ICRA '08 Space Robotics Workshop:
Orbital Robotics

Welcome and Introduction

Rick Wagner, Chairman

Space Robotics Technical Committee

IEEE Robotics and Automation Society

May 20, 2008

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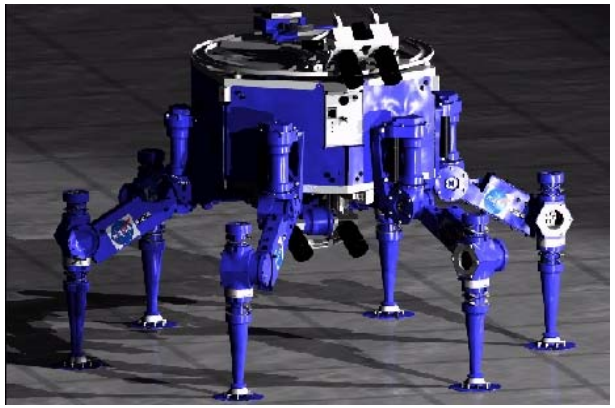
RAS Technical Committees: Space Robotics

Space Robotics TC Web site:
was expanded and maintained (Google 'Space Robotics TC')
http://teamster.usc.edu/~fixture/Robotics/SpaceRoboticsTC/SpaceRoboticsTC.html

Planetary Robotics:
Mars rovers (JPL, ESA, LAAS-CNRS, Swiss Federal Institute of Technology in Zurich, Tohoku University, CMU, Stanford University, Universität Bremen) …



Orbital Robotics:
Inspection and Maintenance Robot (Northrop Grumman); Manipulation of Flexible Space Structures (Georgia Tech); Form Based Control Algorithm (Cleveland State University); Coordinated Control of Space Robot Teams (MIT); Space Manipulator Analysis (JAXA); Autonomous Spacecraft Proximity Maneuvers (Naval Postgraduate School) …

Organizational:
Membership increased from 13 to 18 in 2007; continued cooperation with other organizations; ICRA workshops in '07 and planned for '08 …

Contact Co-Chair to Join:

Rick Wagner (Rick.Wagner@NGC.com)
Dimi Apostolopoulos (da1v@cs.cmu.edu)
Hobson Lane (Hobson.Lane@NGC.com)
Richard Volpe (volpe@jpl.nasa.gov)

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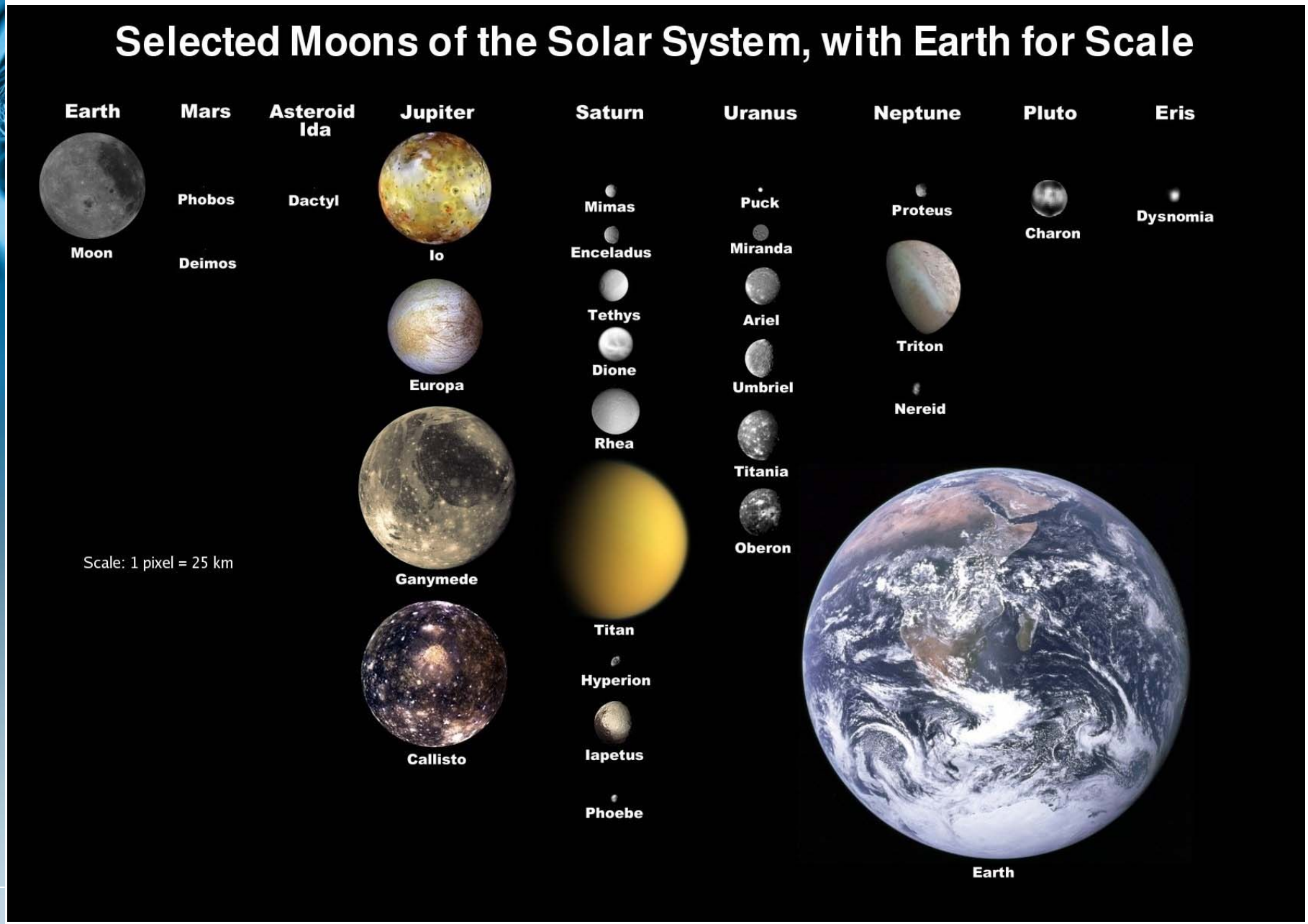
Destinations: Moons (source: Wikipedia)



