Lunar and Planetary Spacecraft

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Solar System Ambassador
Lockheed Martin Aerospace Engineer

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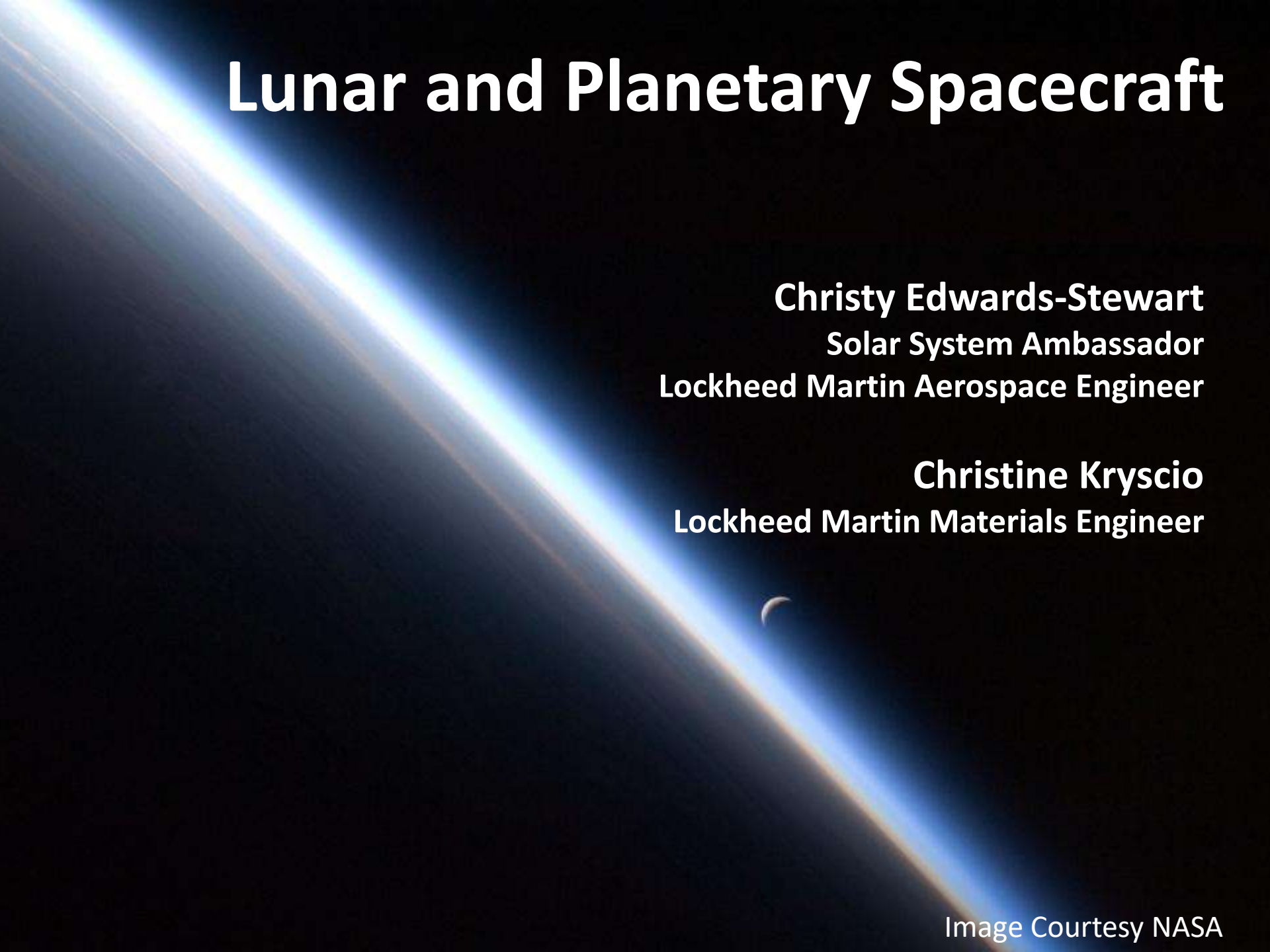
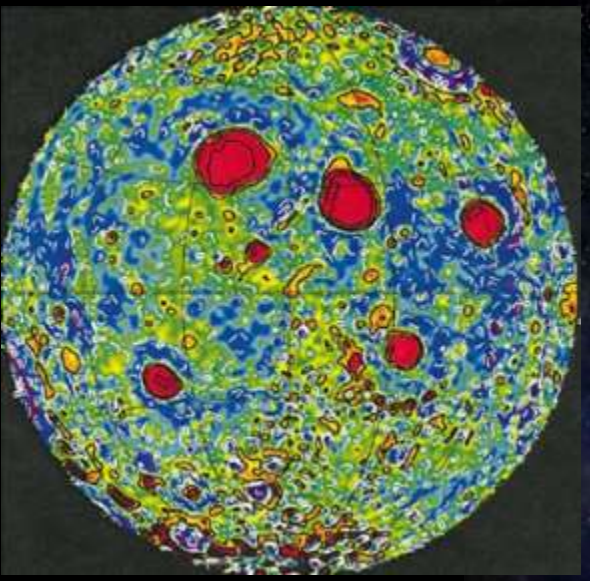


Image Courtesy NASA

Spacecraft Engineering and Operations in Colorado

Images Courtesy Lockheed Martin

- Spacecraft are built in the high-bay at Lockheed Martin
- Engineers and technicians wear “bunny suits” to protect spacecraft
- MAVEN, a Mars orbiter, was the most recent spacecraft to be assembled
- Many NASA robotic spacecraft are flown from Lockheed Martin
- The mission control center has consoles for each subsystem
- Joint team: Lockheed Martin and JPL



