Space and Planetary Science at ASU

Prof. Lindy T. Elkins-Tanton
Arizona State University

School of Earth and Space Exploration

Arizona State University

Photo credit: Christy Till

ASU NewSpace
Arizona State University

Our vision

NewSpace, ASU's Space Technology and Science Initiative leads the integration of academic and commercial space enterprises using ASU's core strengths in space science, engineering and education.

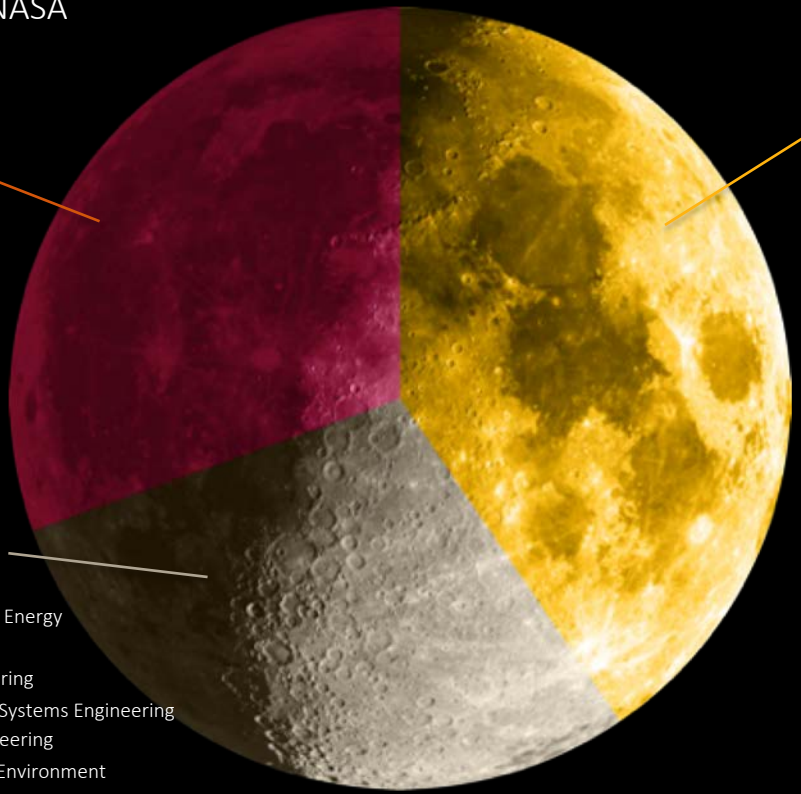
Talent | Innovation | Opportunity

http://newspace.asu.edu

We work with the 240+ Space Investigators at ASU

Investigators proposing to NASA

School of Earth and Space Exploration



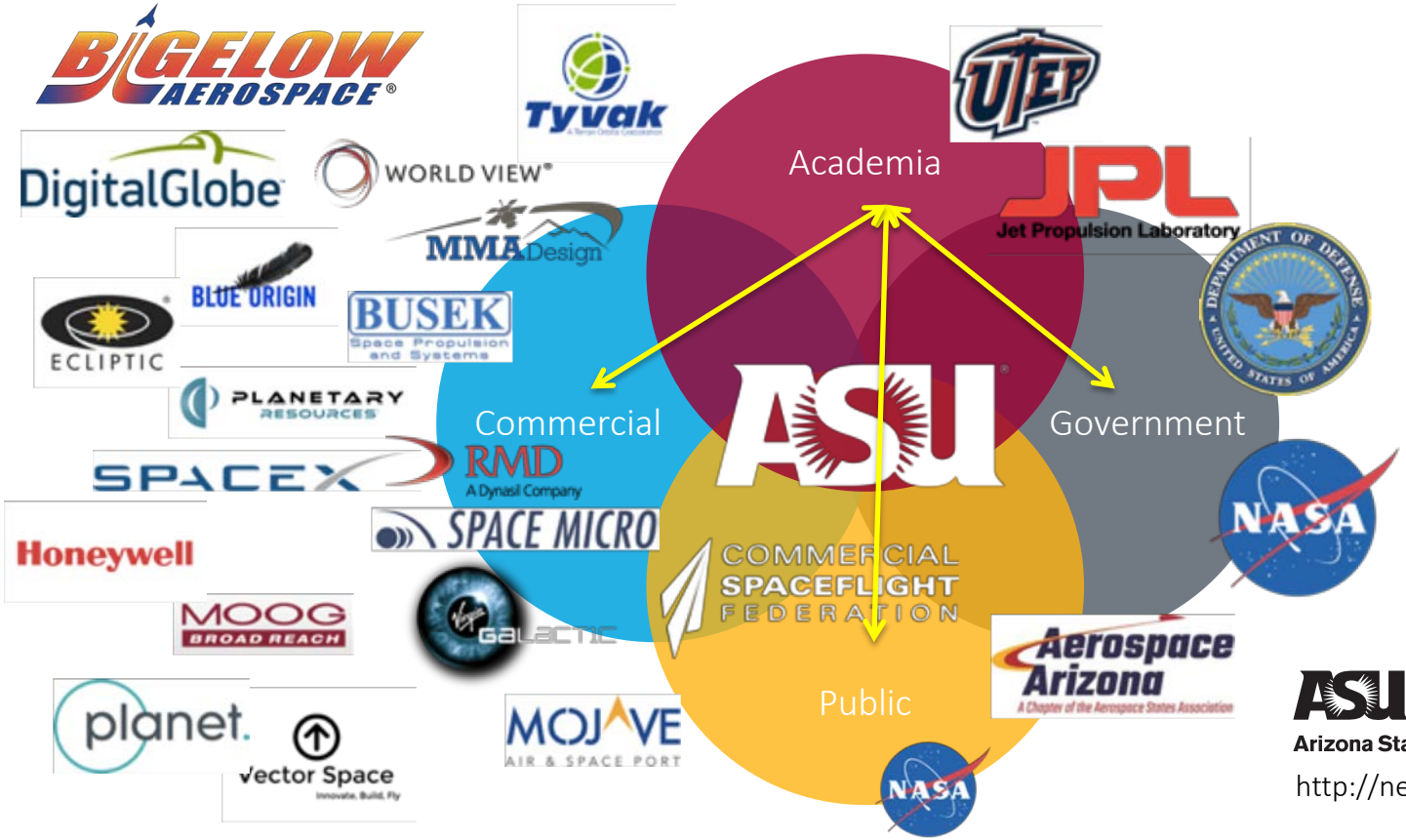
Ira A. Fulton Schools of Engineering

The Polytechnic School
School for Engineering of Matter, Transport and Energy
School of Arts, Media + Engineering
School of Biological and Health Systems Engineering
School of Computing, Informatics, and Decision Systems Engineering
School of Electrical, Computer and Energy Engineering
School of Sustainable Engineering and the Built Environment

Other