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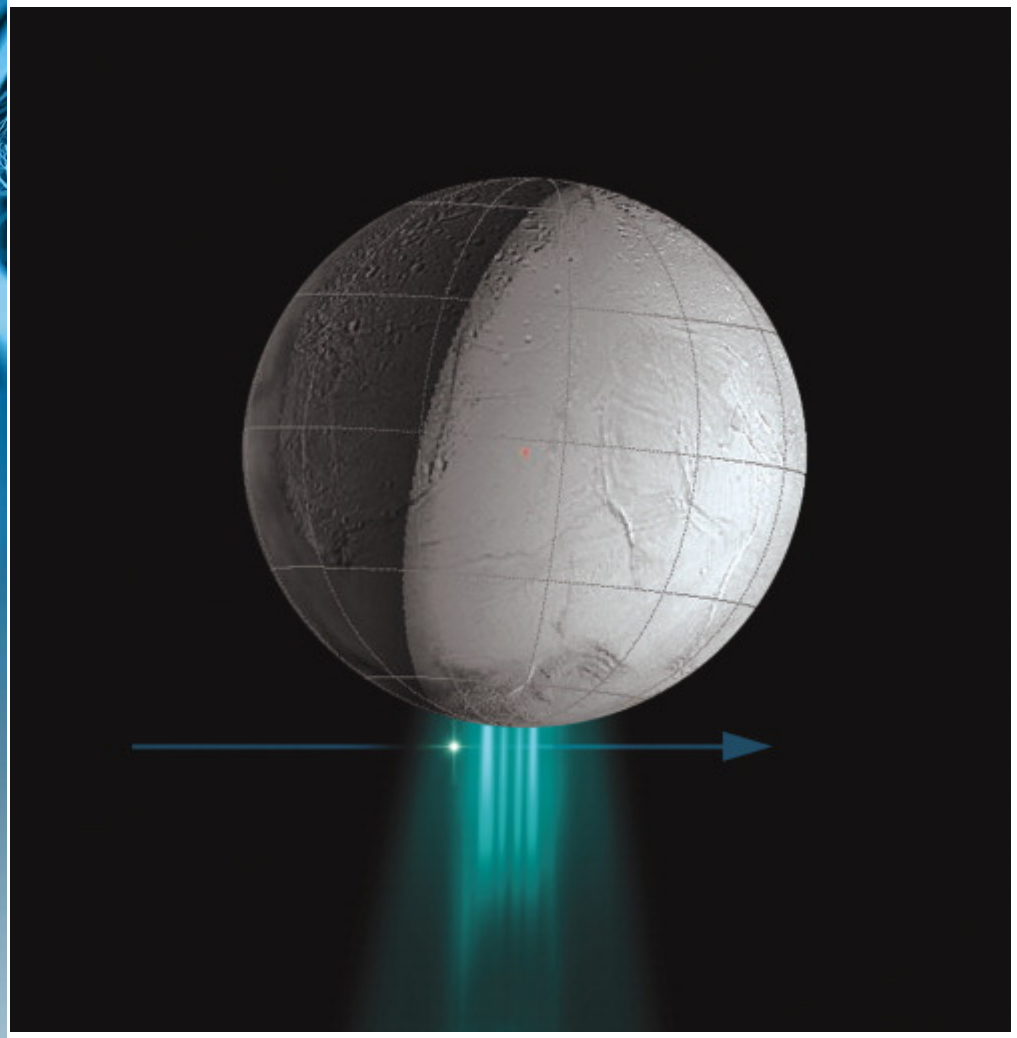
Destinations: Moons (source: Aviation Week & Space Technology)



"A computer graphic created with Cassini data of Saturn's moon Enceladus illustrates the immense scale of its south polar water plumes where data also indicate that relatively warm subsurface temperatures and chemistry could support life. Credit: NASA/JPL." From *Aviation Week & Space Technology*, April 14, 2008. Fair use for educational purposes.

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Destinations: Moons (source: Aviation Week & Space Technology)

From *Aviation Week & Space Technology*, April 14, 2008. Fair use for educational purposes.

