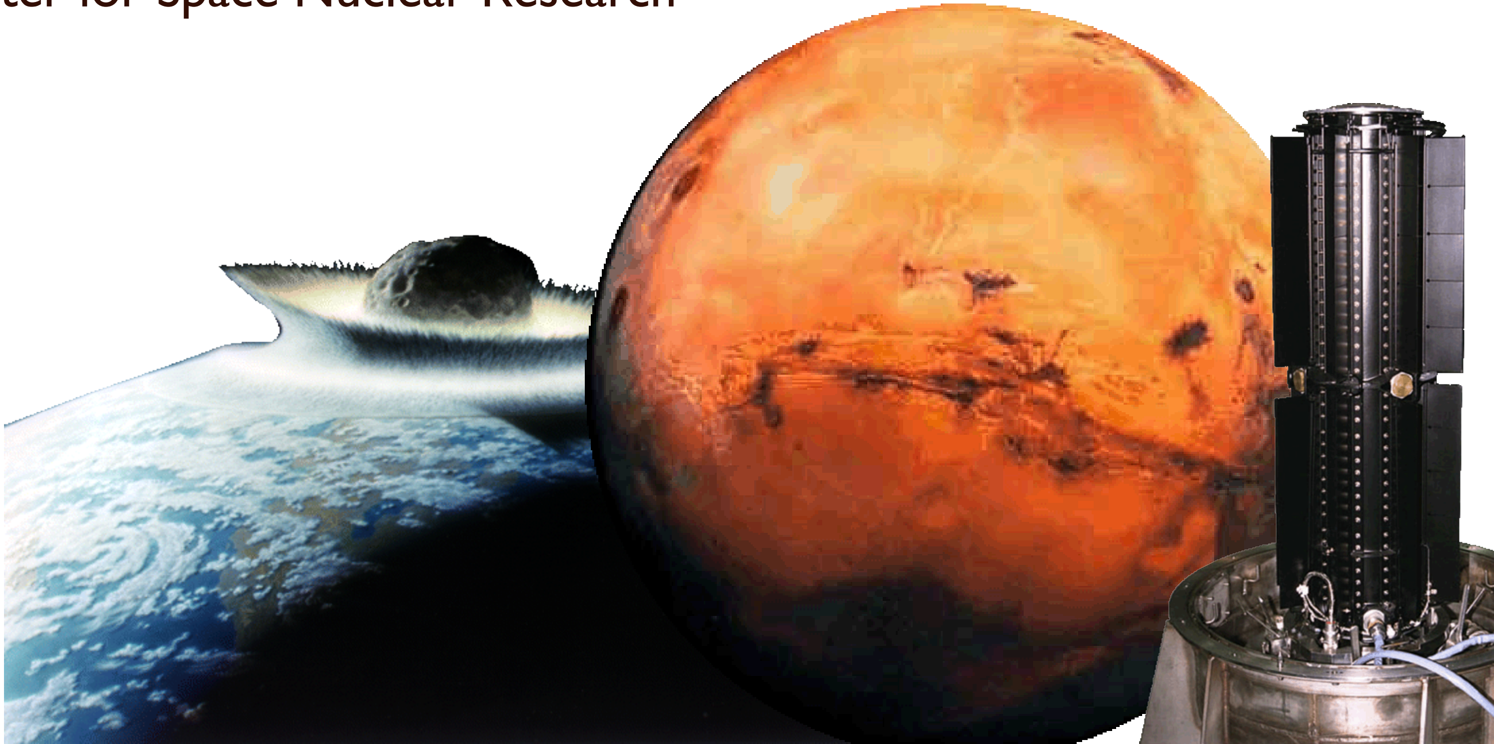
Science Plenary II: Science Missions Enabled by Nuclear Power and Propulsion

Chair / Organizer: Steven D. Howe
Center for Space Nuclear Research



Distinguished Panel

- Space Nuclear Power and Propulsion: The Good, the Bad and the Ugly
  Dr. Ralph McNutt, Applied Physics Laboratory / Johns Hopkins University

- Expanding Science Knowledge: Enabled by Nuclear Power
  Karla B. Clark, Jet Propulsion Laboratory / California Institute of Technology

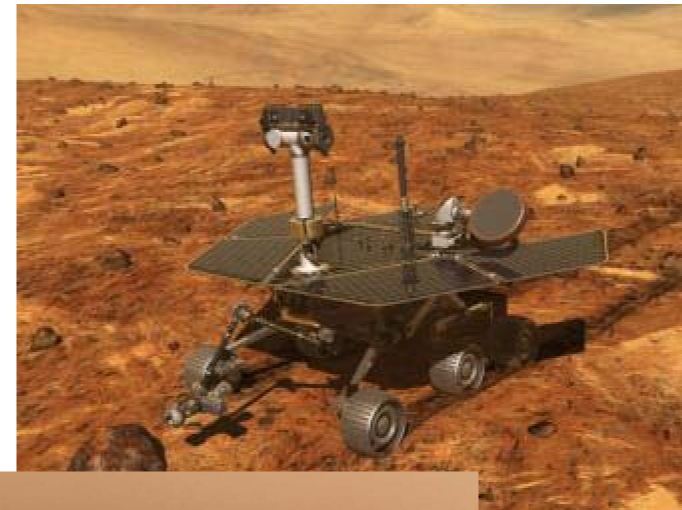
- Increased Science Return and Space Nuclear Power
  Dr. Richard Ambrosi, University of Leicester / UK

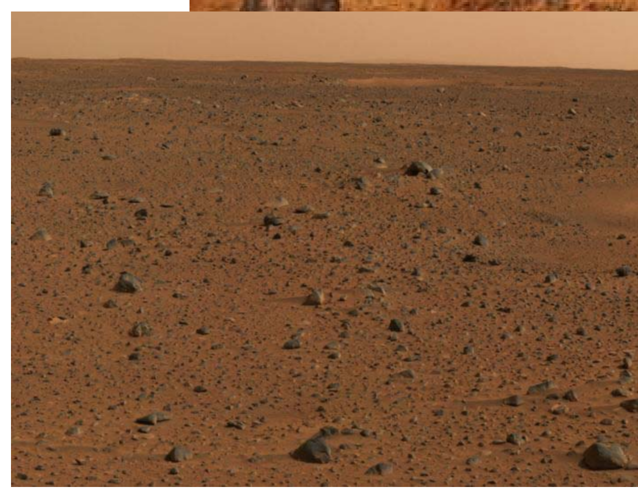
We shall not cease from exploration, and the end of all our exploring will be to arrive where we started and know the place for the first time.

