What We Know and Need to Know about NEOs

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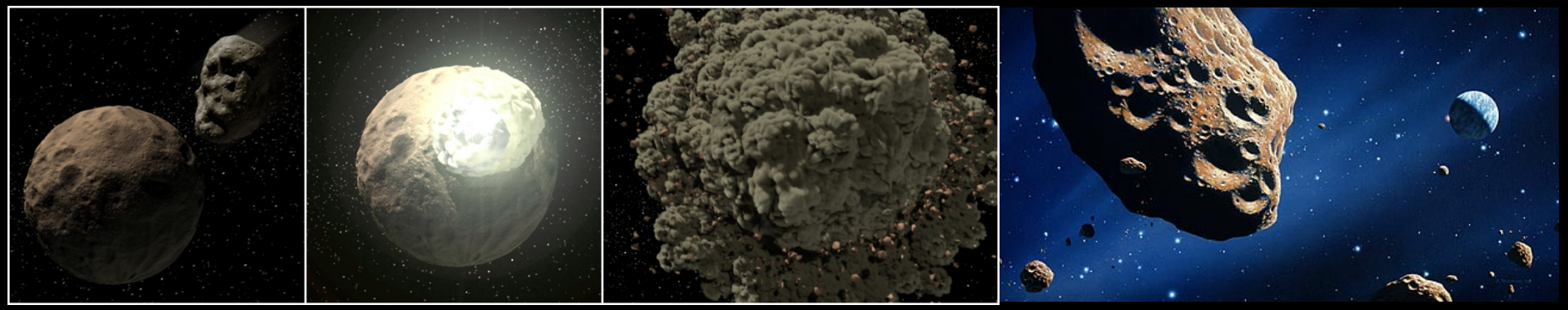
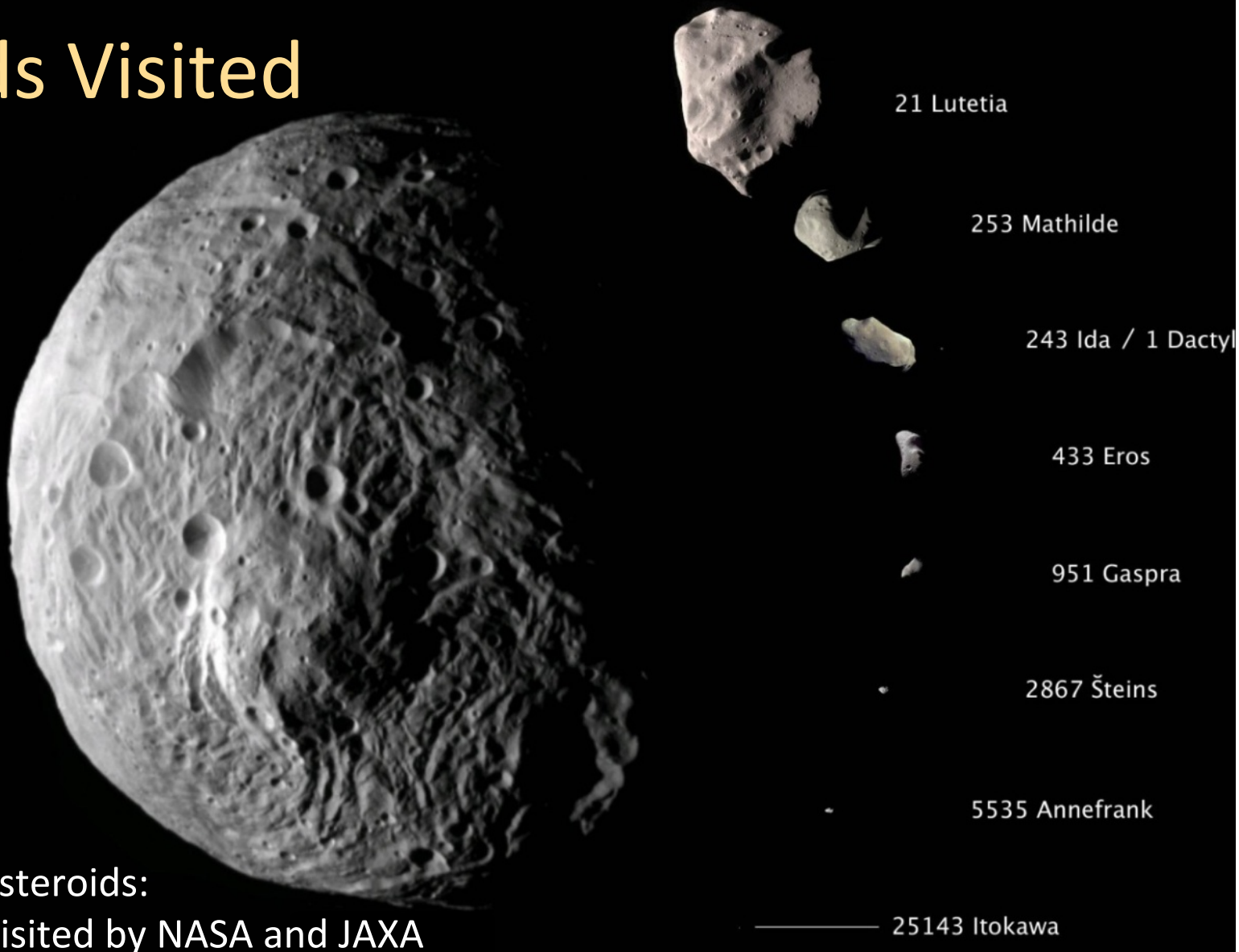
JPL