"The Martian moon Phobos, imaged in color for the first time by Mars Reconnaissance Orbiter (MRO), reveals distinctive red material like that on the Martian surface. This could mean that Mars material, blasted into space by meteorites, has collected on Phobos. It would be much easier for a sample return spacecraft to obtain specimens there, rather than descending through, and back out of, the Martian atmosphere. A Russian spacecraft is set for launch to Phobos in 2009 on a collection expedition. The HiRISE High-Resolution Imaging Science Camera on MRO captured the image with 65-ft. resolution from a 4,200-mi. range. The illuminated face of the moon is just 13 mi. across. The large crater at right, named Stickney, is 5.6-mi. wide. The white material streaming from the rim could be younger soil exposed by the meteorite impact that formed the crater."

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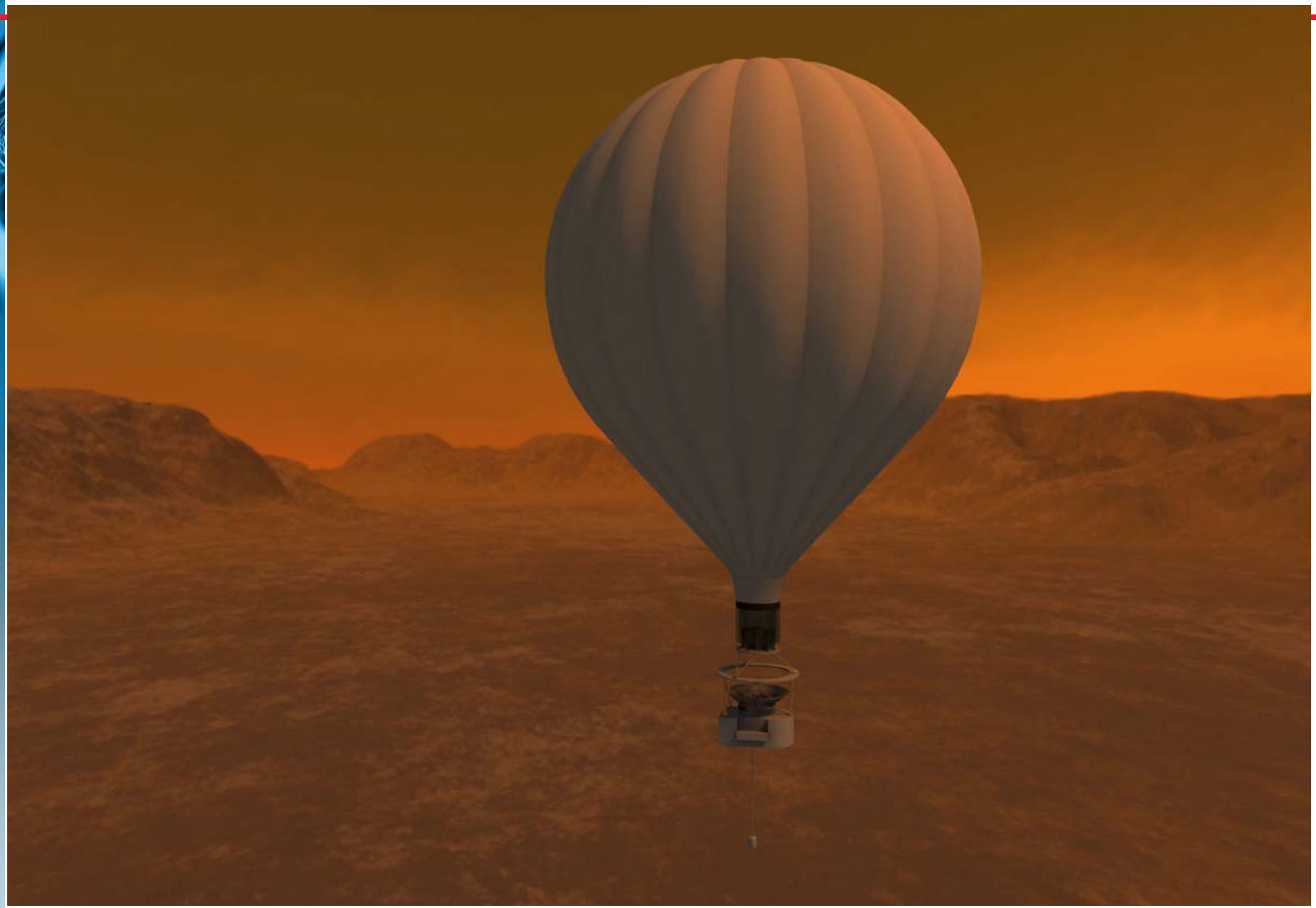
Destinations: Moons (Titan)



From "The Planetary Society Weblog," by Emily Lakdawalla http://www.planetary.org/blog/article/00000568/