ASU Origins Project
Barrett, The Honors College
Beyond: Center for Fundamental Concepts in Science
Biodesign Institute
Center for Meteorite Studies
College of Letters and Sciences
Consortium for Science and Policy Outcomes
Department of Biomedical Informatics
Department of Management
Department of Physics
Department of Psychology
Disability Resource Center
Division of Educational Leadership and Innovation
Julie Ann Wrigley Global Institute of Sustainability
School of Geographical Sciences and Urban Planning
School of Human Evolution and Social Change
School of Life Sciences
School of Mathematical and Natural Sciences
School of Mathematical and Statistical Sciences
School of Molecular Sciences
School of Transborder Studies

Collaborative Partners in Commercial Space



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The NewSpace team

ASU NewSpace
Arizona State University

Jim Bell, Director

Professor, School of Earth and Space Exploration

Craig Hardgrove, Director of Projects

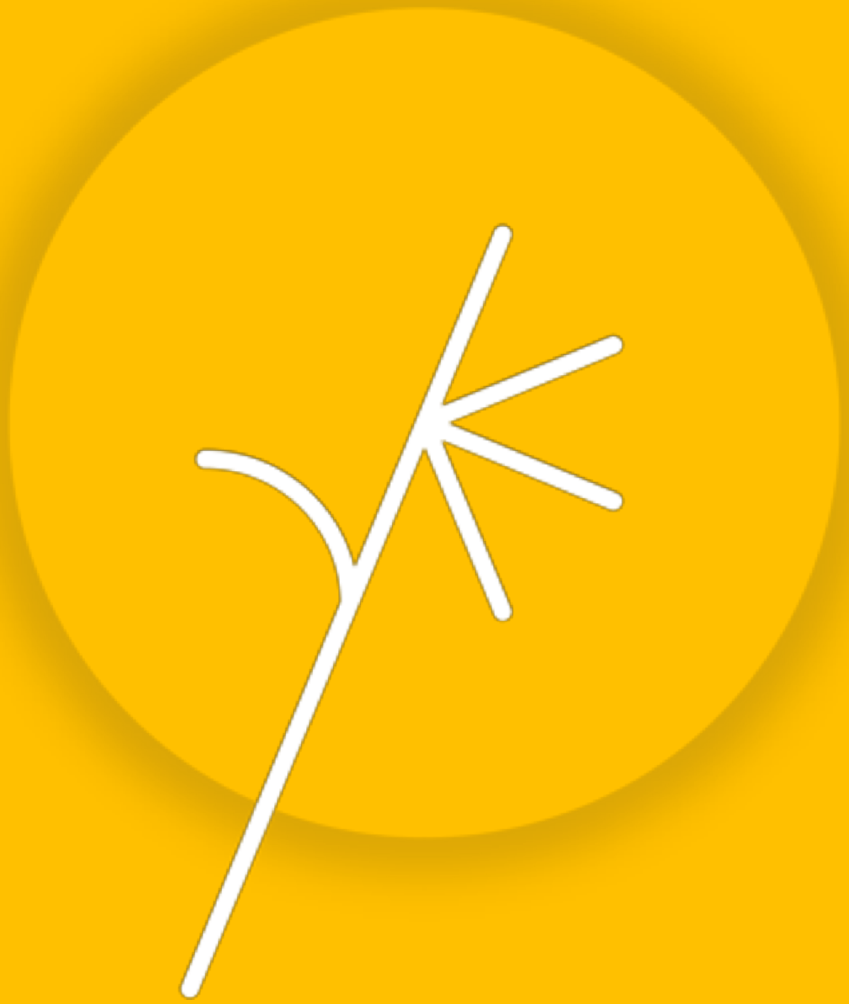
Assistant Professor, School of Earth and Space Exploration

