PROTEUS – A MISSION TO INVESTIGATE THE ORIGIN OF EARTH'S WATER: CREATING HABITABLE WORLDS. K. J. Meech[1], M. F. A'Hearn[2], J. Castillo-Rogez[3] and the Proteus science team[2], [1]Institute for Astronomy, 2680 Woodlawn Drive, Honolulu, HI 96822; meech@ifa.hawaii.edu, [2]University of Maryland, College Park, MD 20742; ma@astro.umd.edu; [3]Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA; Julie.c.castillo@jpl.nasa.gov.

Introduction: Earth, with three fourths of its surface covered with liquid water, is unique in the Solar System. While water is the third most abundant molecule present in dense sites of star and planet formation, we still do not know how water and other volatiles necessary for life were delivered to our planet. Comets were long thought to have seeded Earth with water, but new models and new measurements, including results from the Rosetta mission to comet 67P/Churyumov Gerasimenko, have shown that if we want to know where our water came from, Jupiter family comets may not be the right place to look.

In the last decade, however, a significant reservoir of water has emerged in the outer region of the main asteroid belt. There, a growing number of small worlds have been observed to shed tenuous tails of dust as they near perihelion. These gas-driven active asteroids are called Main Belt comets (MBCs).

The Proteus Mission: To answer questions about the origin of water, isotopic measurements of MBC volatules will be correlated with predictions from two types of models: chemical models which describe the distance-dependent chemistry in the nebula and dynamical models which describe where small bodies were gravitationally scattered during the era of giant-planet migration. Our mission, called Proteus, addresses goals relating to the chemical and physical processes shaping the solar system and how these processes evolved over time.

The Mission Objectives. The Proteus target is MBC 238P/Read. Proteus addresses five science objectives: (1) to determine where Read's ices formed; (2) to distinguish whether the ices have a nitrogen isotope signature more like Earth or more like the outer solar system; (3) to determine at what temperature the ices formed; (4) to determine Read's physical properties using surface composition and geomorphology to compare to comets and asteroids, and (5) to determine whether Read's outgassing emanates from discrete sources or diffuse regions and measure the scattering properties of the outgassed dust.

Mission description. Proteus flies a 6.5-yr mission, launching in 2021 to rendezvous with main belt comet 238P/Read shortly before it reaches perihelion in late 2028 and remains there for five months during its period of maximum activity. Among all possible MBC targets, Read is of special interest because en route we have the opportunity to fly past its likely parent, asteroid 24 Themis, and study their relationship.

Proteus explores Read with a new sensitive, precise, high-TRL mass spectrometer—MASPEX—to characterize the gas environment, measuring isotopic abundances of hydrogen, oxygen and nitrogen as well as the abundances of noble gases. Proteus additionally flies two redundant Dawn-like cameras, which will be used to map the surface to characterize Read's shape, rotation, topography, color, geology and jets and combined with radio science to study its gravity field.

The mission will proceed in four specific phases lasting from three to six weeks in duration. The spacecraft will undertake a series of slow flybys covering a range of phase angles and getting progressively closer to the nucleus, achieving a resolution of 1.3 m per pixel at the mapping altitude of 15 km, and 0.3 m per pixel at 4 km altitude.

Proteus is a mission led by Karen Meech at University of Hawai'i and managed by the Jet Propulsion Laboratory, California Institute of Technology. The mass spectrometer is provided by the Southwest Research Institute and the cameras are supplied by the German Space Agency (DLR).