Why Study NEOs?



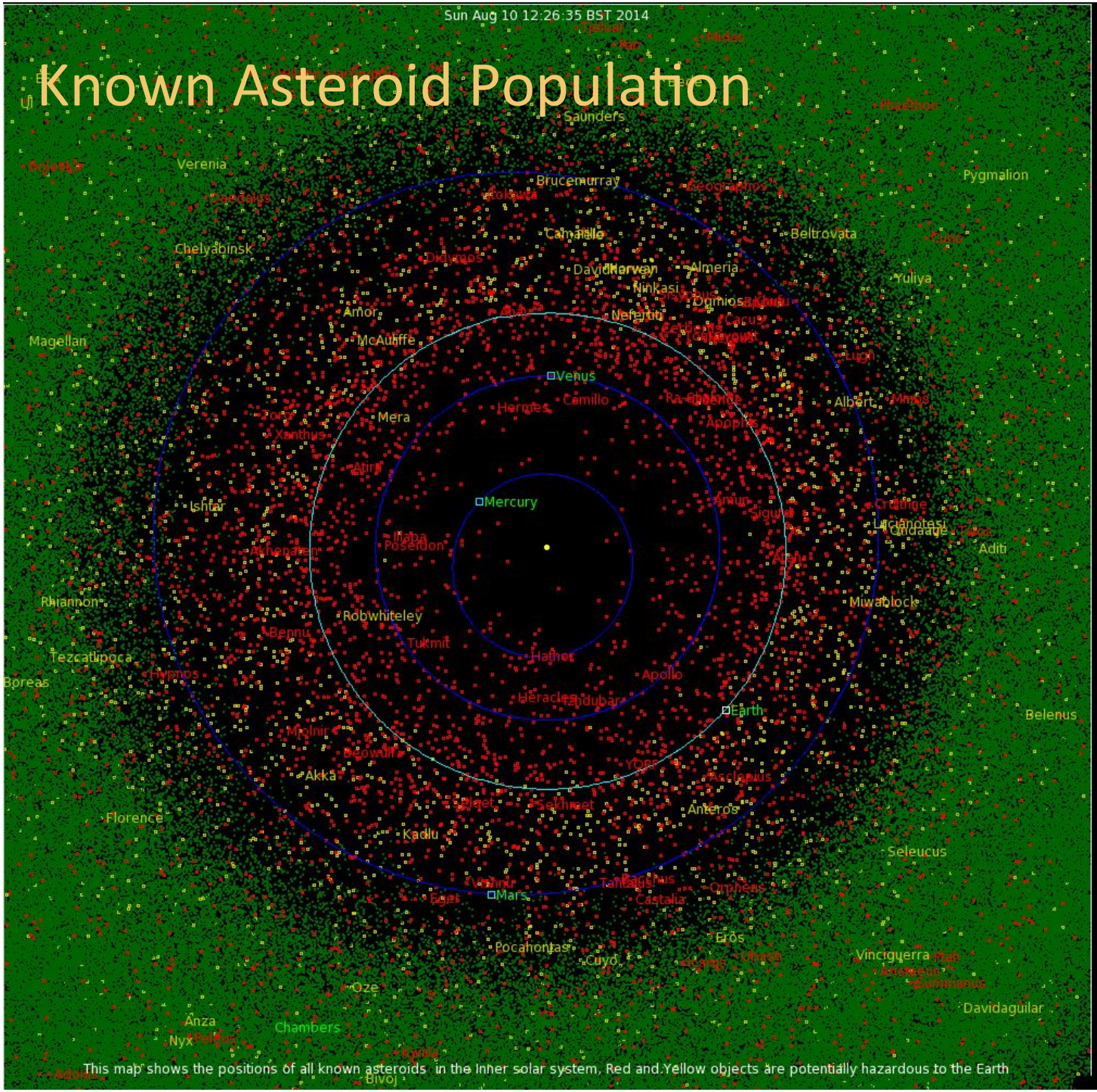
- NEOs are fragments of original planetary “building blocks”
- NEOs and their samples may tell us about:
  - The formation of NEO parent bodies (and what they tell us about the solar nebula, planetesimal formation, etc.).
  - The history of the parent bodies after formation (and what they tell us about planet formation processes, main belt evolution, etc.)
  - The formation and evolution of NEOs as collisional byproducts.
  - The history of NEOs en route to the inner solar system and Earth.