T. S. Eliot

Planetary exploration is getting tougher

- Every mission has returned knowledge different than what was expected
- But planetary exploration is getting increasingly expensive
- Orbital platforms are good but need surface exploration- more expensive
- MERs did great but covered only 15 km total after 5 years
- Surface landings necessitate flat, safe landing site but science may be in nooks and crannies
- We need numbers on the ground
- Need more science per $





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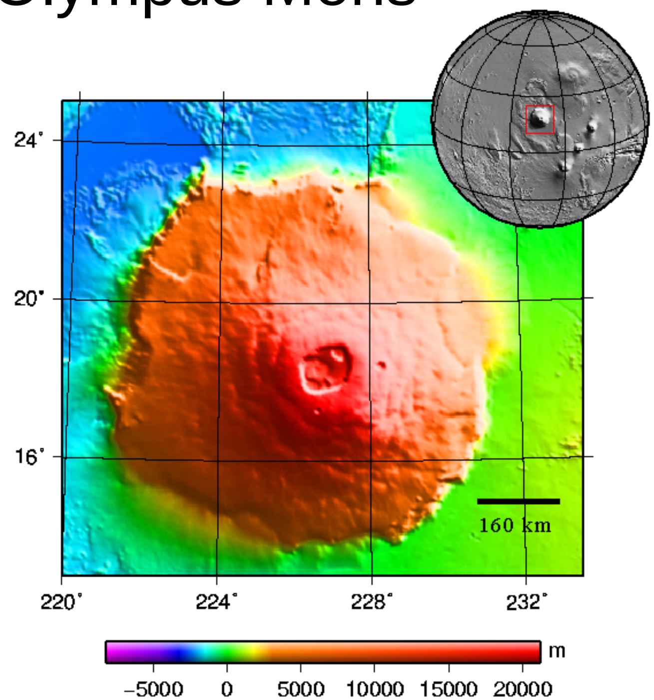
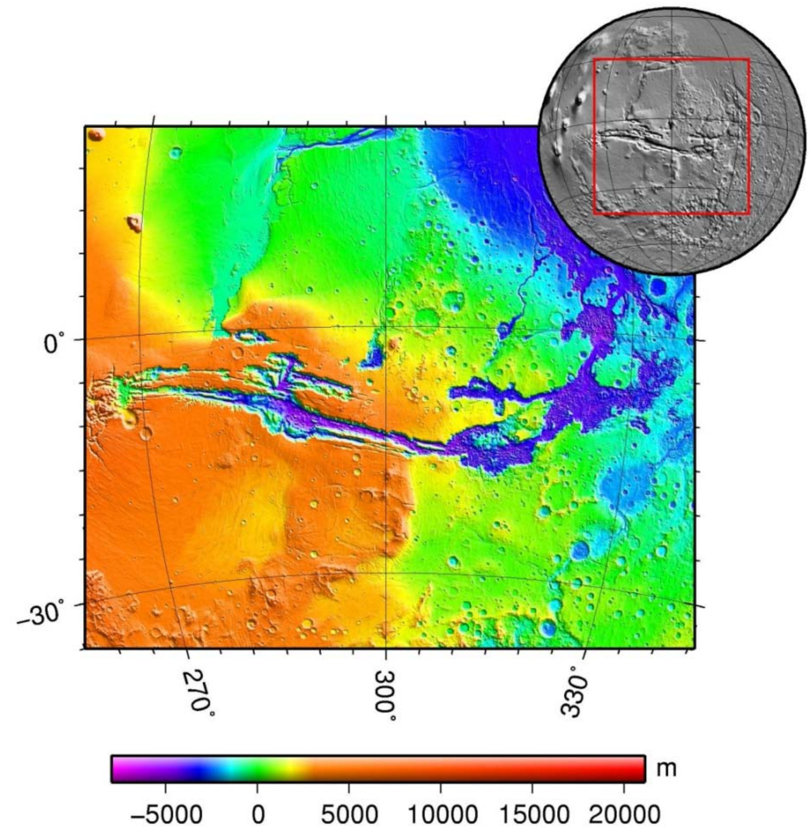
Interest in canyon walls, mountainsides, deep canyon bottoms

Olympus Mons





Valles Marineris

Mars Hopper:

A radioisotope powered, long-lived, long-range mobile platform using in-situ resources

Initiated

June, 2009- CSNR Summer Fellows task

Concept:

Utilize a Radioisotope Thermal Rocket (RTR) to store energy and "hop" a vehicle across the Martian surface

Enables:

- **Science data collection from several regions**
- **potentially support a sample return mission**
- **Could cover "pole-to-pole" in three years**
- **Dozens of small platforms can be delivered due to small size for a meteorology network**

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Ultimate goal is the Mars Sample Return

- High priority mission
- Difficult to accomplish due to ascent/descent requirements
- Conflict between safe landing site and getting samples from interesting regions
- Desire many samples from all over the planet
- Requires a long lived, highly mobile craft to acquire samples and accumulate them at a centralized location

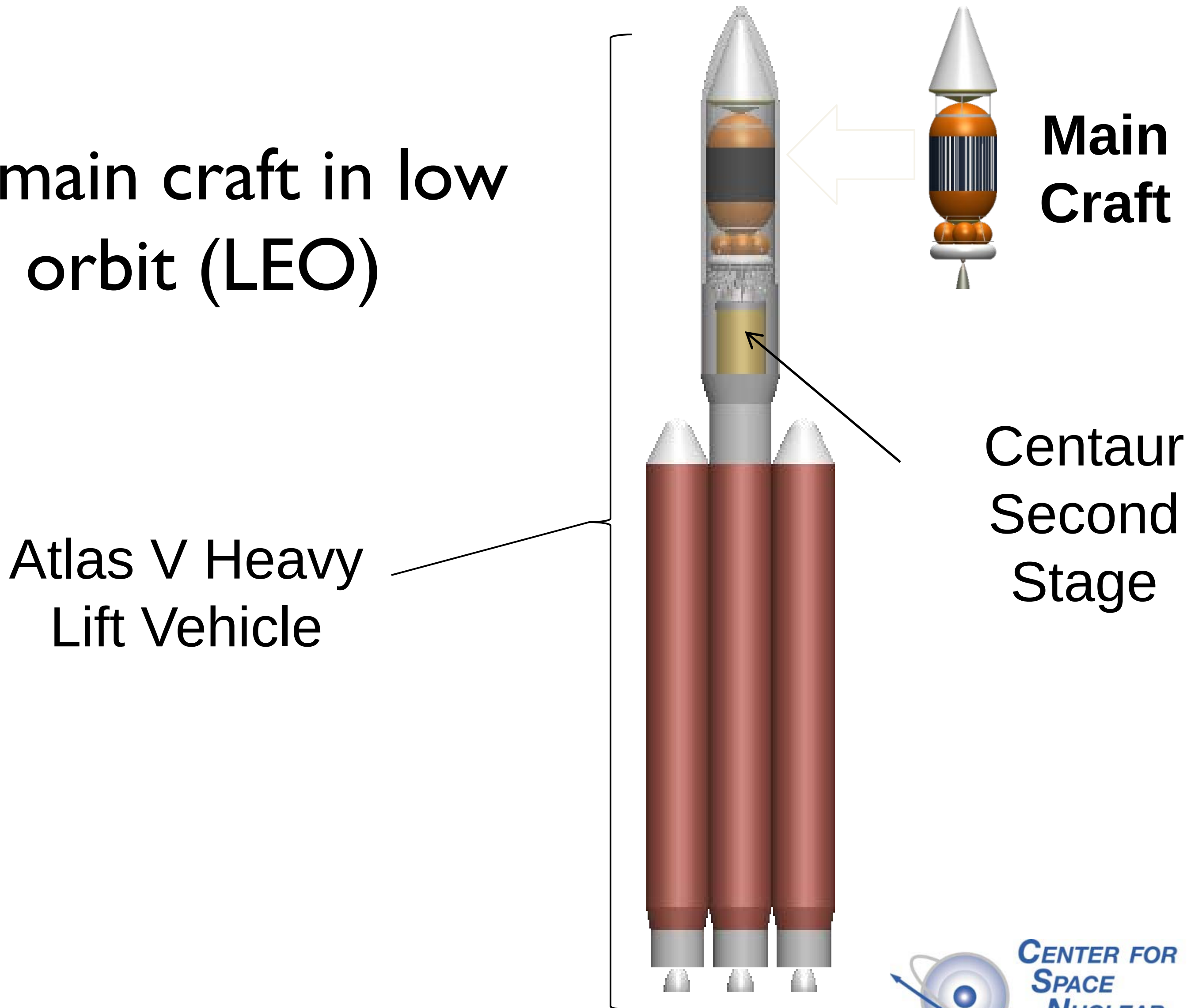
Mars Sample Return Mission Architecture and Preliminary Nuclear Thermal Rocket Spacecraft Design