Tanya Harrison, Director of Research

Postdoctoral Research Scholar

Scott Smas, Program Manager

Tiffanny Rauch, Administrative Assistant

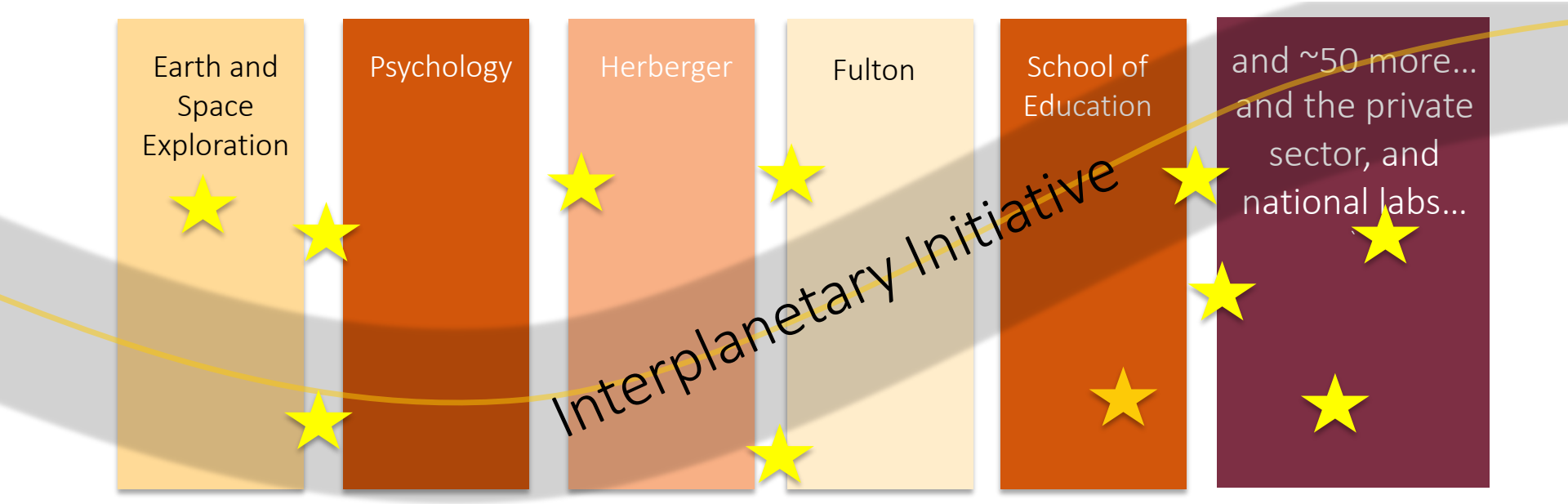


ASU Interplanetary Initiative

Arizona State University

Advancing society through exploration

A pan-university initiative



Big Question Pilots

- What legal, political, and social norms will govern human exploration?
- How will humans react to the discovery of extraterrestrial life?
- How do we galvanize public and private support for space exploration?
- What are the fundamental rules governing the self-sustainability and robustness of ecosystems for long-term space settlement?

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Tech Pilots

- Human and robotic mergers
- Instruments for planetary resource prospecting
- Rapid responsive space missions
- SIMOC: A Scalable Model of an Isolated, Off-world Community

Education Pilots

- Online satellite command and control certificate
- Interdisciplinary capstones in partnership with private sector
- SpaceWorks: continuous capstone based on mission challenges

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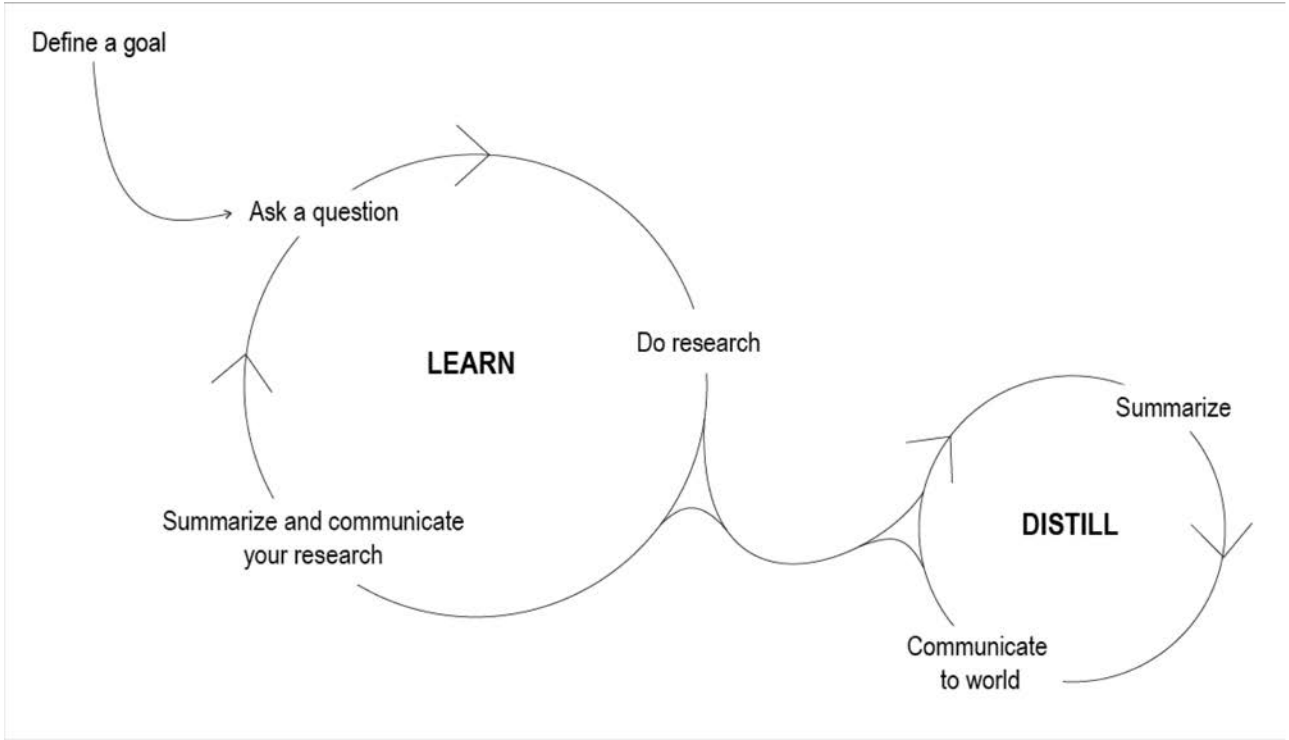
Common theme for all courses: Exploration Learning.