Asteroids Visited



For Near-Earth Asteroids:
Two have been visited by NASA and JAXA
Another (Braille) was flown by (DS1)
Rendezvous and sample return of Bennu by OSIRES-Rex mission (NASA – launch 2016)
Rendezvous and sample return of 1999 JU_3 by Hayabusa2 (JAXA – launch 2014)

Known Asteroid Population



Red objects are possible potentially hazardous objects

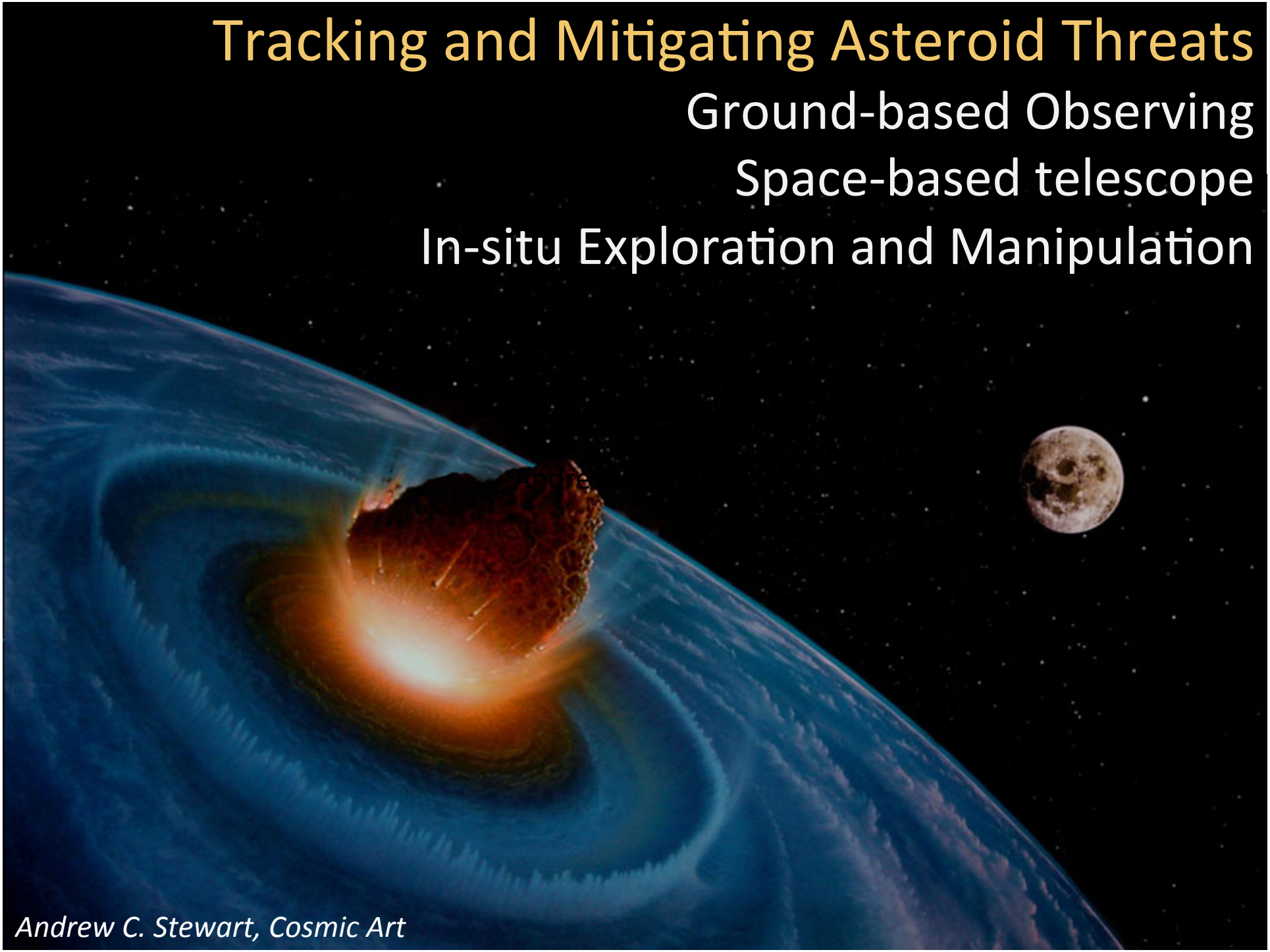
Yellow objects could possibly be perturbed onto Earth-crossing orbits