Basic Mission Design:

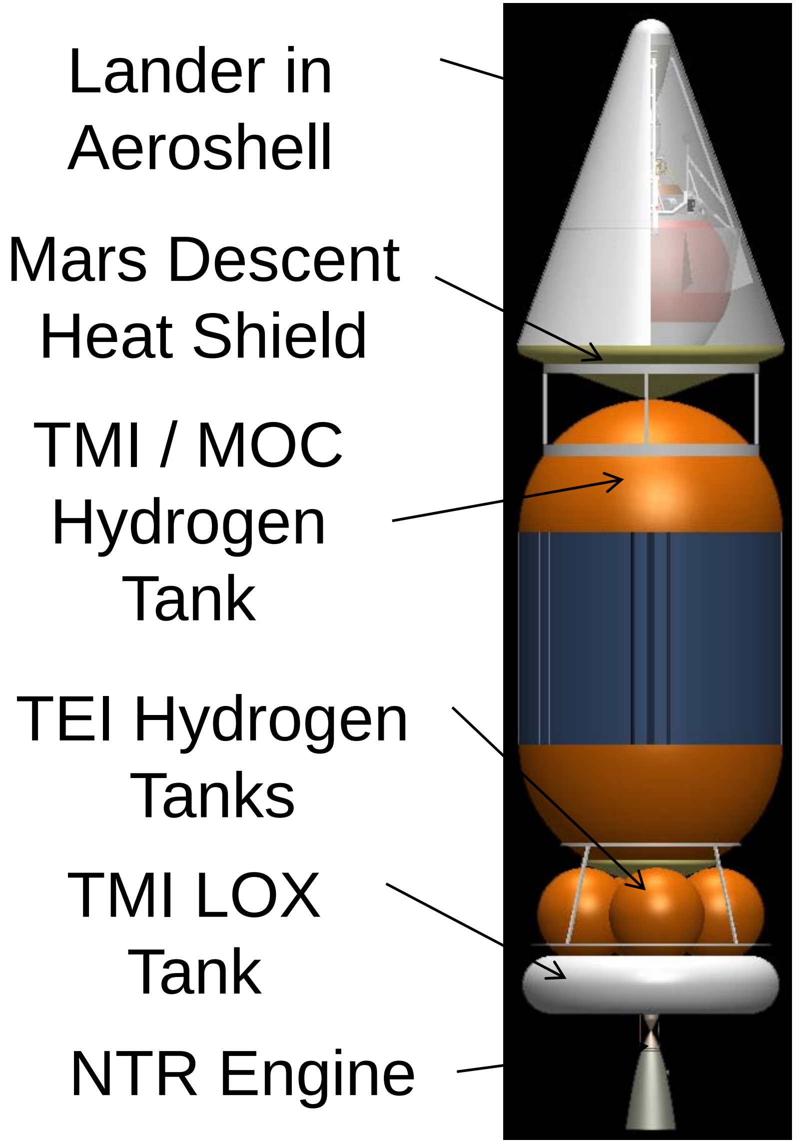
- Place entire craft in LEO with ONE Atlas V Heavy
- Conjunction class transfer to Mars with H_2
- Propulsive orbital insertion
- Descend lander vehicle with NH_3 and 2nd NTR
- 500 day stay on Mars
- Collect 100 kg of Martian samples from Hoppers
- Ascend with CO_2 to 200 km orbit
- Rendezvous with main vehicle and transfer samples
- Transfer to Earth with H_2
- Jettison sample entry capsule to Earth

Launch Vehicle Configuration

Places main craft in low Earth orbit (LEO)



Spacecraft Configuration



Main Craft

- Transports to Mars
- Orbits Mars during collection
- Rendezvous with ascent vehicle
- Transits back to Earth