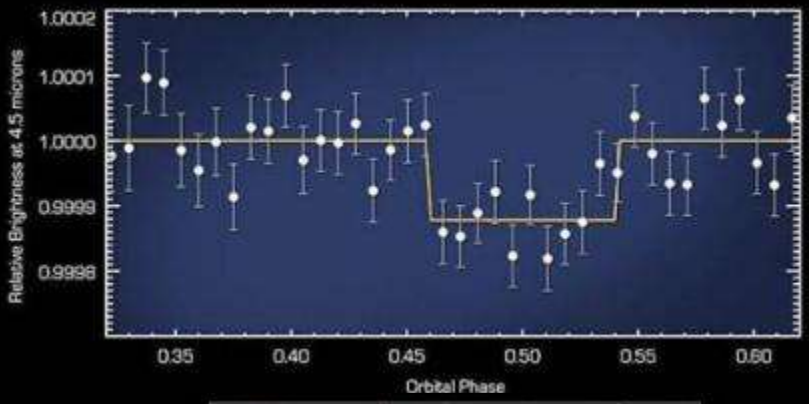
GRAIL

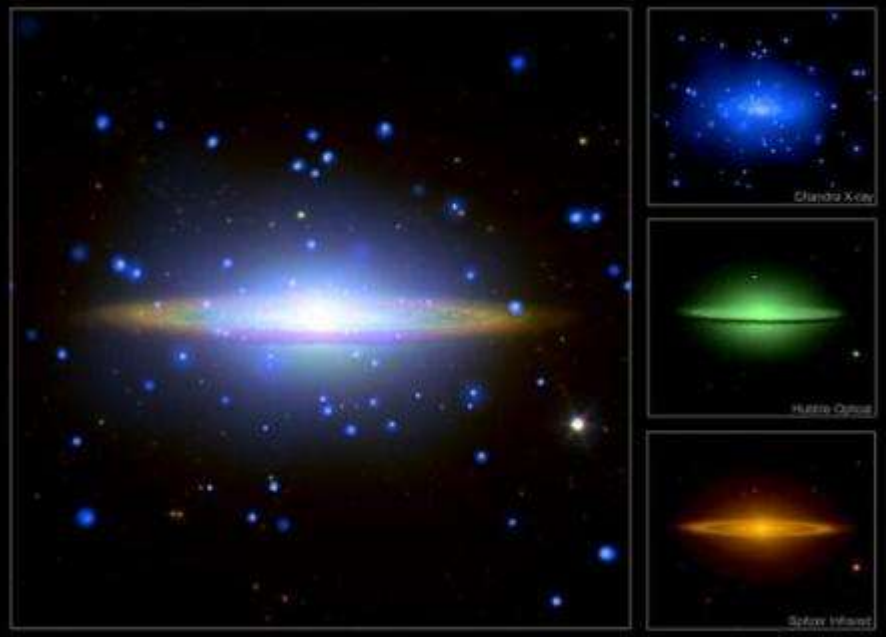
GRAIL Facts - Mission 2011-2012

- **Mission: Mapping the Moon's gravity**
  - Geomorphology and Geology – how Moon formed
- Spacecraft Size: Washer and Dryer Machines
- Flew in formation with 200 km separation distance
- Cruise altitude as low as 8 km (5 miles) above the mountains in extended mission
  - Flew as low as an airplane
- MoonKam provided the opportunity for middle-school students to take pictures of Moon's surface
- End of mission – smashed into the Moon

Images Courtesy NASA/JPL-Caltech

Spitzer





Spitzer Facts – Launched 2003

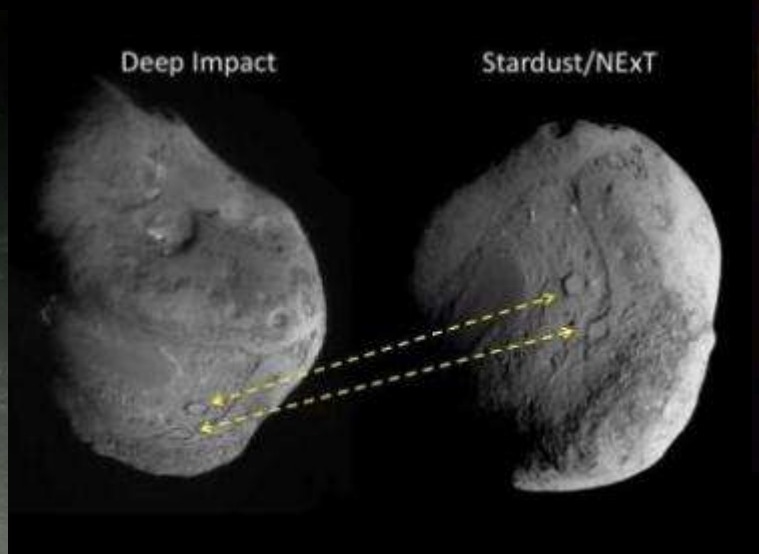
- One of NASA's Great Observatories
- Looks at Infrared light, the heat signature of the universe
  - Can see things that Hubble cannot see, through interstellar dust clouds to the stars forming or exploding inside
- During extended mission, discovered that Spitzer can find planets around other stars

