Probing Psyche: Mission Overview and Operations Concept

Carol Polanskey
Jet Propulsion Laboratory,
California Institute of Technology

L. T. Elkins-Tanton (ASU),
N. Amiri (JPL),
S. H. Bairstow (JPL),
T. D. Drain (JPL),
D. J. Lawrence (JPL),
W. Hart (JPL),
S. Marchi (SWRI),
D. Y. Oh (JPL),
R. Oran (MIT),
T. H. Prettyman (PSI),
C. T. Russell (UCLA),
D. A. Seal (JPL),
D. Wenkert (JPL),
D. Williams (ASU),
and the Psyche Team

June 14, 2018

Copyright 2018. All rights reserved. Government sponsorship acknowledged.
What do we know about (16) Psyche?

- Tenth largest asteroid in the Main Belt
- Largest M-type asteroid with diameter of 226 km
- High radar albedo of 0.37 consistent with iron-nickel
- High thermal inertia of \( \sim 120 \text{ J m}^{-2} \text{ S}^{-0.5} \text{ K}^{-1} \)
- High density – estimates between 4,500 kg/m\(^3\) to 6,980 kg/m\(^3\)

Psycbe is likely the stripped core of an early planetesimal
Science Objectives

Objective A: Determine whether Psyche is a core, or if it is unmelted material.

Objective B: Determine the relative ages of Psyche’s surface regions.

Objective C: Determine the global abundances, in portions of Psyche's surface that appear to be a metal phase, of light elements S, K, and Si.

Objective D: Determine whether Psyche was formed under more oxidizing or more reducing conditions than Earth's core.

Objective E: Characterize Psyche’s topography.
Psyche is a massive body with unknown gravity.

**Psyche**
- $R = 113$ km
- $M = 9 M_{\text{Psyche}}$

**Eros**
- $R = 16$ km
- $M = (0.00024) M_{\text{Psyche}}$

**Bennu**
- $R = \sim 0.25$ km
- $M = (0.000000003) M_{\text{Psyche}}$

**Vesta**
- $R = 265$ km
- $M = 9 M_{\text{Psyche}}$

**Dawn**

Predecisional information, for planning and discussion only.
Psyche’s Payload: Three simple science instruments

Gamma Ray and Neutron Spectrometer (APL)

Magnetometer Sensors
UCLA/MIT

Multispectral Imagers
ASU/MSSS

Spacecraft chassis built by SSL
Avionics, flight software, communications, and fault protection by JPL

Gravity Science (MIT/JPL)
Planned interplanetary trajectory

Launch – August 2022

Mars Gravity Assist – May 2023

Capture – January 2026

End of Operations – October 2027
Psyche mission planned science orbits

21 months of orbital science operations

**Orbit A:** 56 days (41 orbits @ 32.5 hrs, ~700 km alt)
- Magnetic field detection requirements complete

**Orbit B:** 76 days (162 orbits @ 11.2 hrs, ~290 km alt)
- Topography requirements complete
- Spectral Imaging requirements complete

**Orbit C:** 100 days (369 orbits @ 6.5 hrs, ~170 km alt)
- Gravity requirements complete

**Orbit D:** 100 days (585 orbits @ 4.1 hrs, ~85 km alt)
- Elemental composition requirements complete

Predecisional information, for planning and discussion only
Orbit A
Orbit B
Orbit C
Orbit D

Predecisional information, for planning and discussion only
Typical orbit scenario

Spacecraft attitude profile during a typical orbit

SUN

X

Z Ecliptic

Attitude Nadir (Observe)

Attitude HGA-to-Earth (Downlink)

S/C not to scale

Predecisional information, for planning and discussion only
Psyche: Journey to a Metal World

Unique target body

High heritage instrument suite

Heritage operations concept

=> To observe for the first time, a planetary core