Exploration learning requires defining an area of curiosity, asking questions inspired by that curiosity, finding the resources needed to investigate those questions, and assessing one's conclusions and methodology.

We have a working group with the goal of bringing knowledge creation into the classroom – you are welcome to join!



Beagle's inquiry cycle, used in the classroom to model and teach iterative and collaborative problem-solving.

Through exploration learning, learners should:

- Recognize and be unafraid of unsolved problems,
- Be curious about what is known and how we know it,
- Be willing to work toward answers in steps over time,
- Develop independence and initiative in working toward solutions,
- Have patience with ambiguity,
- Have patience with dead ends (“failures”) and thus build resilience,
- Understand the difference between a problem *they* have not solved, and a problem *no one* has solved,
- Practice listening and respecting the contributions of teammates and
- Experience knowledge creation.

The vision

In the Technological Leadership major, students gain the leadership, analytical, and design skills they need to solve the world's big challenges. Content is no longer the differentiator in education. Most jobs require learning once in the position. With this major we aim to make the transition from school to workforce continuous, with life-improving skills for every arena.

By changing education, we can solve every other problem facing society today. This major will be interdisciplinary, completed in three years, and scalable. Students connect directly with employers through summer internships. We seek, through this major, to fulfill a part of ASU's responsibility for the economic, social, cultural, and overall health of our communities, by producing students who recognize unsolved problems and have the confidence, grit, and the 21st-century skills to solve them.

The major outline

B.S. in Technological Leadership

Three years with summer internships.

We envision two parallel courses that all students take in every semester:

An **Inquiry** class that pursues complex goals with many iterations of the inquiry cycle, as one would if pursuing a multi-step complex problem in life or work.

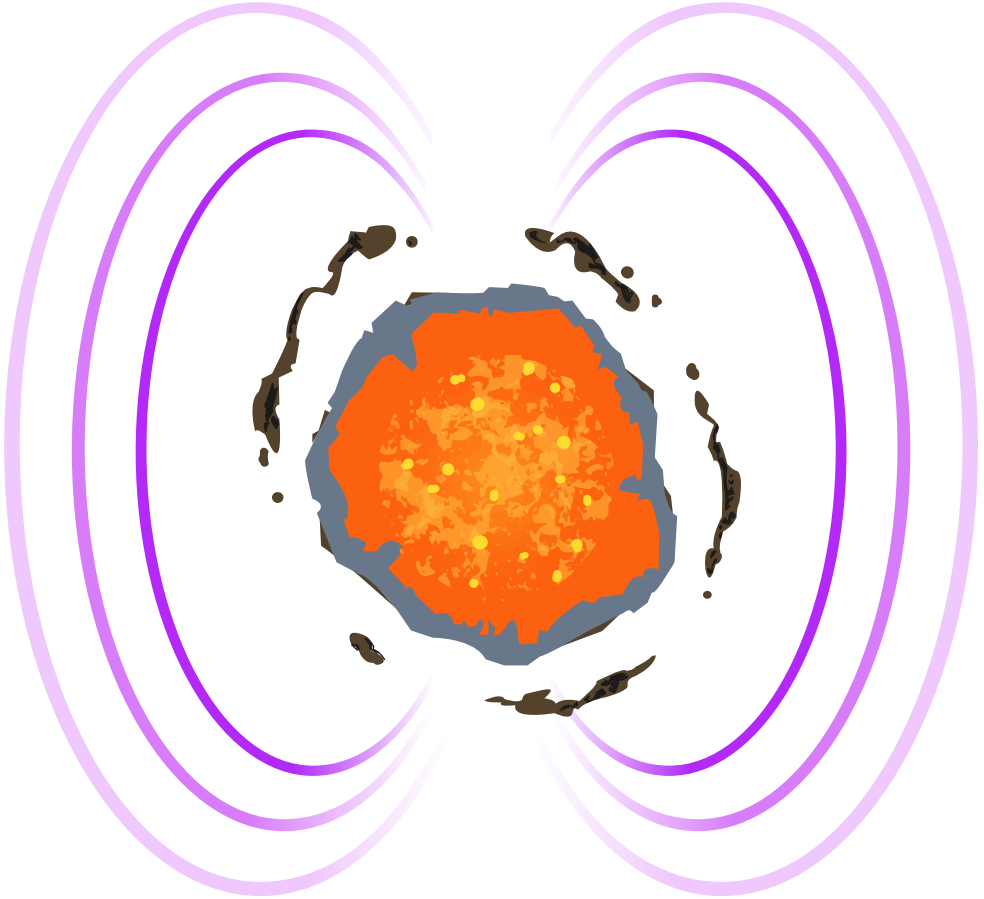
A **Making** seminar that has students working in teams to solve engineering problems, or problems of art, humanities, or civic engagement.