Images Courtesy NASA/JPL-Caltech

Stardust

Stardust Facts – Launched 1999

- Flew by the asteroid Annefrank and the comets Wild 2 and Tempel 1
- Captured comet dust inside material called Aerogel, nicknamed “solid smoke,” and brought them to Earth
- Revisited the Deep Impact crater site
- Basis for new mission OSIRIS-REx



Images Courtesy NASA/JPL-Caltech

OSIRIS-REx and Orion

Osiris-REx Facts - Launches 2016

- Asteroid sample return mission

Orion Facts – Test Flight 2014

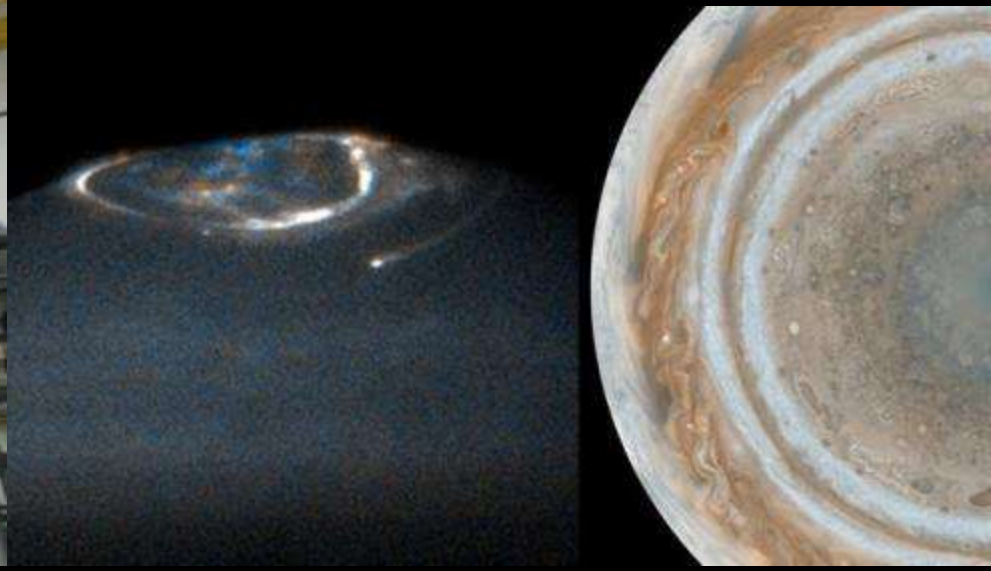
- Spacecraft designed to carry astronauts to deep space locations including asteroids