Tracking and Mitigating Asteroid Threats

Ground-based Observing

Space-based telescope

In-situ Exploration and Manipulation

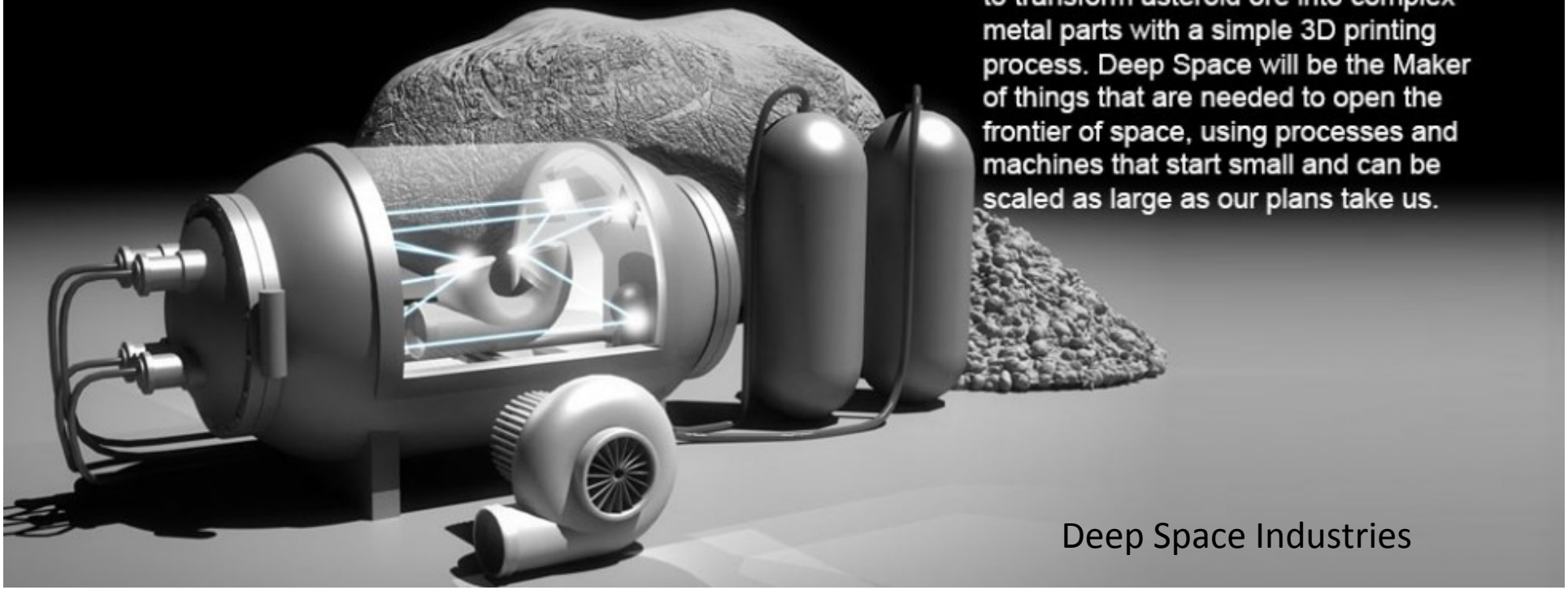


Andrew C. Stewart, Cosmic Art

Commercial Interest

Many Potential Players:

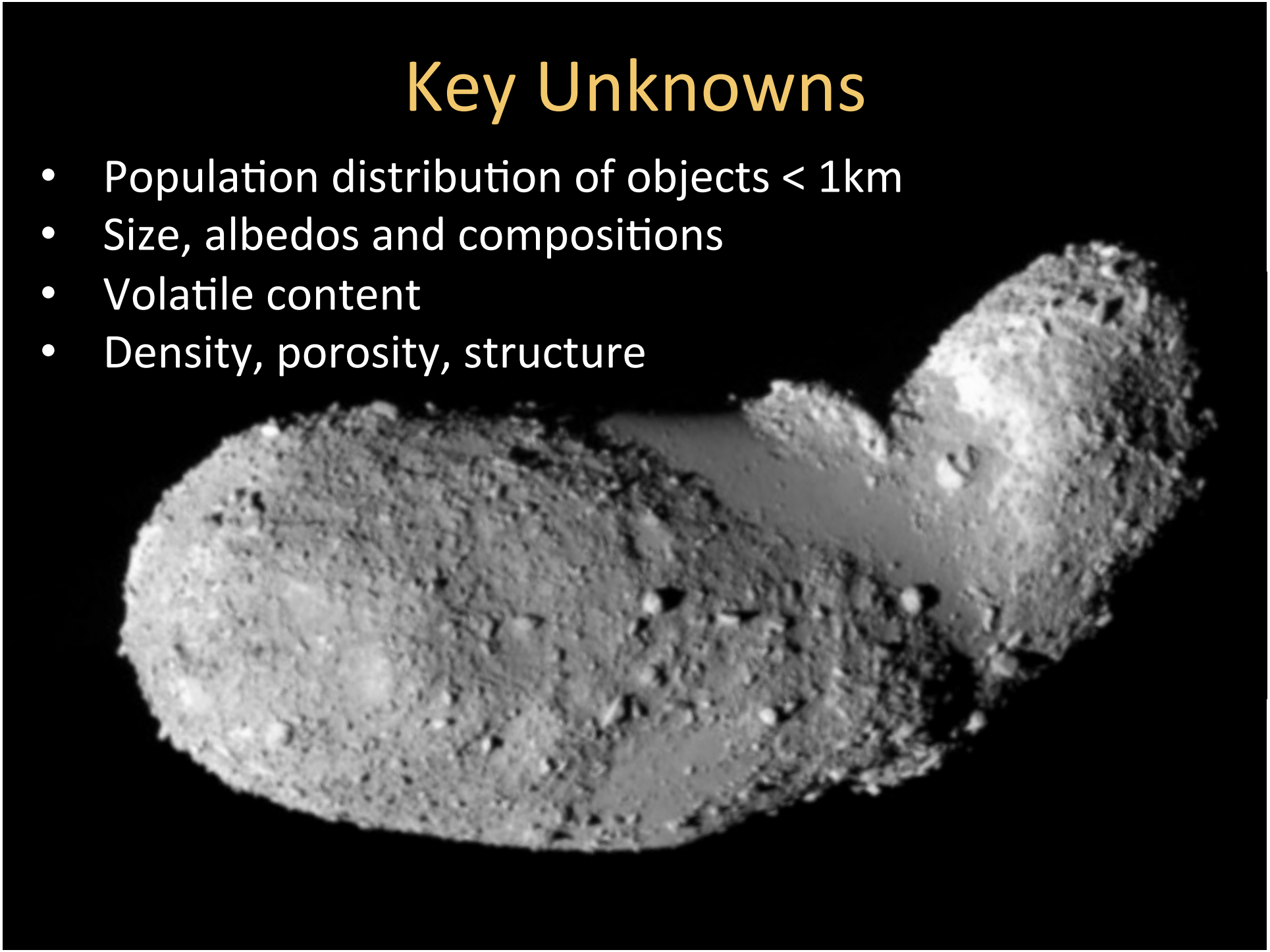
- Deep Space Industries
- Planetary Resources
- SpaceX
- B612
- Lockheed, Boeing, Orbital…..