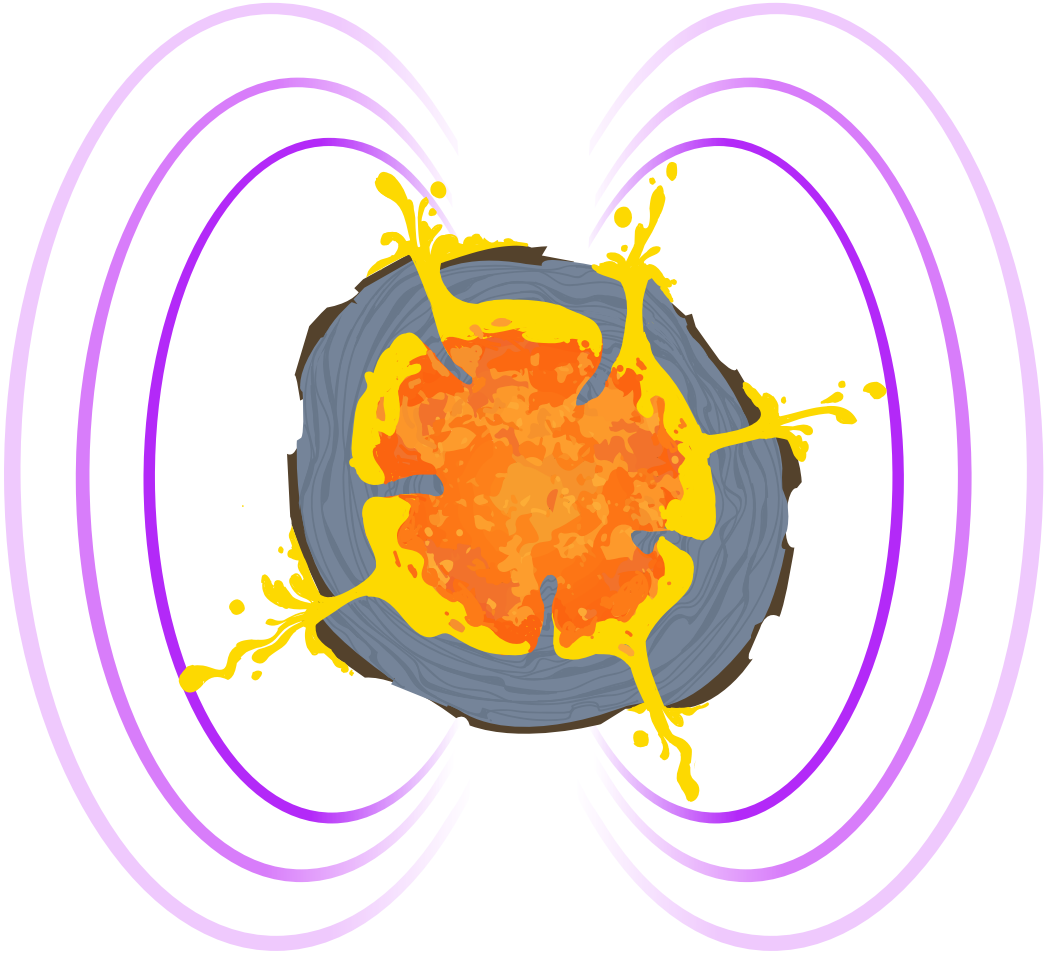
We are hoping to roll out in August 2019!


PSYCHE


福島
Koriyama
郡山
FUKUSHIMA
NIIGATA
Iwaki
いわき
TOCHIGI
IBARAKI
Nagano
長野
GUNMA
Kanazawa
金沢
TOYAMA
ISHIKAWA
NAGANO
SAITAMA
Tokyo
東京
FUKUI
GIFU
Matsue
松江
TOTTORI
KANAGAWA
CHIBA
Nagoya
名古屋
KYOTO
SHIGA
AICHI
SHIZUOKA
OKAYAMA
HYOGO
Kyoto
京都
Hamamatsu
浜松
HIROSHIMA
Himeji
姫路
Osaka
大阪
Kobe
神戸
Kurashiki
倉敷
NARA
MIE
KAGAWA
Matsuyama
松山
TOKUSHIMA
WAKAYAMA
EHIME
Kochi
高知
KOCHI