Images Courtesy NASA

Juno

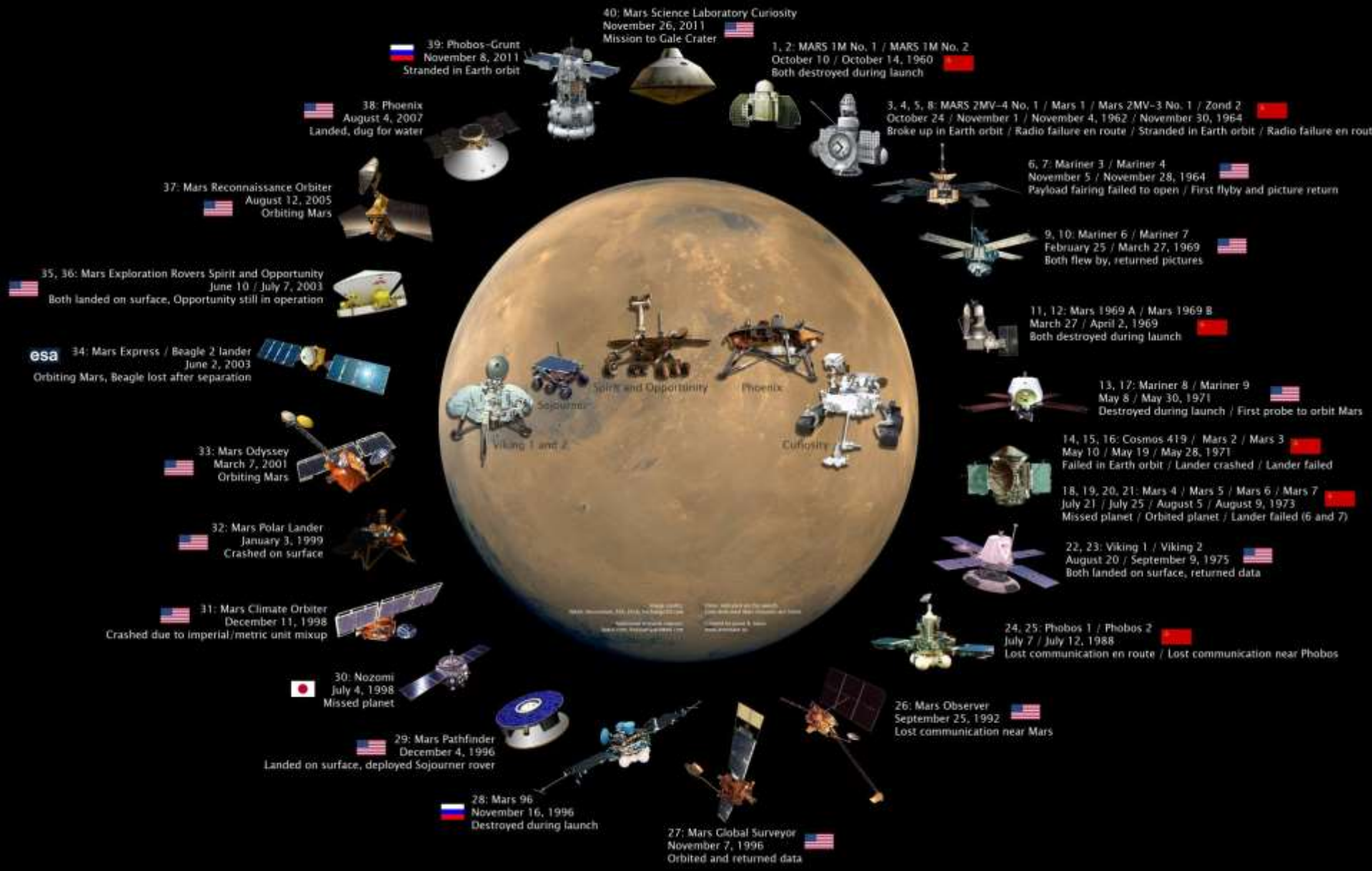
Juno Facts – Launched 2011

- Mission: Study what Jupiter is made of, its gravity and magnetic fields, and its auroras
- Journeyed past Mars in 2012
- Earth Fly-by was October 2013
- Arrives at Jupiter in 2016