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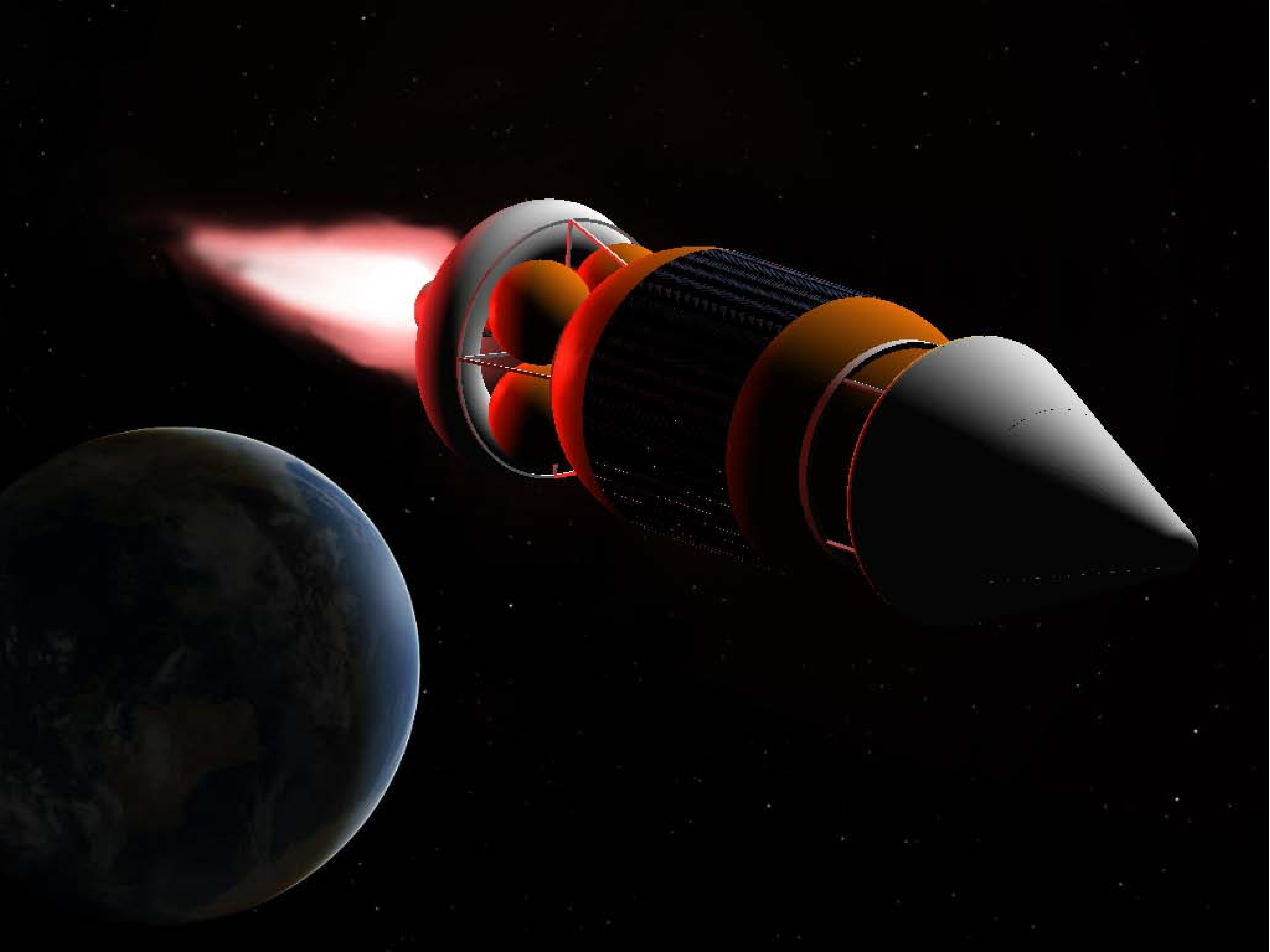