Arizona
Flagstaff
PSYCHE
Phoenix
Massachusetts
Tucson

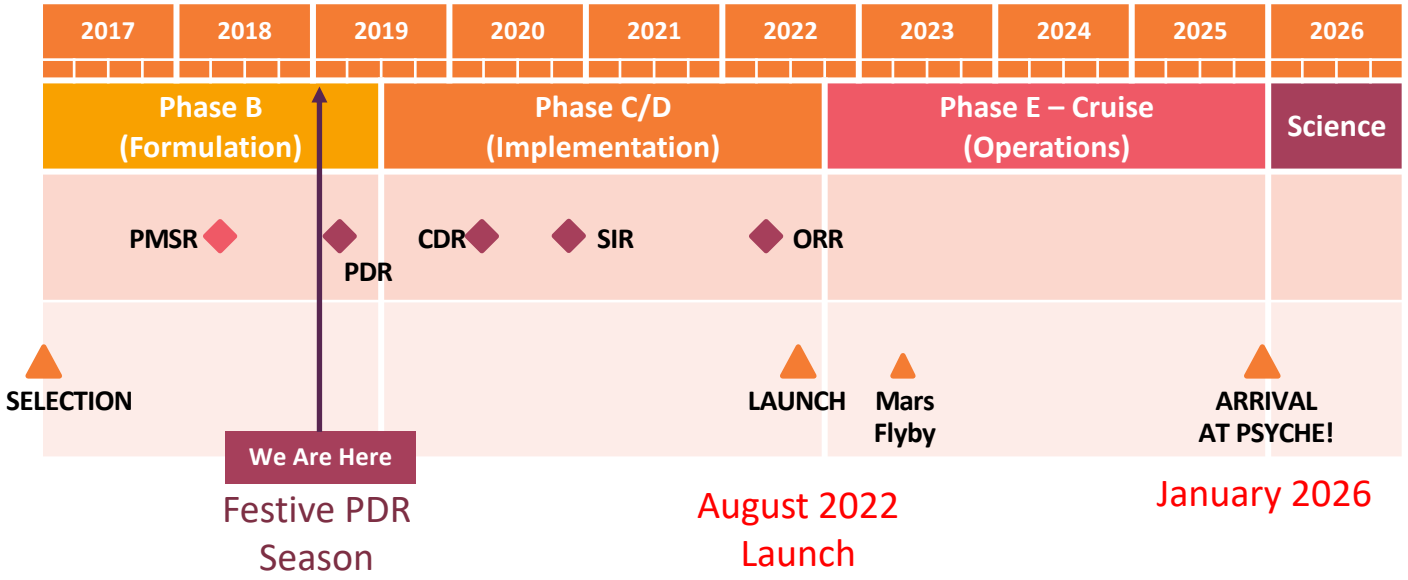





PSYCHE
JOURNEY TO A METAL WORLD


PSYCHE

Project timeline



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.

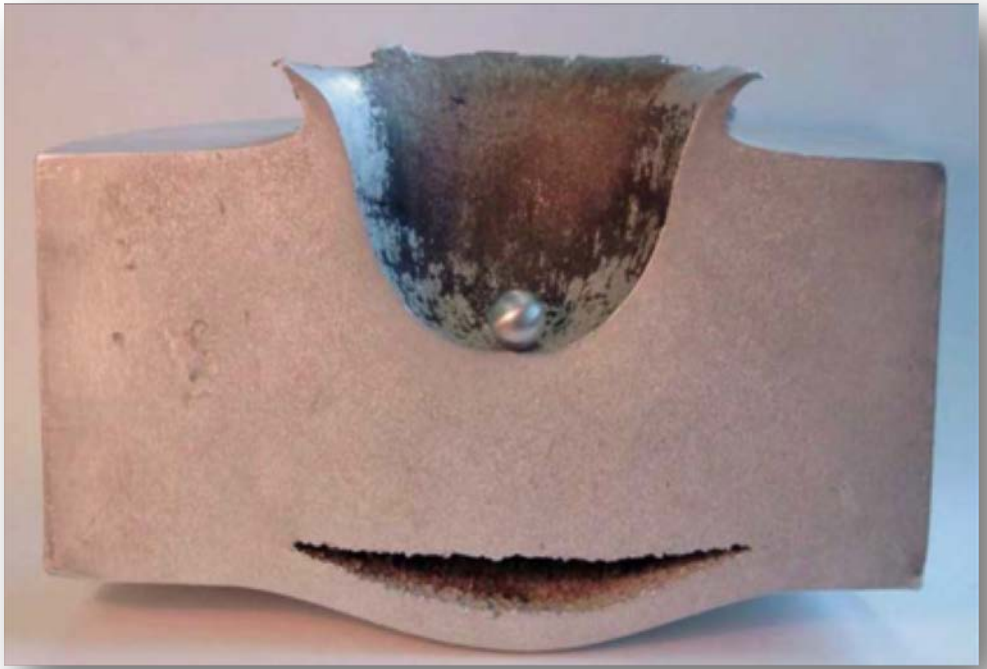
Objective D: Determine whether Psyche was formed under more oxidizing or more reducing conditions than Earth's core.

Objective E: Characterize Psyche's topography.

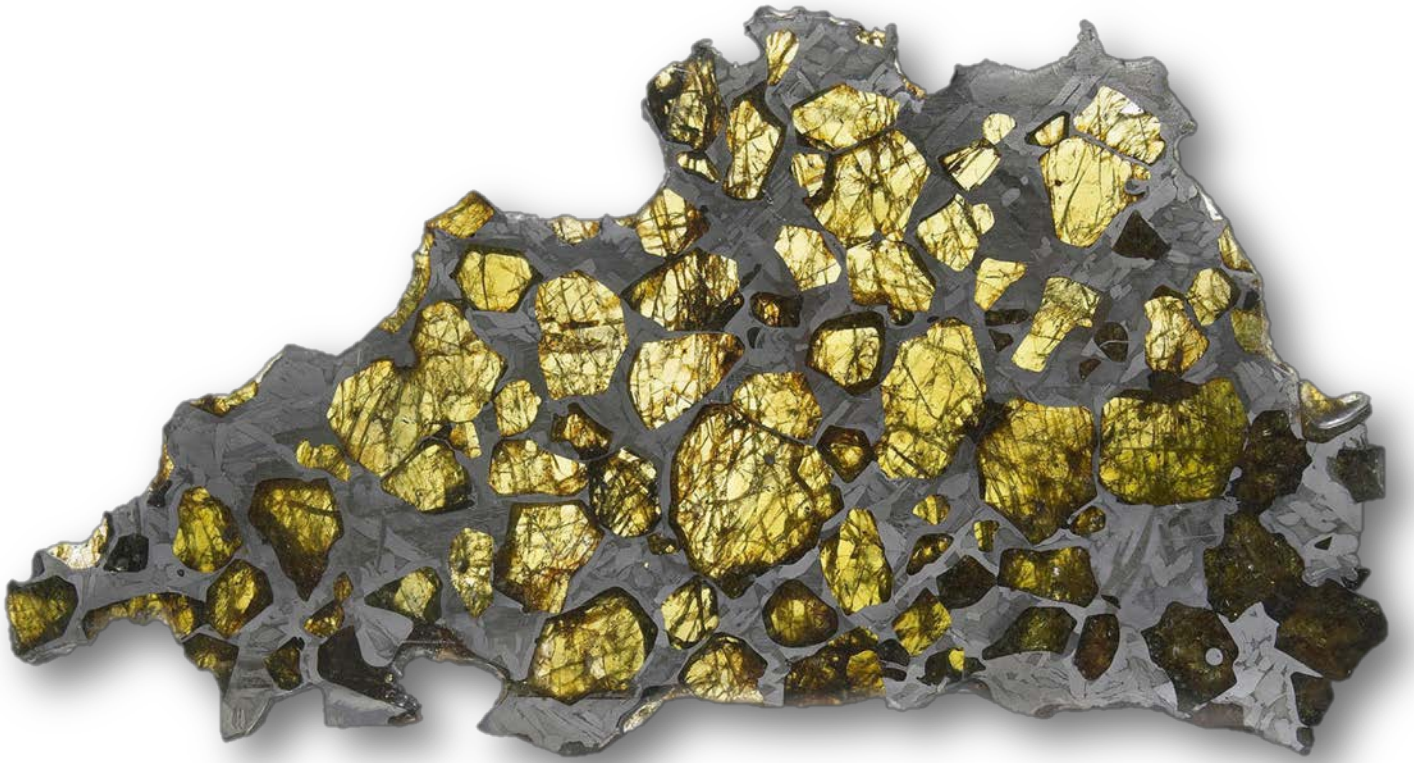
Objective E: Characterize Psyche's morphology

