm will then count the number of dark to light pixels and send that data down, with some images also being sent to correlate the pixel data. This will yield longitudinal data about the effect of solar angle on dust accumulation rates.

Technology objective: This picosatellite is also designed to move 0.25m away from the landing site and is required to take scientific data from at least three locations. At this time the lack of imaging data of Apophis prevents us from identifying a landing location. Mobility increases the probability of mission success by enabling the picosatellite to move in case the original landing location and orientation are less than ideal. Our current mobility strategy is to use three reaction wheels and a flywheel. We have plotted the maximum velocities and angles at which we can move, taking into account the escape velocity of Apophis.

Structure and Subsystems: Our total mass limit is 500g and our total volume must not exceed 10cm x 10cm x 5cm; therefore, all structures and subsystems must be as light and as durable as possible. We are currently at a 15.6% mass margin, a 31.38% volume margin, and a 16.67% power budget margin. The material we will use for our frame is Aluminum 6063-T1 alloy. We will use two 10Wh batteries to power our picosatellite on the surface, sufficient even if 25% of the full battery power is lost during transit. We are planning to use the Tyvak Intrepid system board which combines the onboard computer, the EPS, the inertial measurement unit, and the radio transceiver, all in one package [7]. We are also working on thermal control strategies to keep the systems alive in the extreme cold, a larger concern than mitigating the sun’s heat.