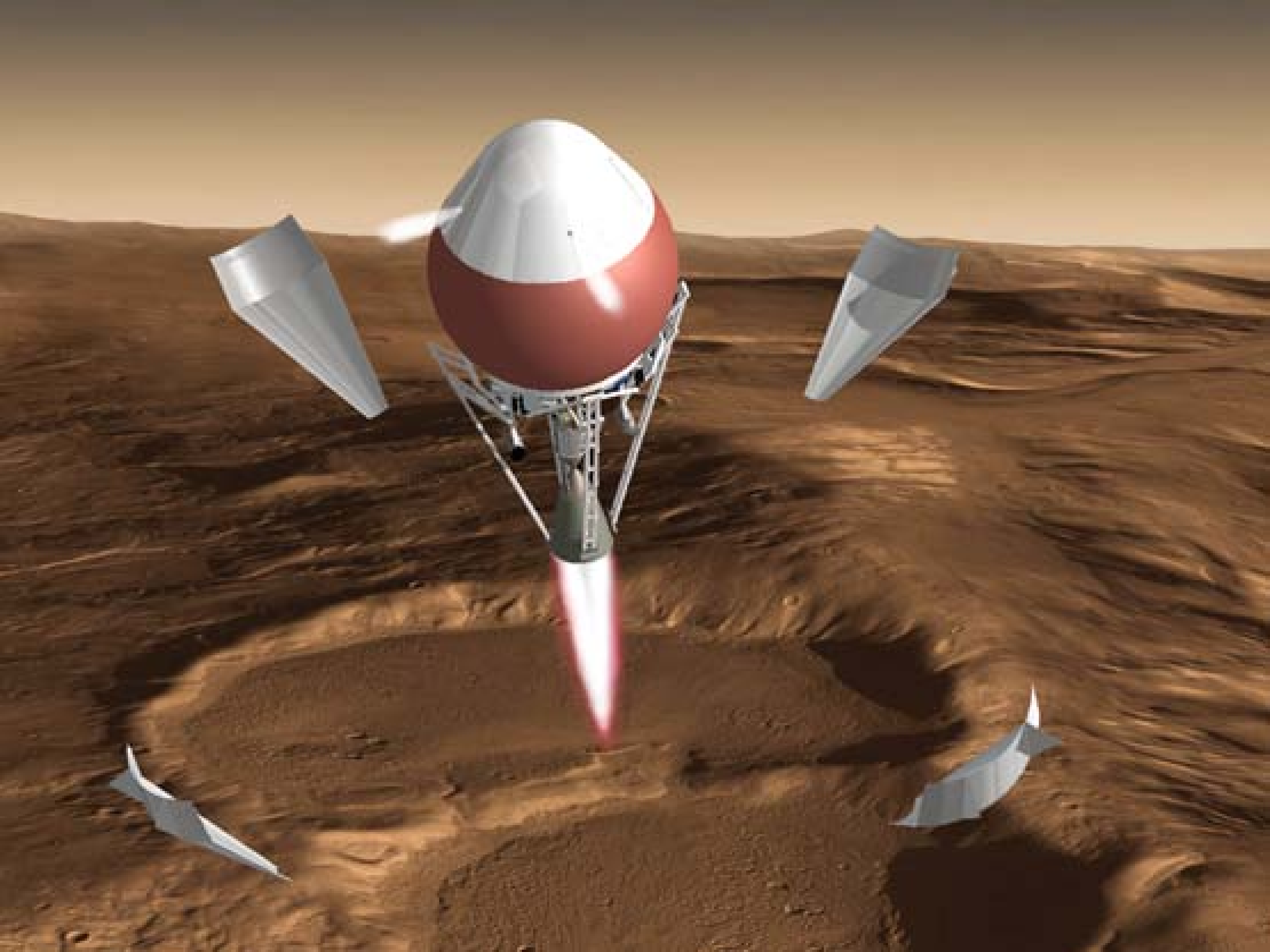
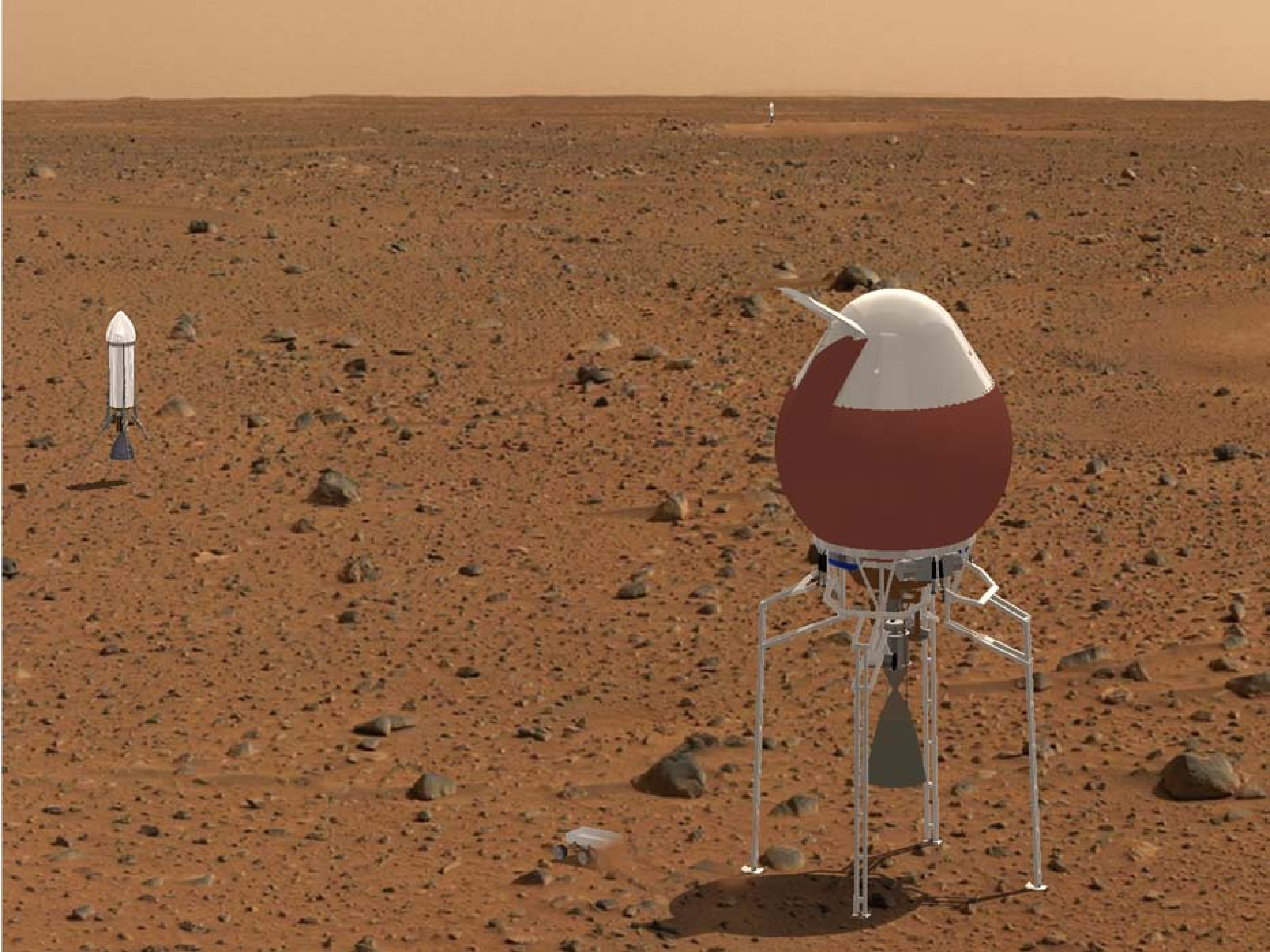
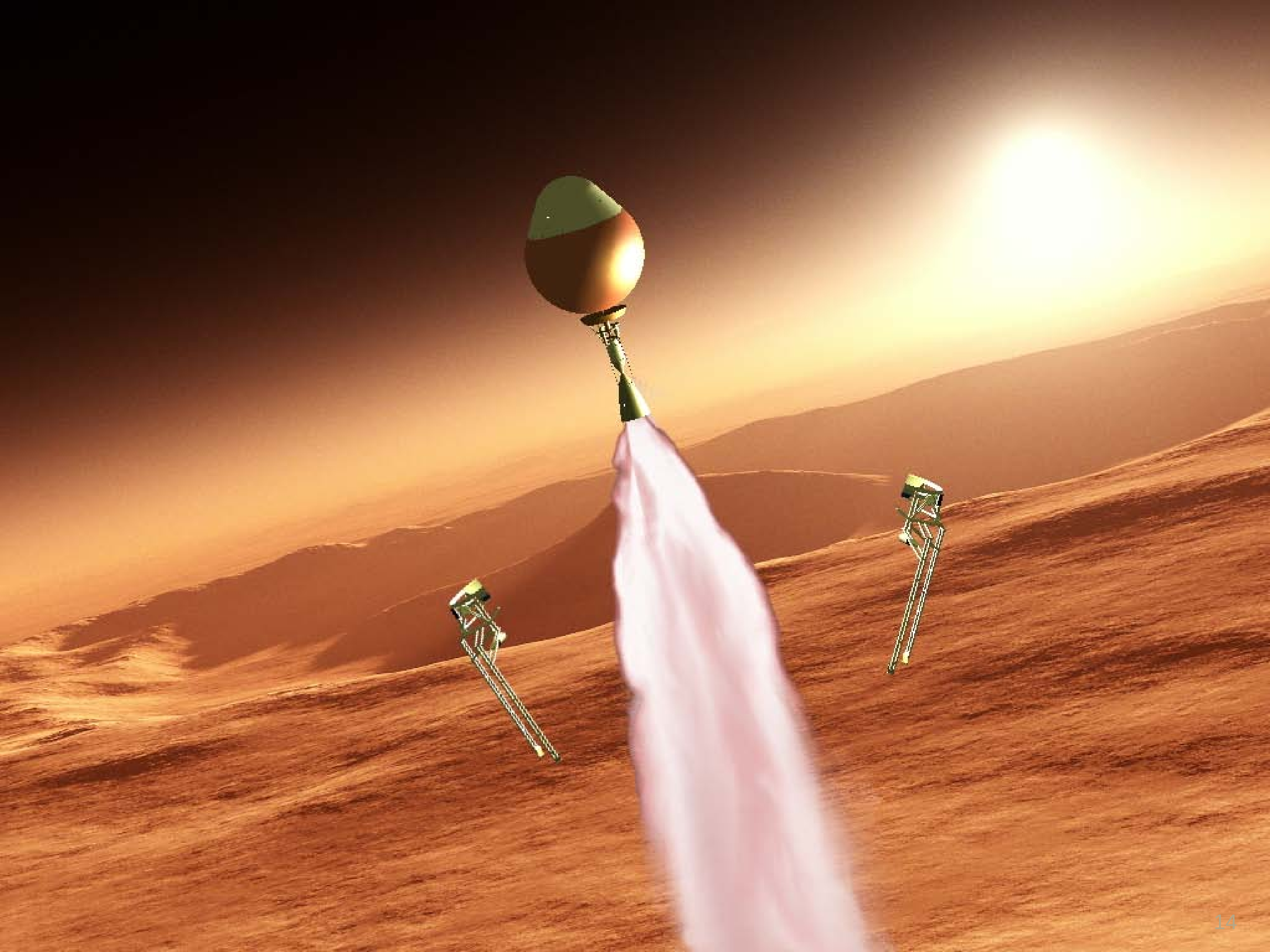