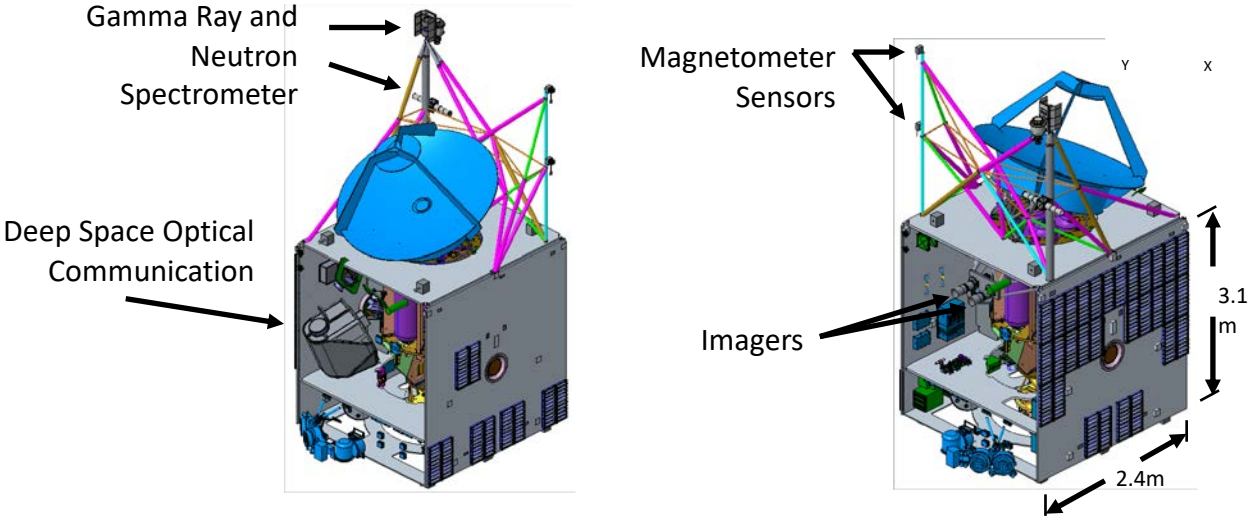
Image by Patrick Young and Karen Knierman