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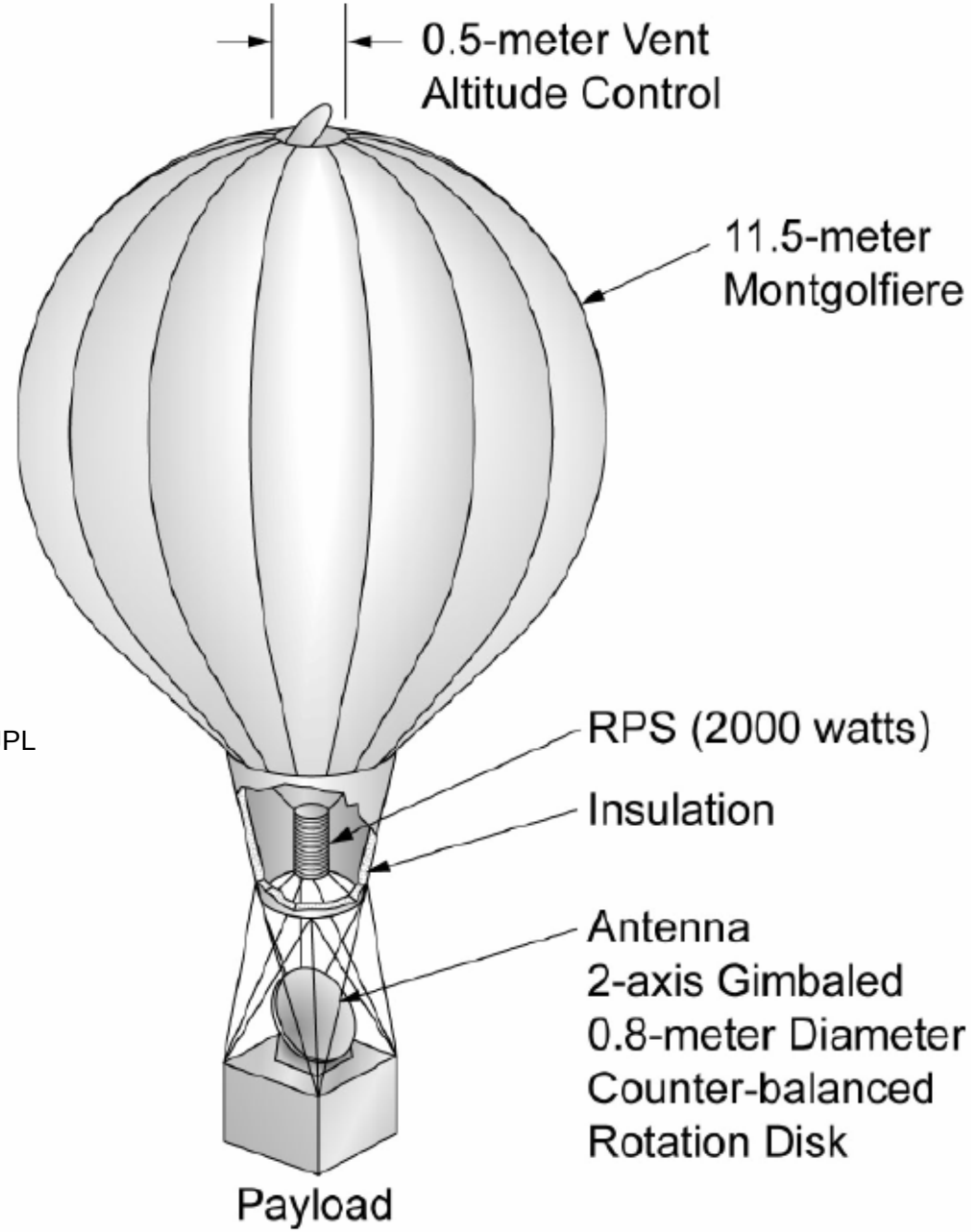
Destinations: Moons (Titan)

"Analytical predictions show that a 10-m diameter balloon can carry a 125-kg payload at 8-km altitude (0.96-bar, 85K) with only 2000 watts of RPS waste heat."

From "Montgolfiere Balloon Missions for Mars and Titan" by Jack A. Jones, et al., NASA JPL



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Destinations: Mars (source: Aviation Week & Space Technology)

"Tons of ice and dust cascade down a 700 meter tall cliff at the edge of the ice cap surrounding the north pole of Mars in this image collected by the High Resolution Imaging Science Experiment (HiRise) camera on NASA's Mars Reconnaissance Orbiter (MRO)." From *Aviation Week & Space Technology*, March 10, 2008. Fair use for educational purposes.