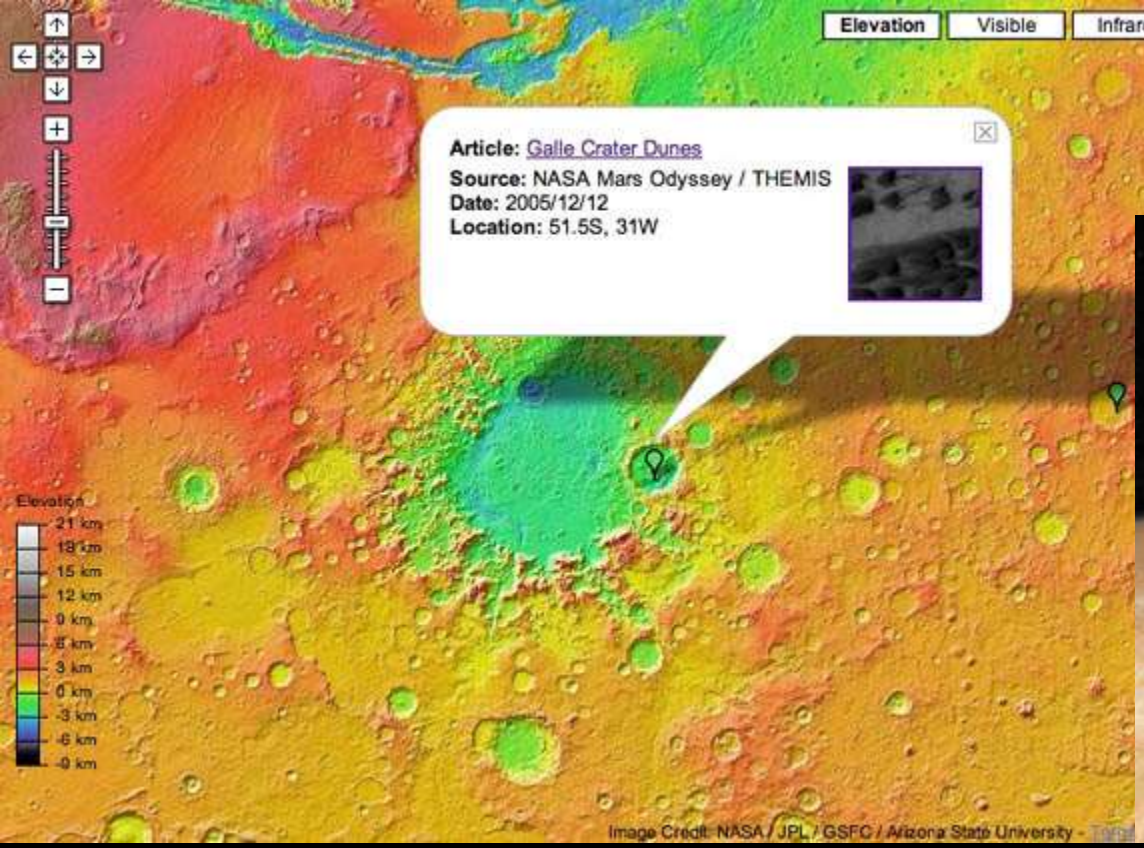


Images Courtesy NASA/JPL-Caltech

Mars Exploration Family Portrait

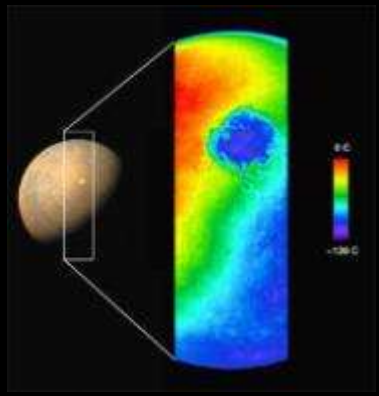


Mars Odyssey



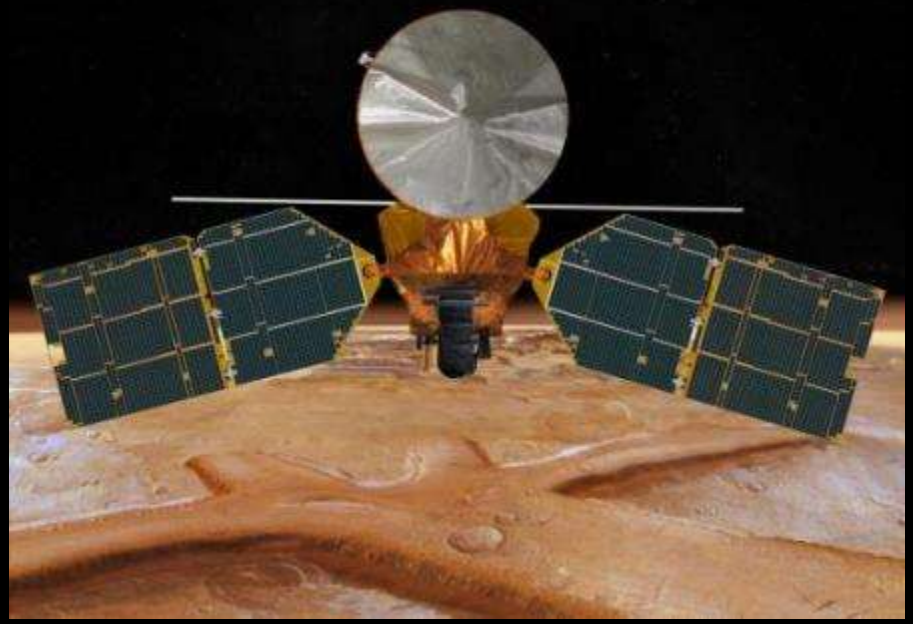
Mars Odyssey Facts – Launched 2001

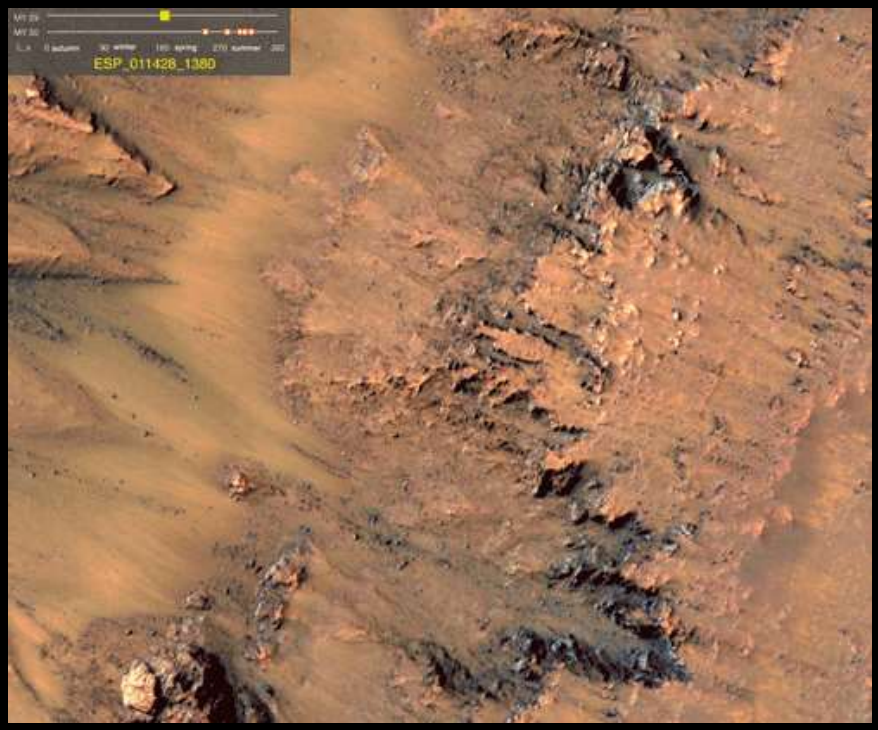
- **Mission: Mapping the Mars Surface and Rover Relay**
  - Infrared camera - looks at the heat signature of Mars
  - Communication with Mars rovers Opportunity and Curiosity
- Aerobraking – used Mars atmosphere to slow down
- Detected water ice at the Martian poles



Images Courtesy NASA/JPL-Caltech

Mars Reconnaissance Orbiter





MRO Facts – Launched 2005

- **Mission: Mapping the Mars Surface and Rover Relay**
  - Martian geology in visible spectrum
  - Communication with Opportunity and Curiosity
- Camera can see rocks the size of beach balls, rover tracks, dust devils
  - Took pictures of rover landing sites
- Discovered what appears to be flowing water on Mars in 2011