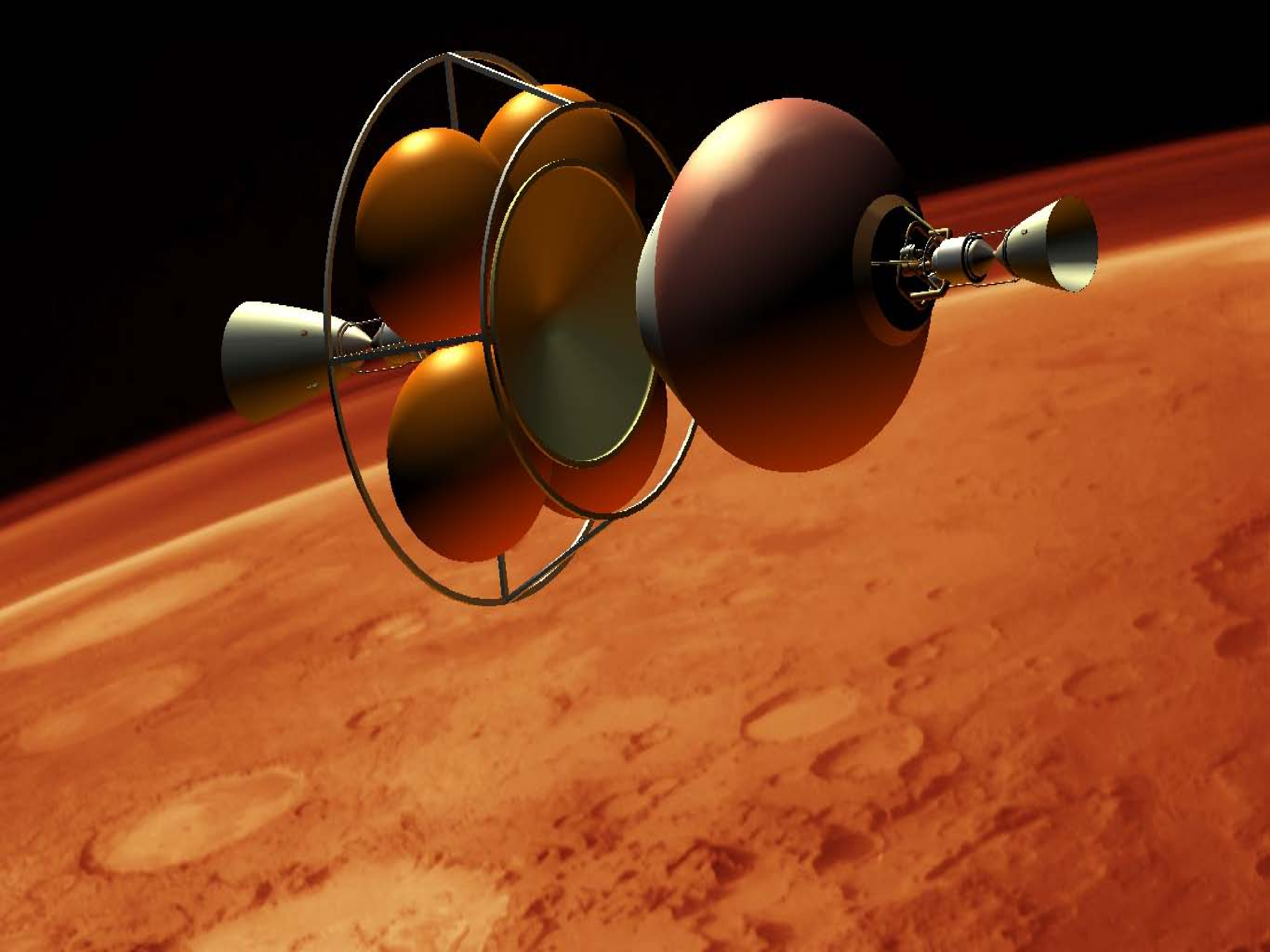
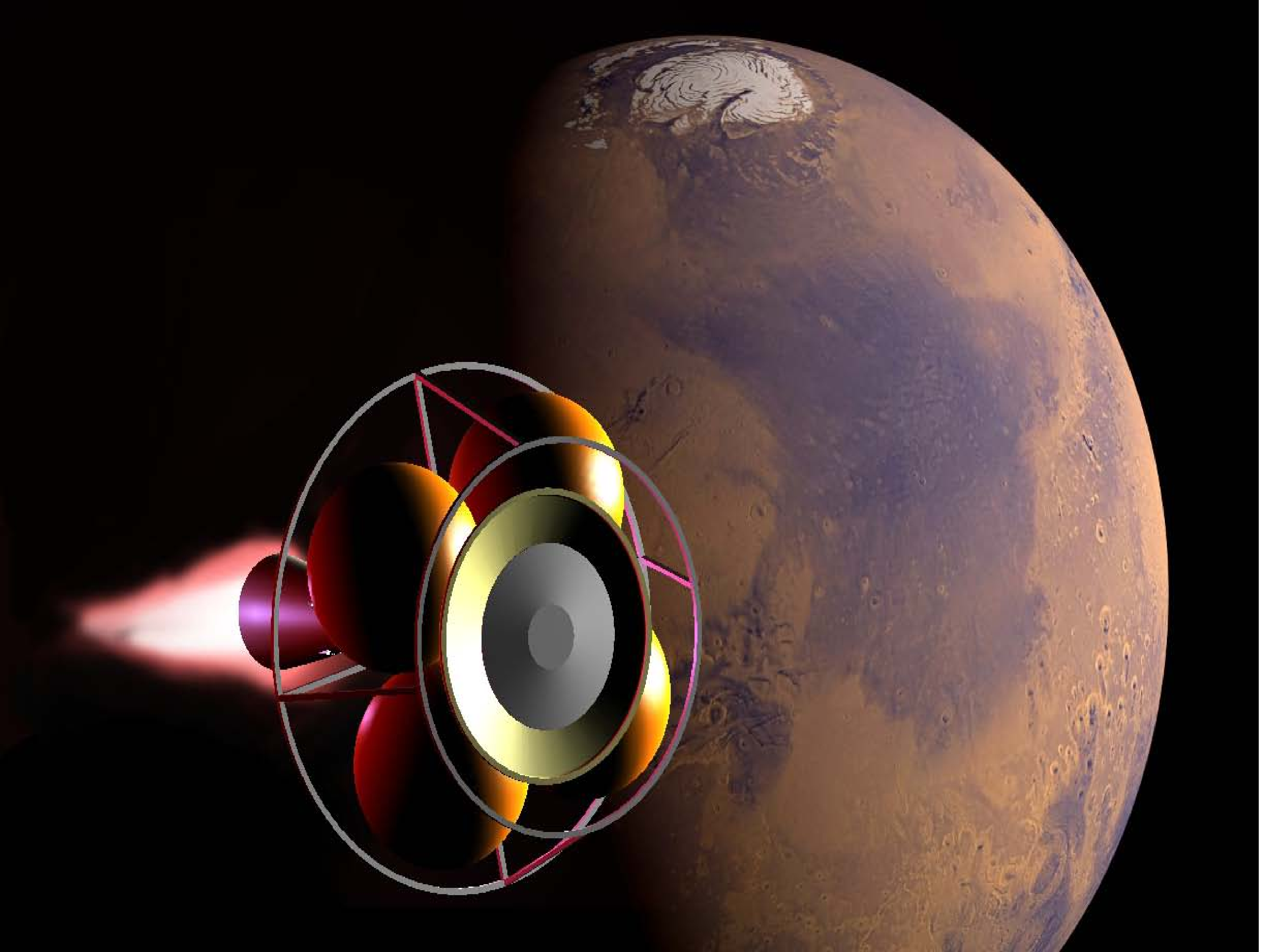