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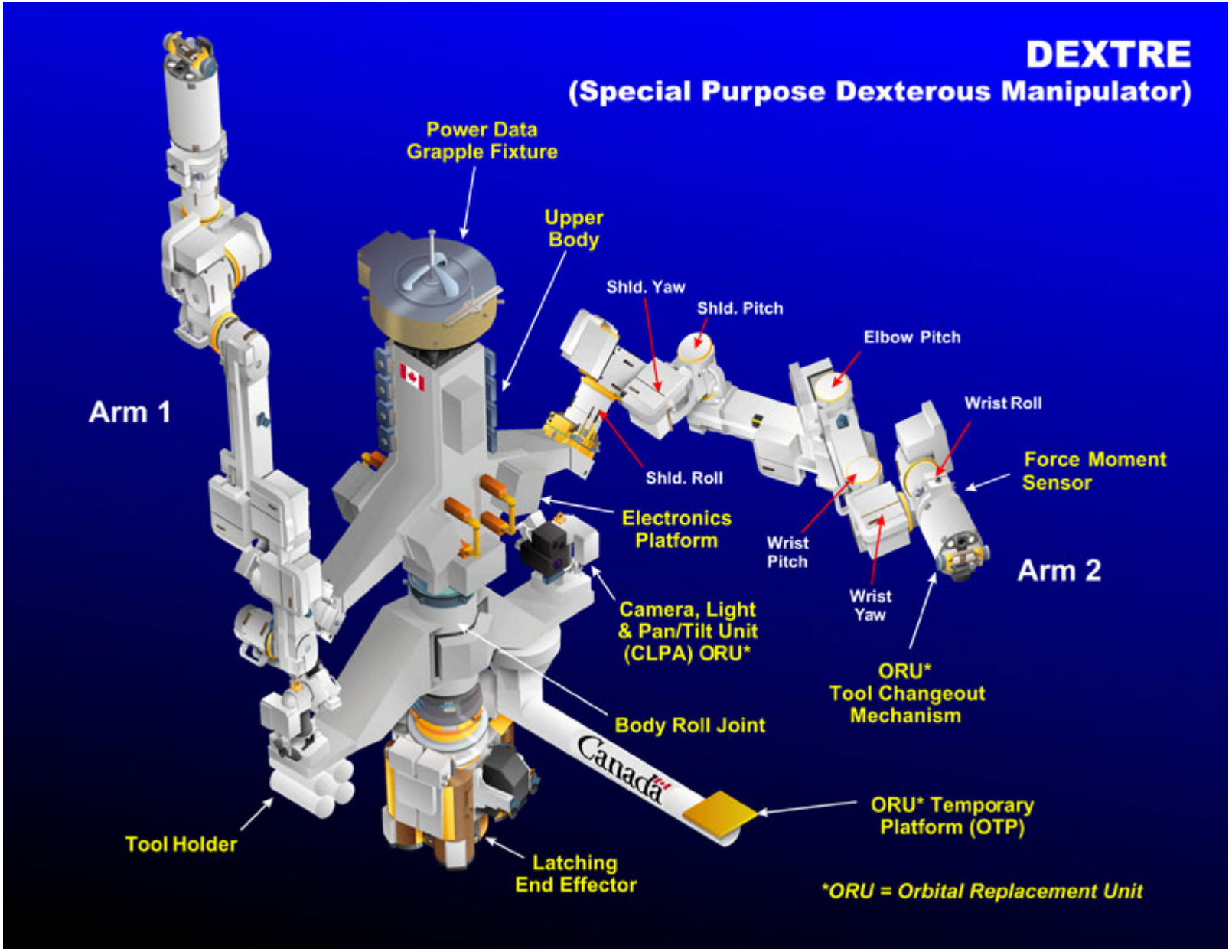
Destinations: LEO (source: Canadian Space Agency)



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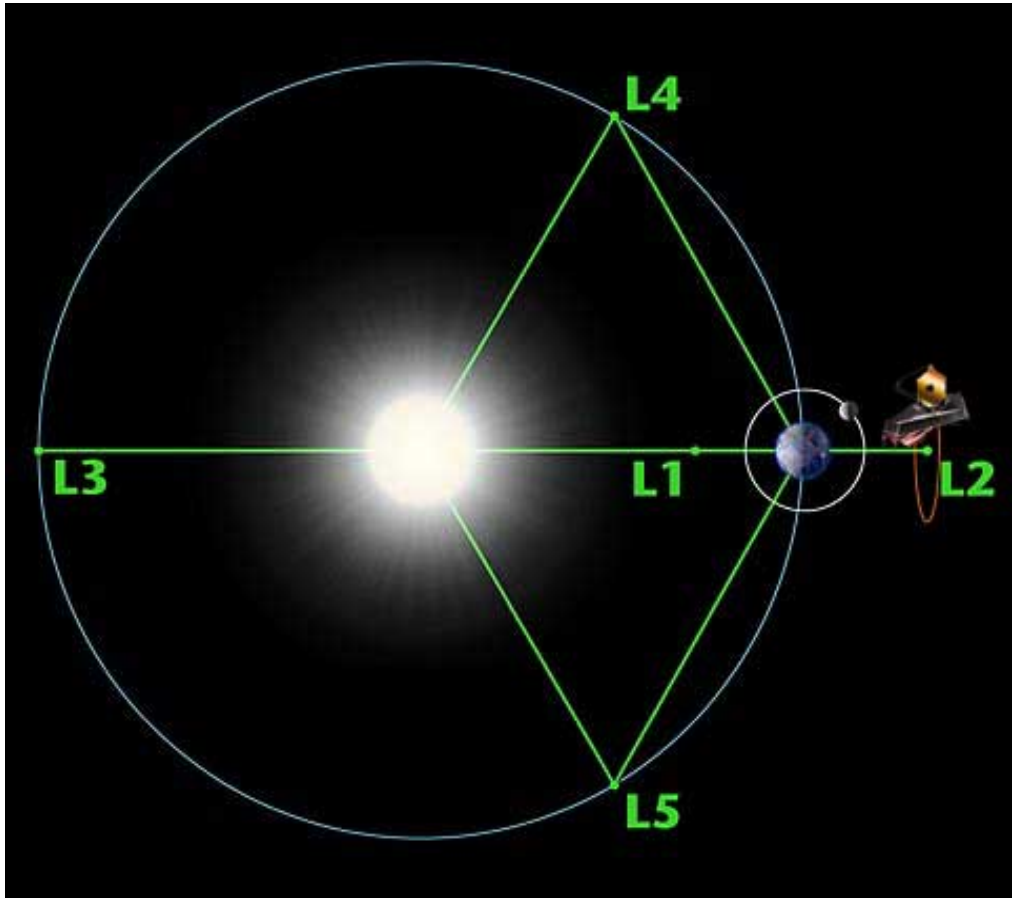
Destinations: Earth-Sun Lagrange Point L2

"In the case of JWST, the 3 bodies involved are the Sun, the Earth and the JWST. Normally, an object circling the Sun further out than the Earth would take more than one year to complete its orbit.