Deep Space Industries

Key Unknowns

- Population distribution of objects < 1km
- Size, albedos and compositions
- Volatile content
- Density, porosity, structure



Emerging Capabilities

- Investments in nanosats and rapid trajectory design tools are paying off
- Microinstruments
- New detectors (CCD and IR)
- Synergies between human spaceflight, commercial interests and science

INSPIRE

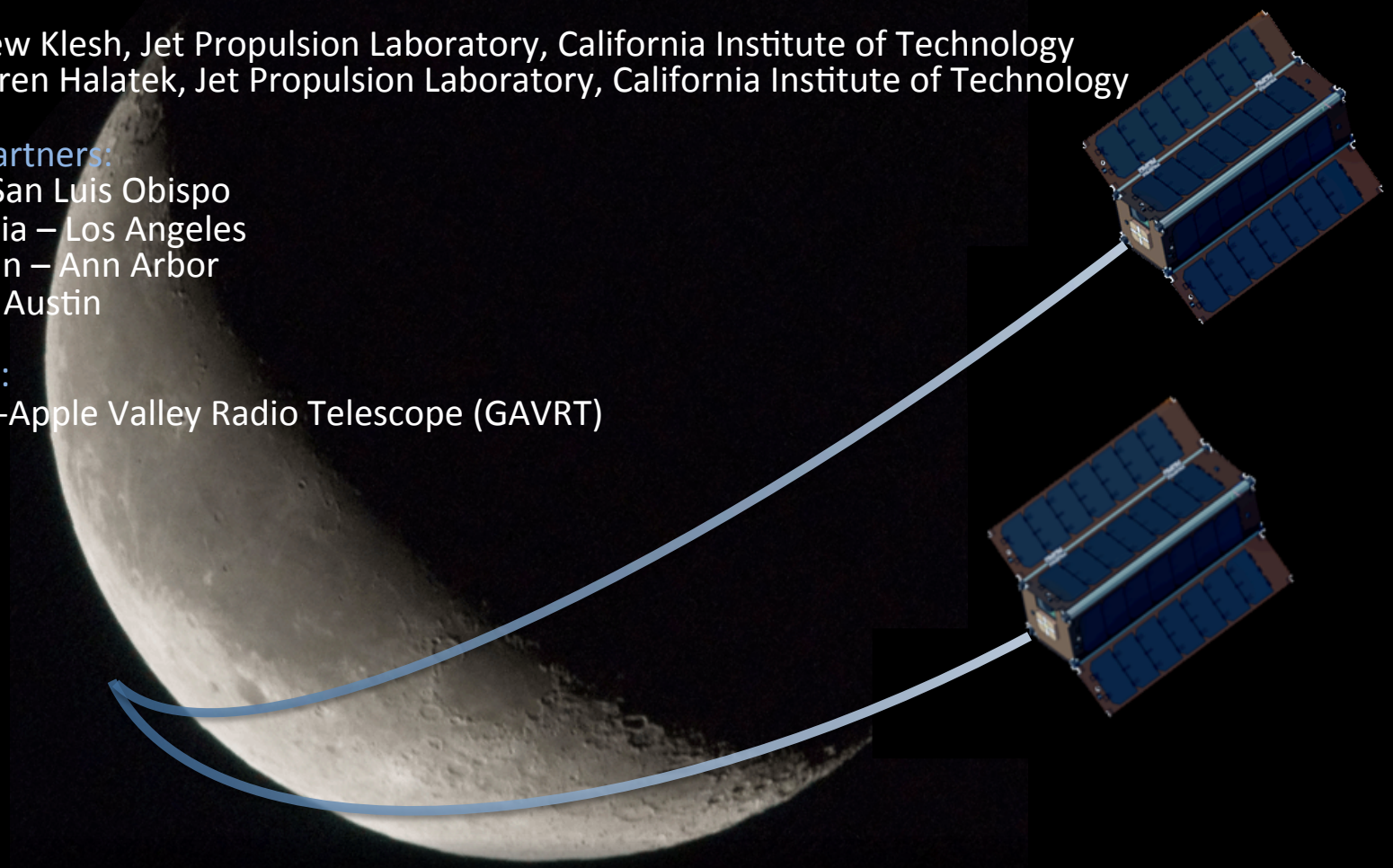
Interplanetary NanoSpacecraft Pathfinder In a Relevant Environment