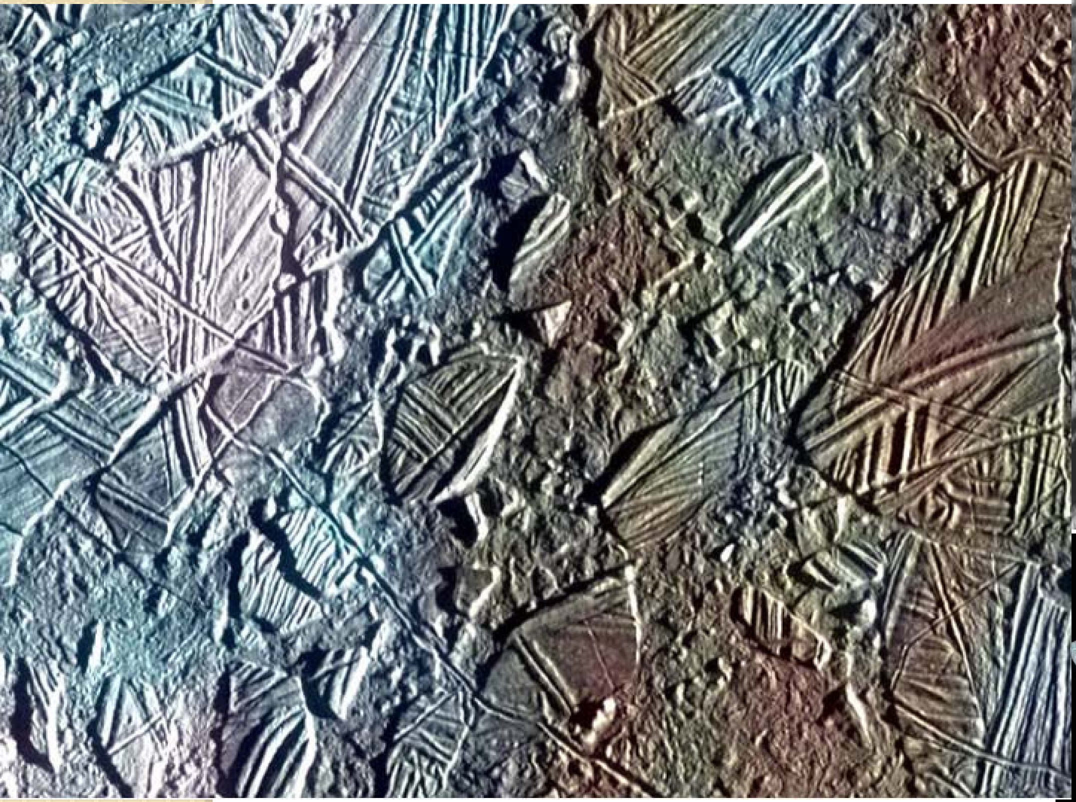


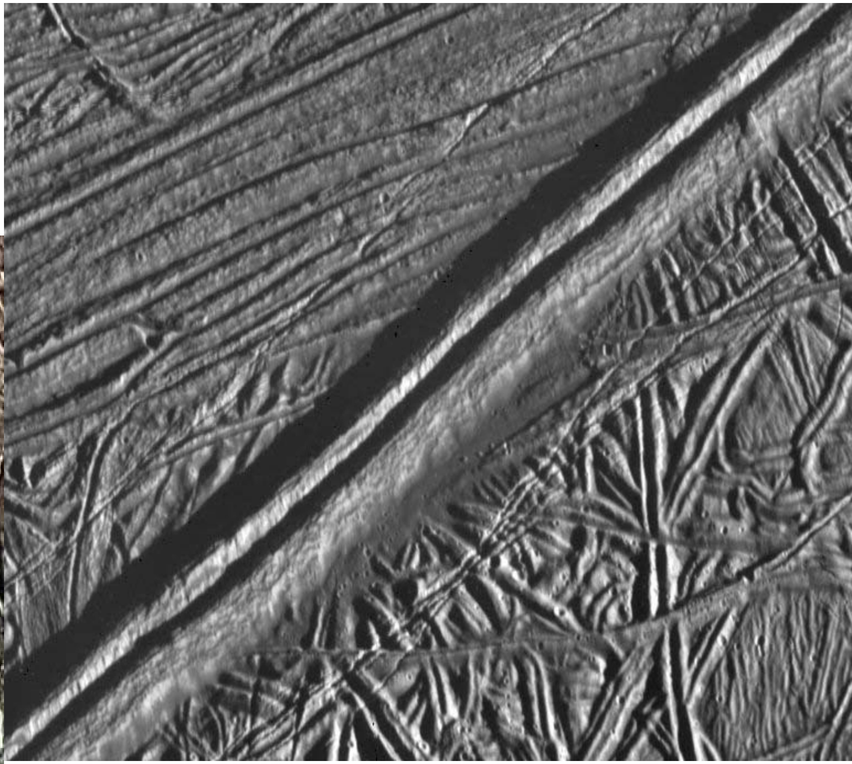


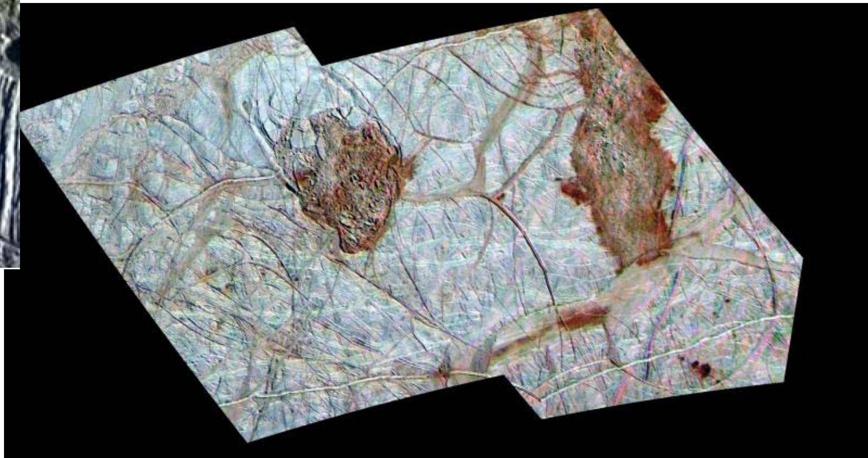




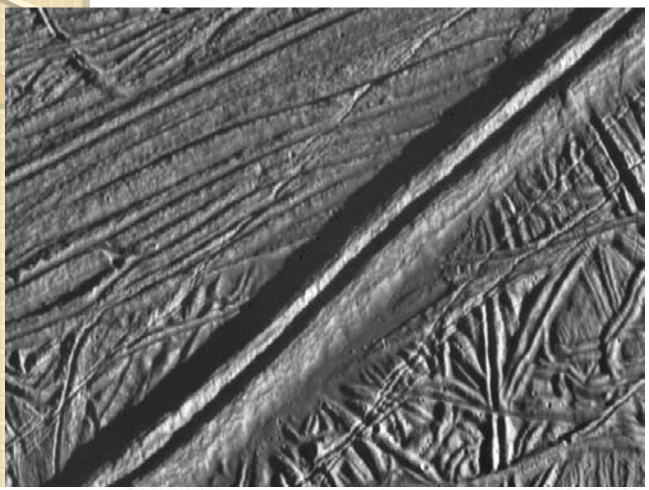
Hopper for Europa

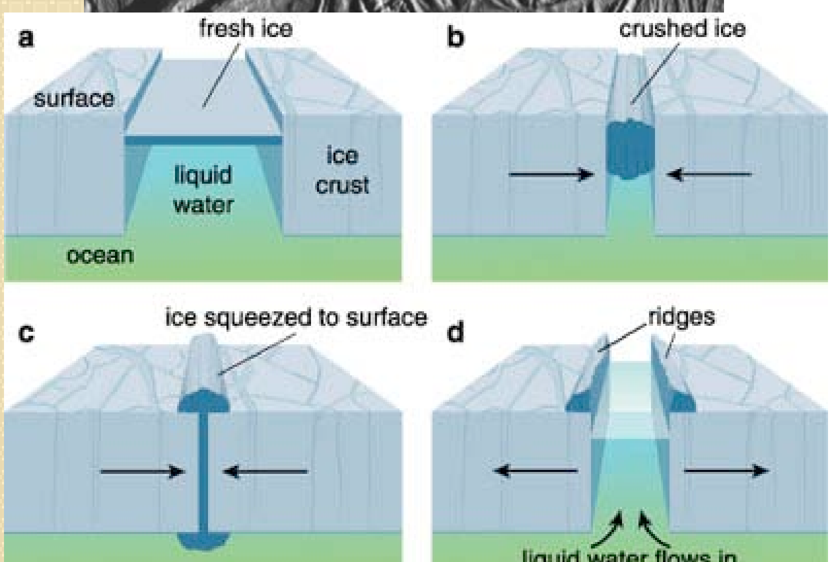


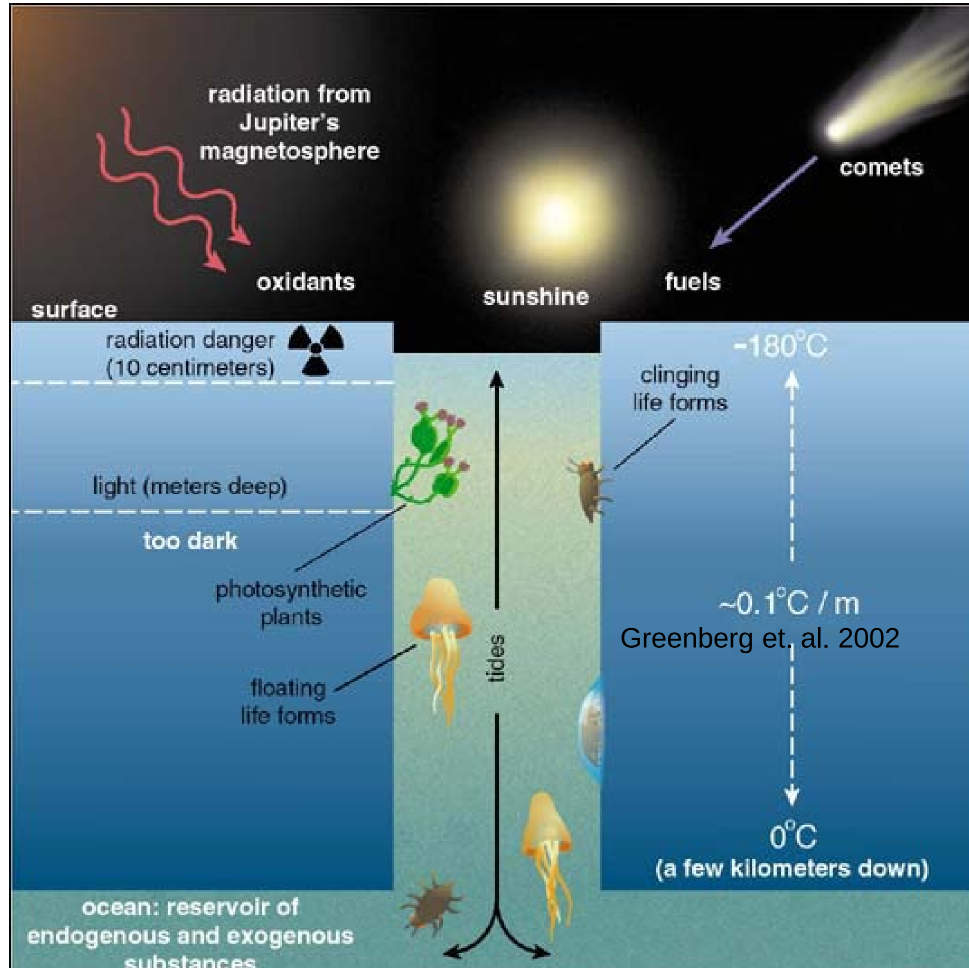




Active cracks allow access to sub-surface ocean water (and organics?)