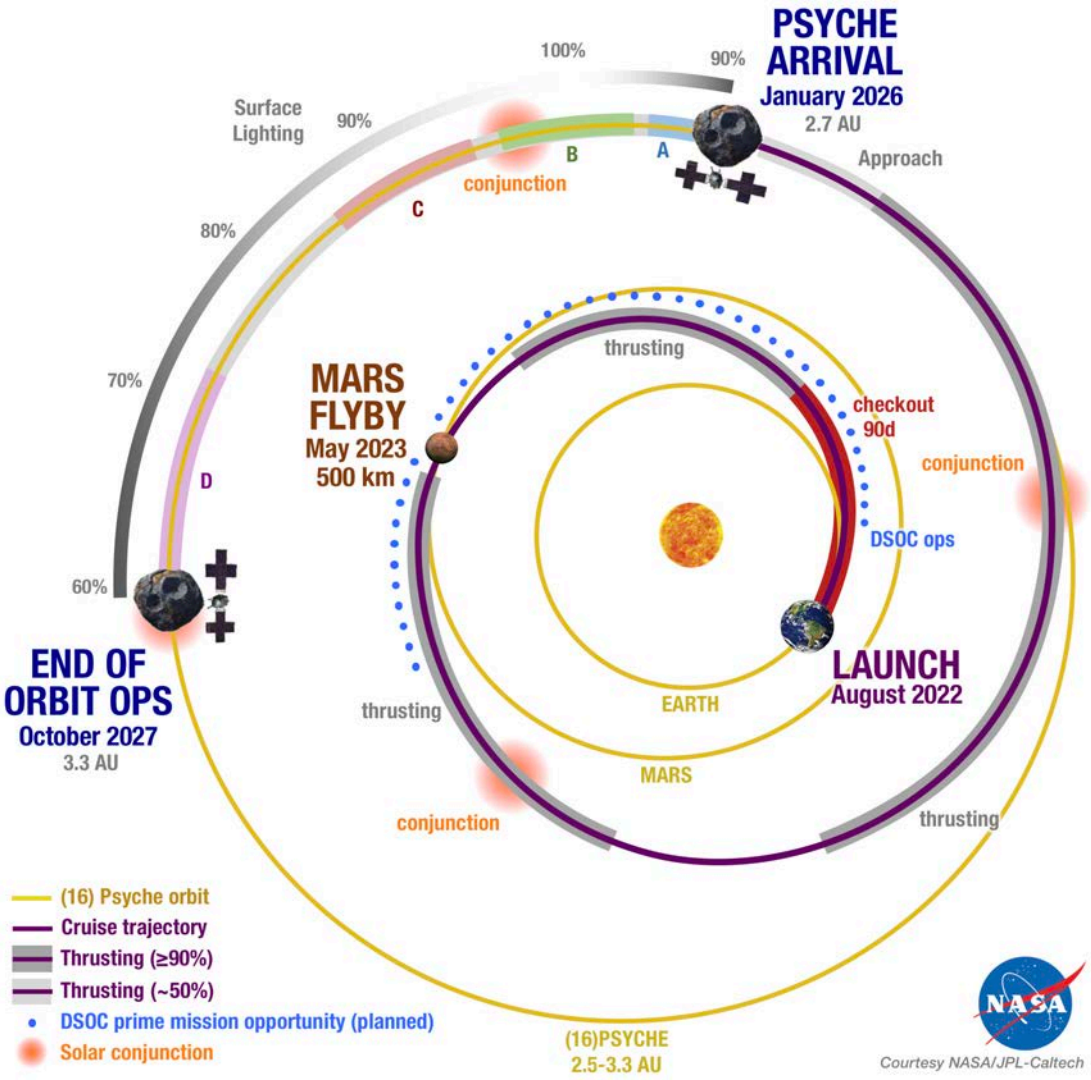
No one has seen a meteoroid crater in metal



Parts of the surface could be made of pallasite

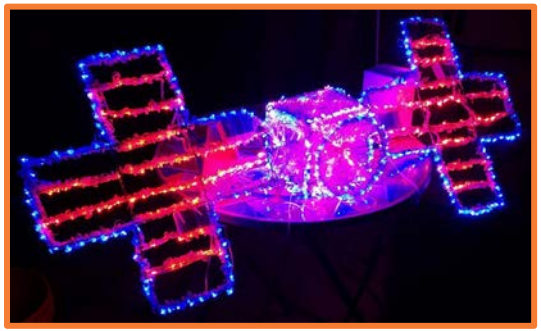



Gamma Ray and
Neutron
Spectrometer
Deep Space Optical
Communication
Magnetometer
Sensors
Imagers
Y
X
3.1
m
2.4m
24.76 m
7.34
m


PSYCHE ARRIVAL
January 2026
2.7 AU
100%
90%
Surface Lighting
90%
80%
70%
60%
Approach
A
B
C
D
conjunction
MARS FLYBY
May 2023
500 km
thrusting
checkout
90d
conjunction
DSOC ops
LAUNCH
August 2022
EARTH
MARS
thrusting
thrusting
conjunction
thrusting
END OF ORBIT OPS
October 2027
3.3 AU
(16) Psyche orbit
Cruise trajectory
Thrusting (≥90%)
Thrusting (~50%)
DSOC prime mission opportunity (planned)
Solar conjunction
(16)PSYCHE
2.5-3.3 AU
NASA
Courtesy NASA/JPL-Caltech

Psyche Student Collaborations Overview

- Attract and train future instrument and mission leads, both science and engineering
- Facilitate innovation by including people from fields outside science and engineering
- Cover a spectrum of intensity of experience vs. number of people involved
- Include ways for people at any level of education or nationality to participate



Psyche Student Collaborations Programs

- ***Capstone Projects:***
  Mission-focused capstone projects in existing university capstone courses nationwide
- ***Psyche Inspired:***
  Undergraduates nationwide share the excitement of Psyche through creative works
- ***Innovation Toolkit:***
  Free online courses on skills/knowledge critical to innovation in space exploration
- ***Science Outreach Interns:***
  Engage the public/K-12 locally; develop materials for wide use
- ***Evaluation:***
  Ongoing evaluation of all programs
- ***Publication:***
  Ongoing publication of procedures, findings, and recommendations

Psyche Student Collaborations: August 2017 – May 2019

Capstone Projects
- 260 undergraduate students on 42 teams
- 7 universities
- 14 majors
- 27 faculty
- Alumni program

Psyche Inspired
- 28 students
- 9 universities
- 20 majors
- More than 100 works
- Annual Showcase (physical and virtual)
- Coffee table book (physical and virtual)
- Alumni program

Innovation Toolkit
- Process and Lifetime of a Space Mission
- The Inclusive Mindset: Tools for Building Positive Team Culture

Science Outreach Interns
- Tours featuring Psyche given to more than 10,000 K-12 students
- Materials development for outreach (lesson plans, hands-on activities, web content)

Evaluation
- Program evaluation: *empowerment evaluation* (Fetterman, 2001)
- Course-based assessments

Publication and Dissemination
- *Internat'l J of Engineering Education* (Bowman & Elkins-Tanton, et al., accepted)
- *Capstone Design Conference*
- 5 ASU news articles (2 by undergraduates)
- 2 Psyche blog posts by undergraduates

Psyche: Journey to a Metal World

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