Images Courtesy NASA/JPL-Caltech

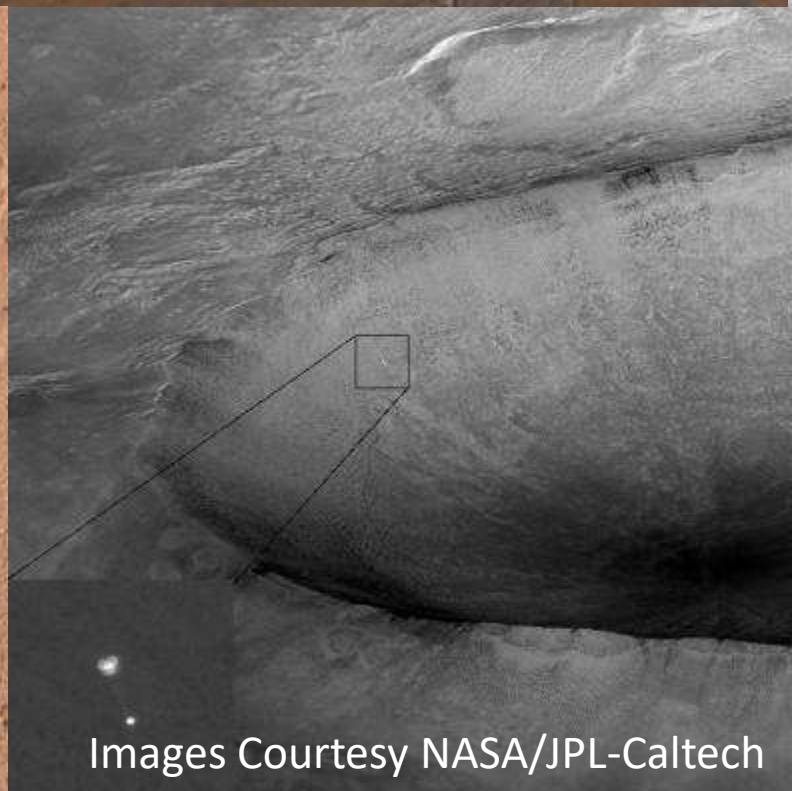
Phoenix and InSight

Phoenix – Launched 2007

- MRO's famous picture: first time a spacecraft has been imaged landing on another planet
- Found water ice beneath the Mars soil, using a scoop

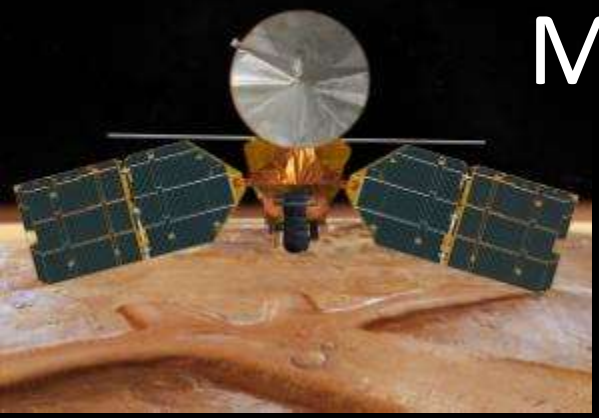
InSight – Launches 2016

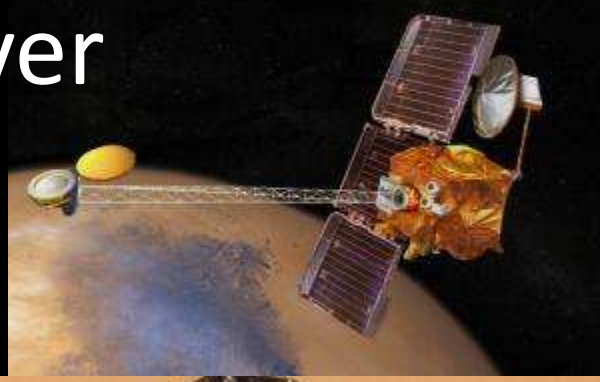
- Spacecraft will look like Phoenix
- Will measure Mars-quakes

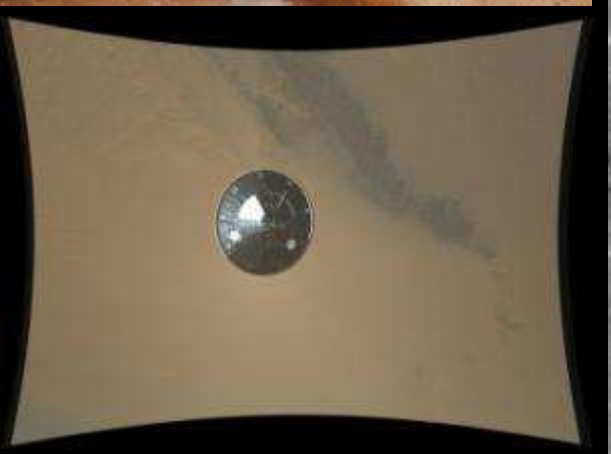


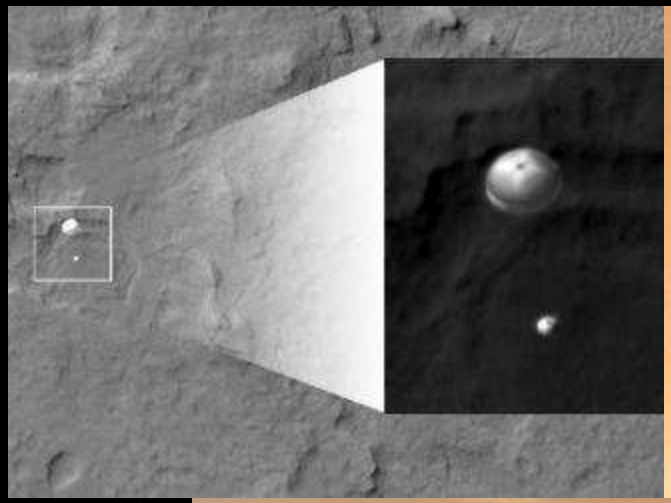
Images Courtesy NASA/JPL-Caltech

Mars Curiosity Rover Landed in 2012!