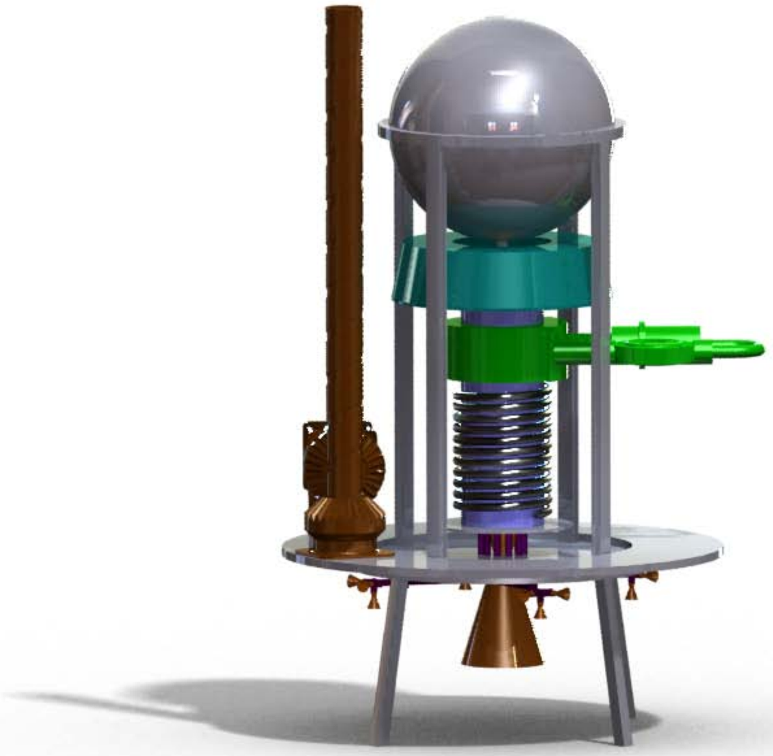






Greenberg et. al. 2002

Final Europa concept model



So if your mission target:

1) is in a gravity well
2) is where the sun don't shine
3) is so cold that the air is frozen
4) is so far that light asks "are we there yet"
5) or needs a craft to keep going and going

Call for Nuclear Power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