However, the balance of gravitational pull at the L2 point means that JWST will keep up with the Earth as it goes around the Sun. The gravitational forces of the Sun and the Earth can nearly hold a spacecraft at this point, so that it takes relatively little rocket thrust to keep the spacecraft in orbit around L2."



From the NASA GSFC Website "The James Webb Space Telescope" http://www.jwst.nasa.gov

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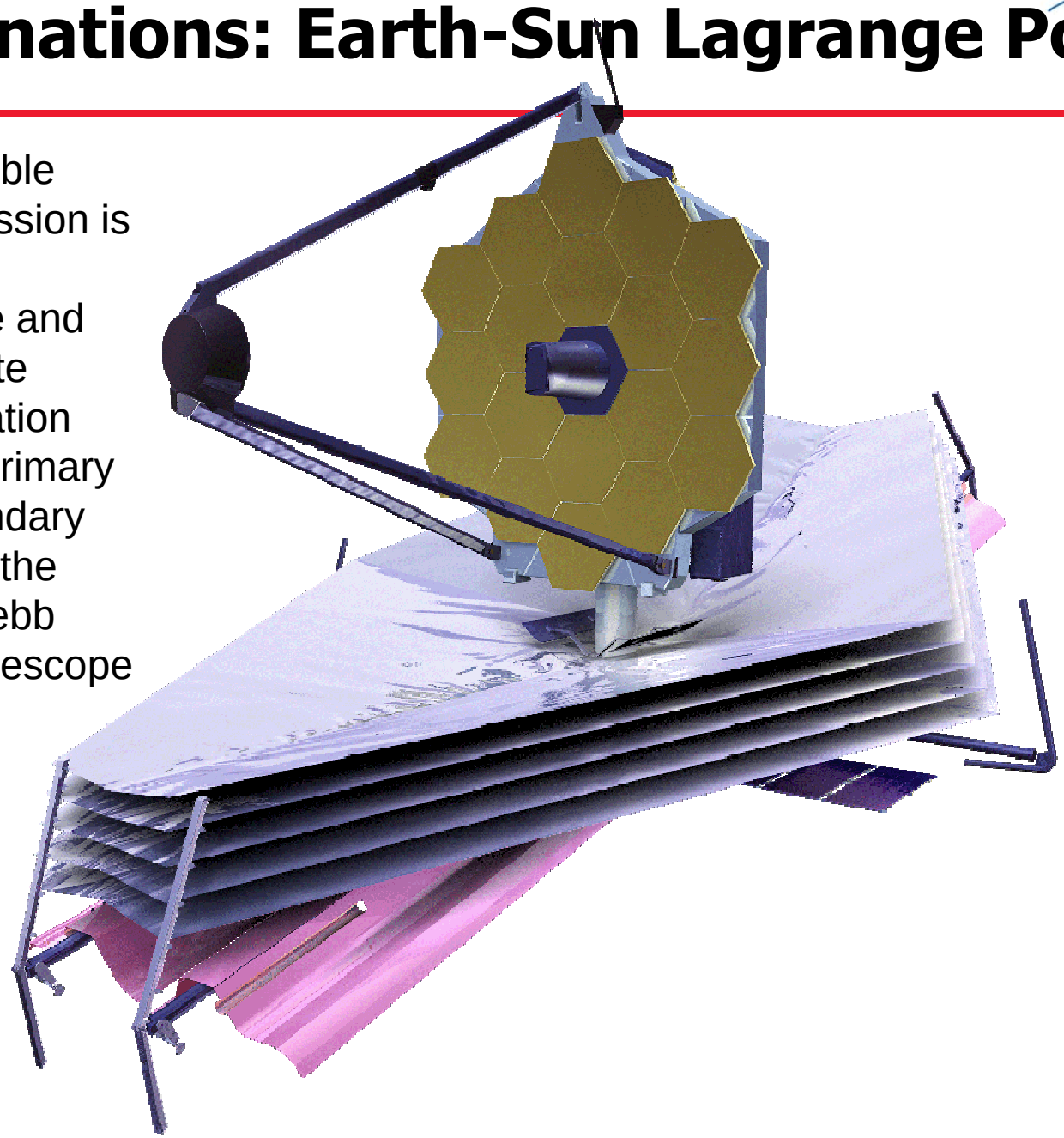
Destinations: Earth-Sun Lagrange Point L2

One possible robotic mission is to remove particulate and condensate contamination from the primary and secondary mirrors of the James Webb Space Telescope