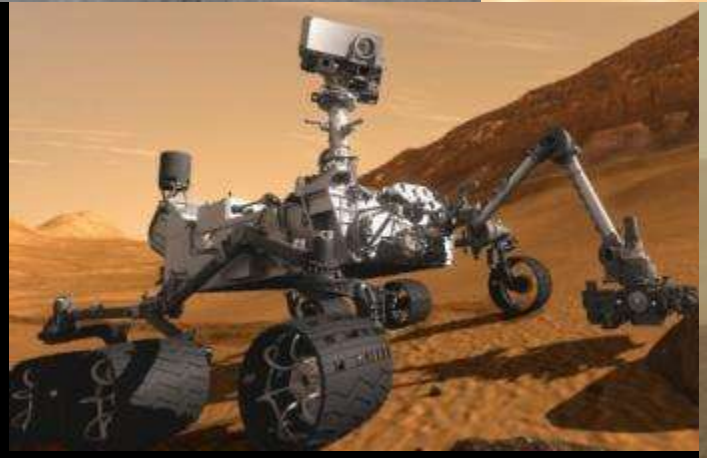






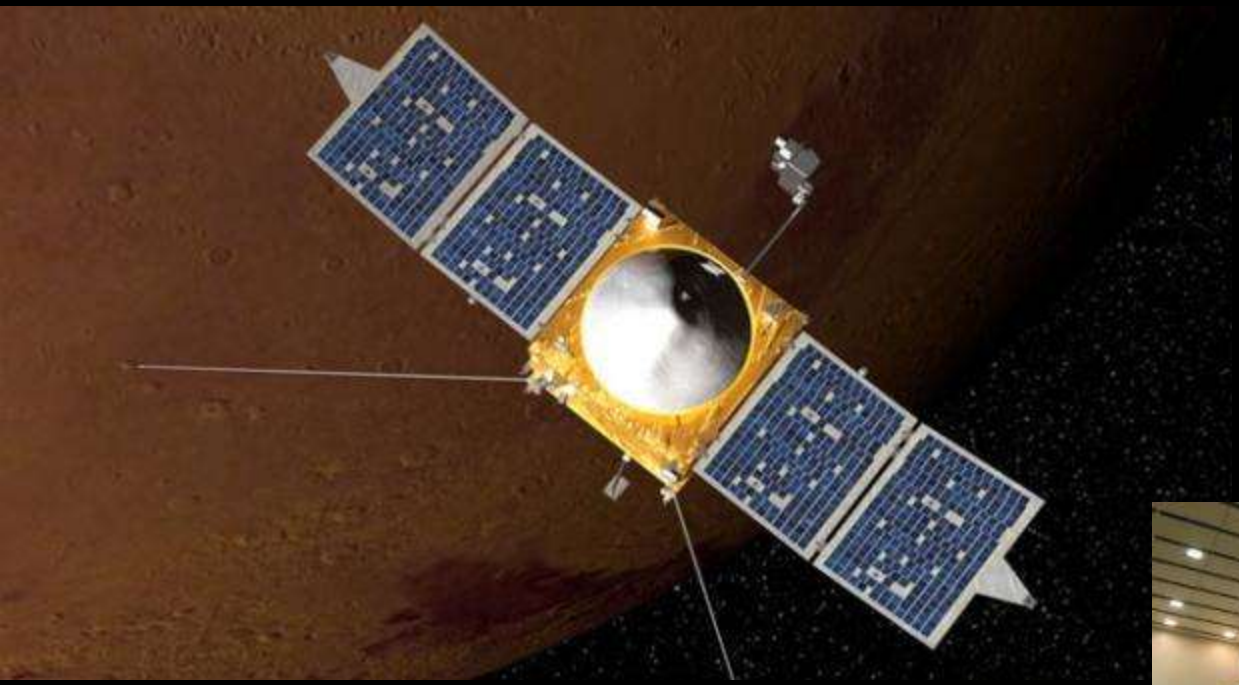
Curiosity Landing Facts

- Heat shield build in Colorado
- Odyssey was communication satellite for rover to send data and pictures to Earth
- MRO took picture of Curiosity parachute and lander