Low-cost mission leadership with the world's first CubeSat beyond Earth-orbit

PI: Dr. Andrew Klesh, Jet Propulsion Laboratory, California Institute of Technology
PM: Ms. Lauren Halatek, Jet Propulsion Laboratory, California Institute of Technology

University Partners:
- Cal Poly - San Luis Obispo
- U. California – Los Angeles
- U. Michigan – Ann Arbor
- U. Texas – Austin

Collaborator:
- Goldstone-Apple Valley Radio Telescope (GAVRT)



Jet Propulsion Laboratory
California Institute of Technology
CAL POLY GAVRT UCLA MICHIGAN THE UNIVERSITY OF TEXAS AT AUSTIN

INSPIRE Overview

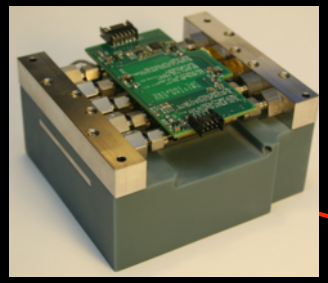
CubeSat Overview:
Volume: 3U (10x10x30cm)
Mass: 4.05 kg
Power Generation:
3 Axis Stabilized: 21 W
Tumbling: 13.7 W
Data Rate: 62-260000 bps

Software:
Developed in-house (protos)

I&T:
In-house S/C I&T, external environmental testing, NASA CLI P-Pod/Launch Integration

Operations:
Primary: DSN
Secondary (Receive only): DSS-28 (GAVRT), & Secondary Stations, ex: Peach Mountain

S/C components provide ***the basis for future high-capability, lower-cost-risk missions*** beyond Earth expanding and ***provide NASA leadership in an emergent domain***



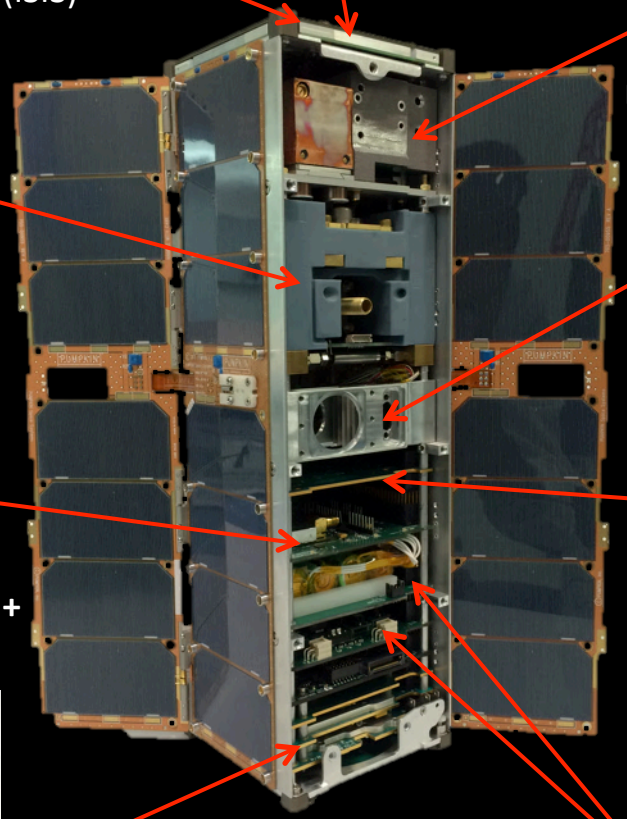
Cold-Gas ACS (U. Texas)

C&DH + Watchdog Board + Lithium UHF (AstroDev)

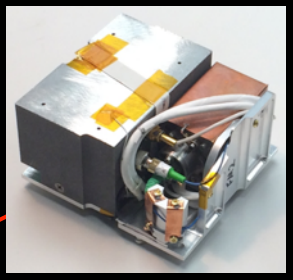
Nav/Comm X-Band Radio (JPL)