The JWST primary mirror is 6.5 meters (21.3 feet) across

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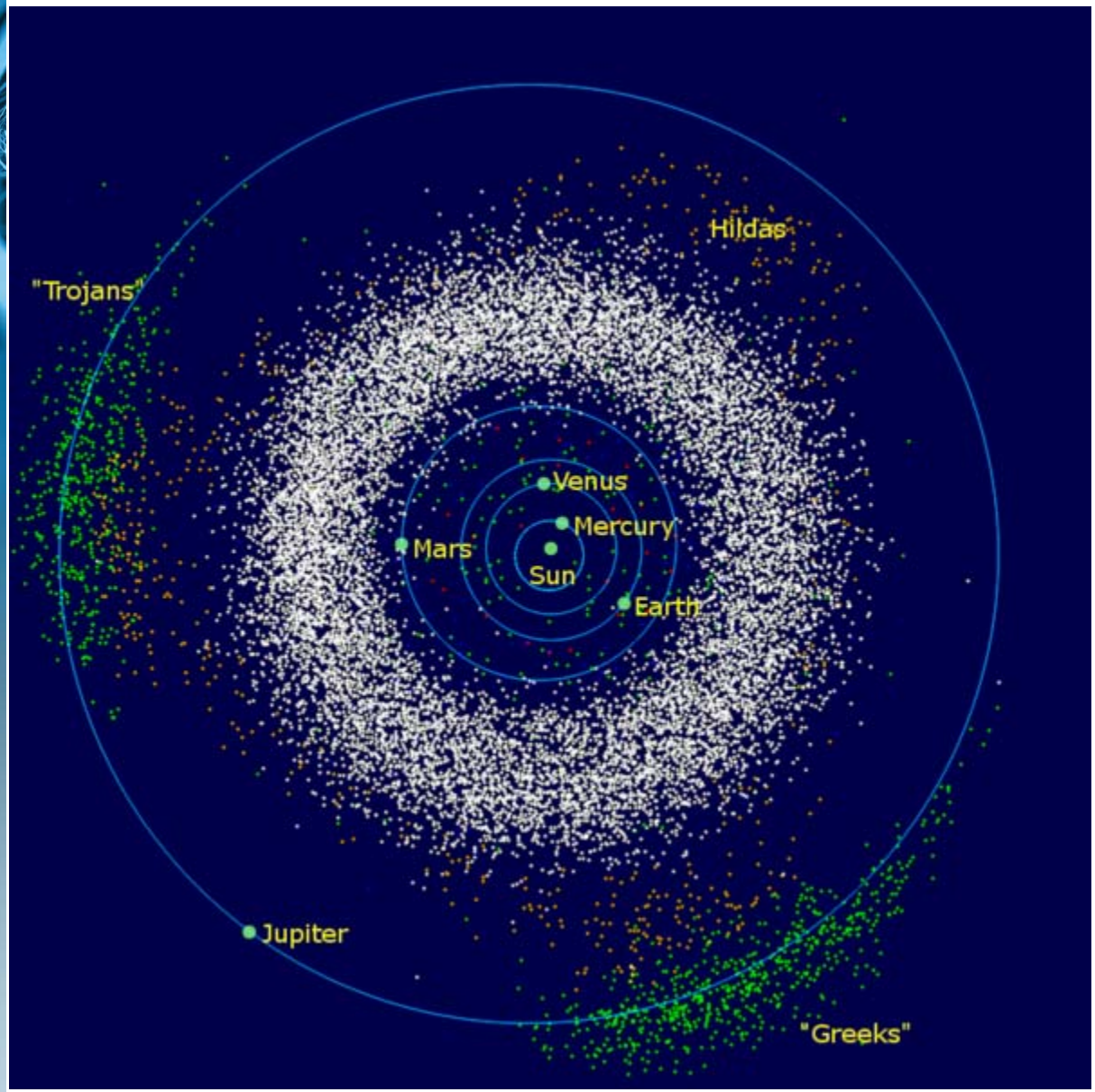
Destination: Trojan Asteroids (source: Wikipedia)



"Trojan" and other asteroids provide abundant opportunities for exploration. Asteroids are also space material resources that could be mined robotically.

Lifeboat Foundation LEO Habitat

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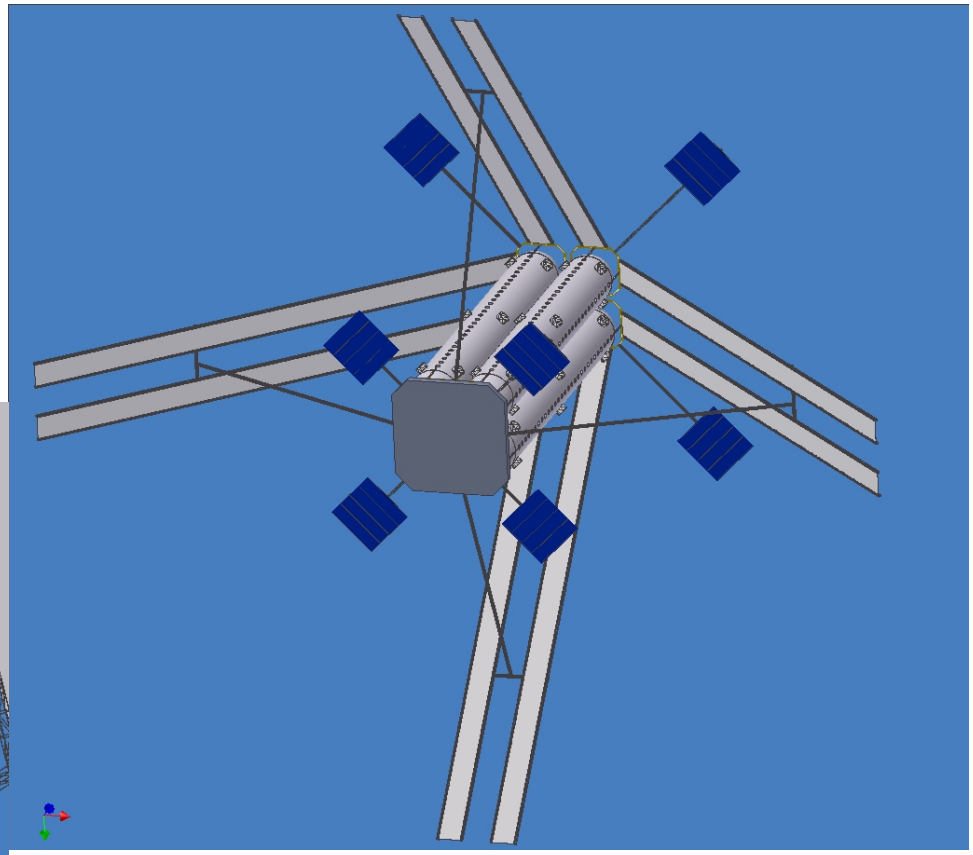
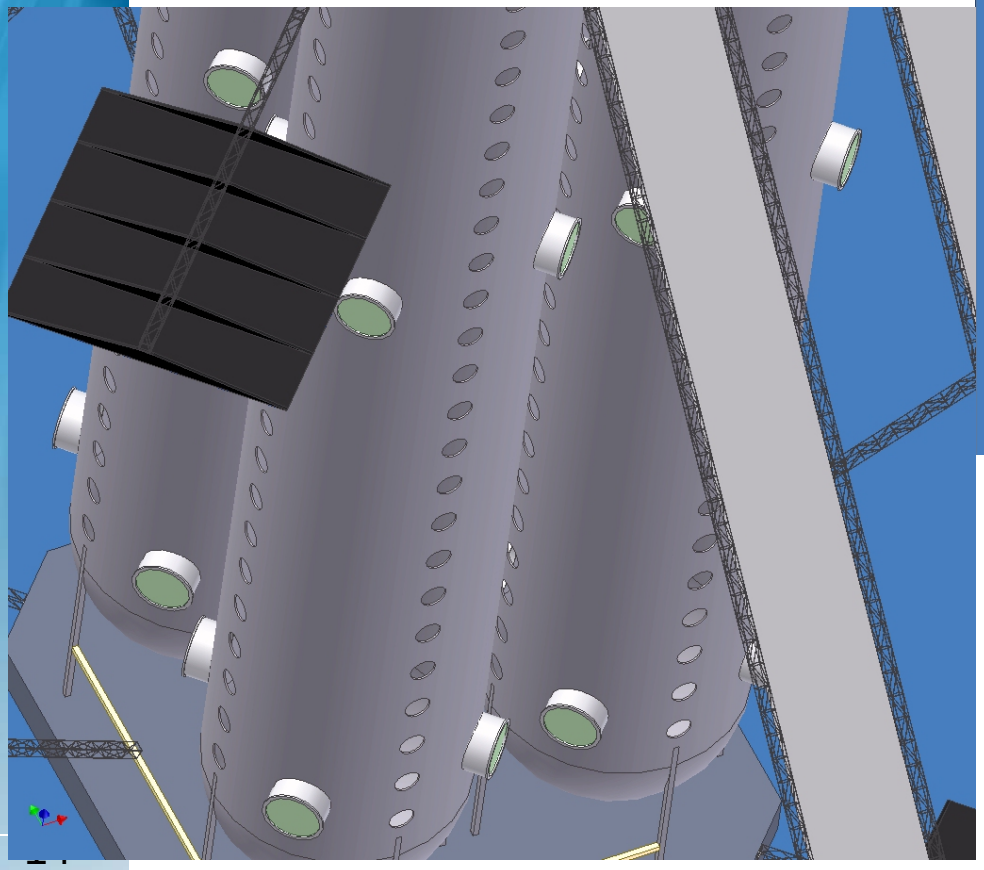
Destination: Habitat in Interplanetary Space

Each vessel is 23 meters (75 feet) in diameter and 175 meters (575 feet) long, with a wall thickness of 1/4 meter (10 inches).

(Inspired by Gerard O'Neill, Princeton University)





The assembly is gravity gradient stabilized and always points the radiation shield toward the sun. There is no spin or rotation, so the residents spend their lives in zero gravity. Consequently, space vehicles can approach and dock to the city from just about any direction.

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Orbital Robotics Keynote Address

- **Prof. Dave Akin**
  - **Director of the Space Systems Laboratory at the University of Maryland**
  - **Neutral Buoyancy Research Facility**
    - **A 50-foot diameter, 25-foot deep water tank that is used to simulate the microgravity environment of space**
  - **There are currently five robots being tested, including**
    - **Ranger, a four-armed satellite repair robot**
      - Launched by NASA in 1996, Ranger and its predecessor robot were both constructed in the Space Systems Lab
    - **SCAMP, a 6 degree of freedom free-flying underwater camera platform**
  - **Current research activities also include**
    - **MX-2 suit, a simplified neutral buoyancy spacesuit for use in EVA research**
    - **Power Glove, a prototype motorized spacesuit glove which will help reduce astronaut hand fatigue**
    - **TSUNAMI, an apparatus to test human neuromuscular adaptation in different gravitational fields and different simulations of weightlessness**