UHF Antenna (ISIS)

X-Band Patch Antennas (JPL) [two sets]



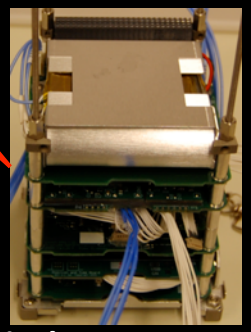
Deployable Solar Panels + Structure (Pumpkin)



Magnetometer (JPL/ UCLA)

Star Tracker (Blue Canyon)

Processing Board (CalPoly / Tyvak)

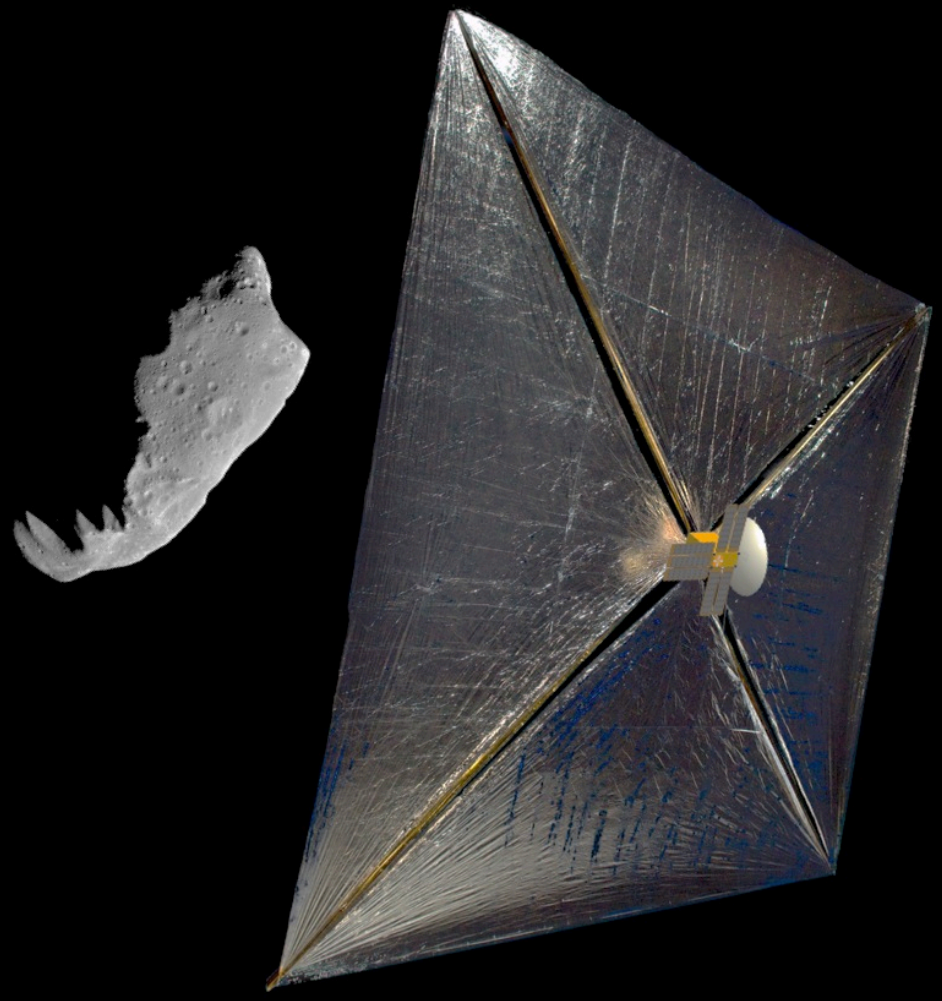


Electrical Power System + Battery Board (U. Michigan)

NEA Scout

Characterize one candidate NEA with an imager to address key Strategic Knowledge Gaps (SKGs)

(J. Castillo-Rogez, PI)



- Demonstrates low cost reconnaissance capability for HEOMD (6U CubeSat)
- Measure volume, spectral type, spin mode and orbital properties, address key physical and regolith mechanical SKGs during flyby

Summary

- Importance of understanding NEOs is well-appreciated
- Intersecting interests of diverse stakeholders
- Emerging technologies afford opportunities
- KISS Workshop will attempt to capture the current status and sustainable path to NEO exploration