Images Courtesy NASA/JPL-Caltech

Maven

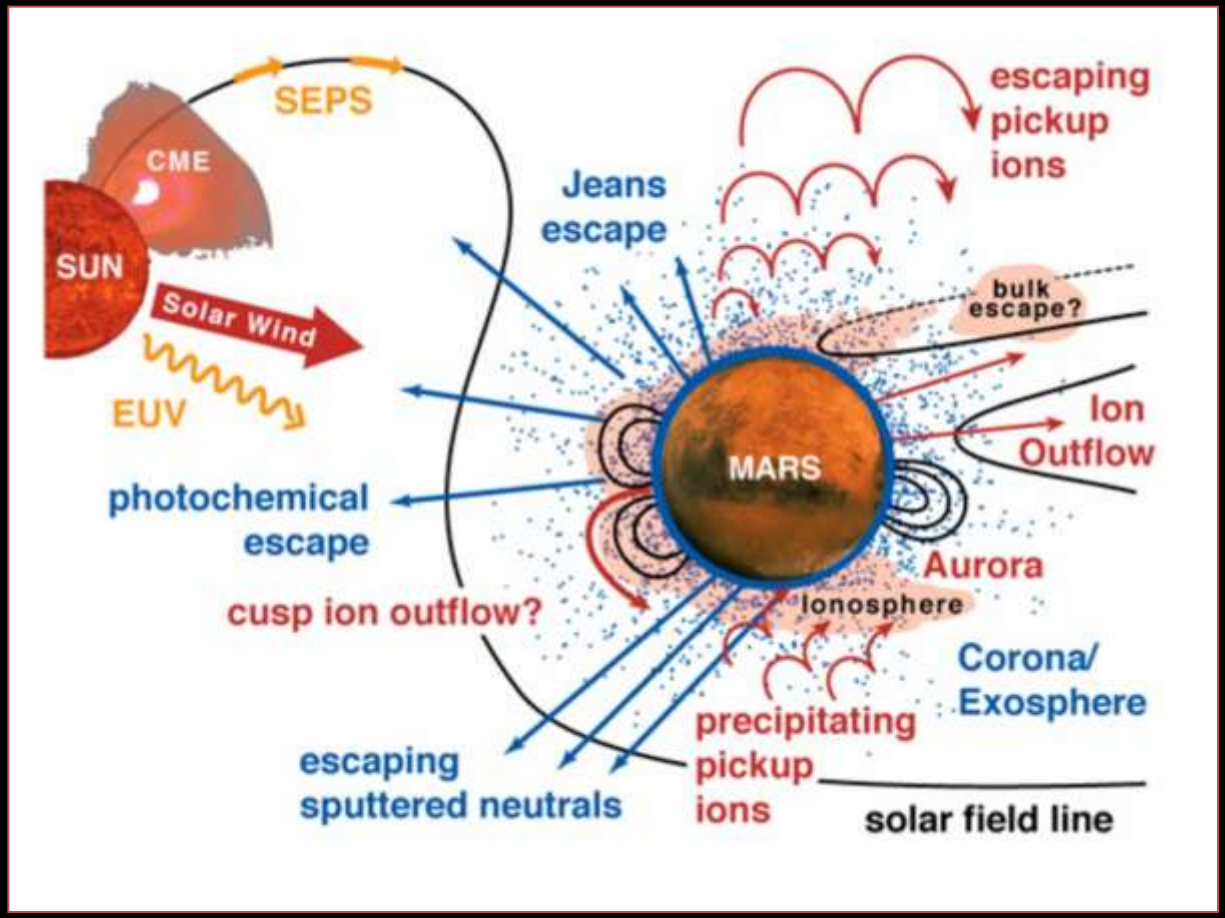


Maven Facts – Launches 2013

- Mission: Study Mars atmosphere and climate
- Will perform “deep dives” into atmosphere

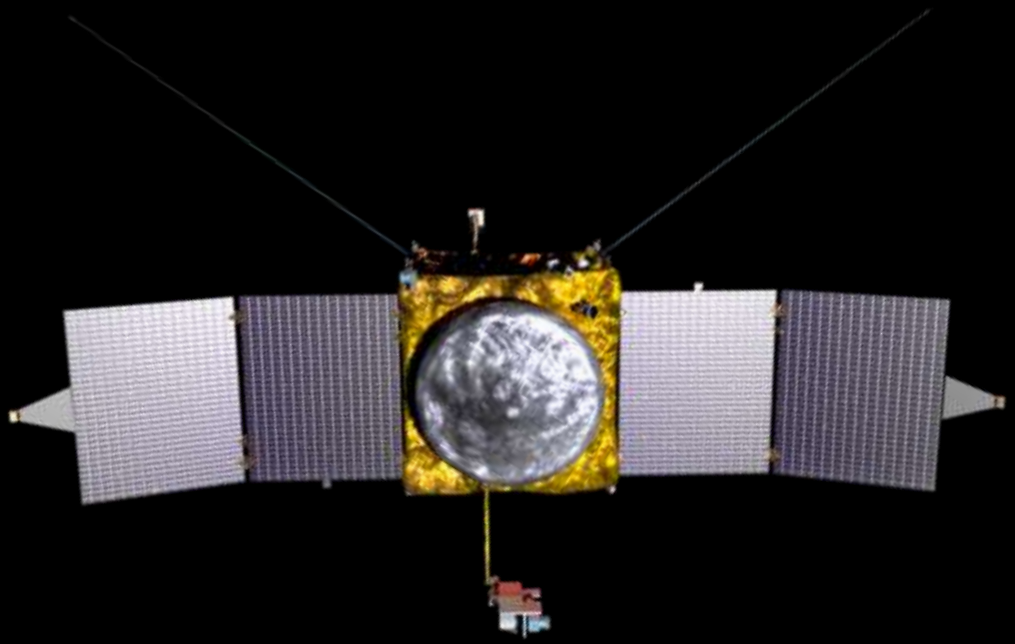
Images Courtesy NASA/JPL-Caltech

MAVEN Will Allow Us To Understand Escape Of Atmospheric Gases To Space



- MAVEN will determine the present state of the upper atmosphere and today's rates of loss to space.
- Measurements will allow determination of the net integrated loss to space through time.

The MAVEN Spacecraft



Same weight fully loaded as a GMC Yukon – 2550 kg.

Same length as a school bus – wingtip-to-wingtip length of 37ft.

MAVEN Fun Facts

- Average power required is ~300 Watts. You could power six spacecraft with the energy required to run the average blow dryer.
- 296 connectors, 1637 splices, 10,396 wire terminations with over 10 miles of wire.
- The MAVEN communication system can transmit data to Earth up to 550,000 bits per second, which is similar to 3G cellphone service.
- The MAVEN fuel tank holds about 500 gallons of hydrazine propellant, or nearly 900 (889) six packs of Coke.
- If MAVEN uses up all its fuel at the end of the mission, it will have traveled about 300 million miles and have gotten about 600,000 miles per gallon.
- The MAVEN spacecraft has two 55 A-hr 28V batteries. That’s enough energy to run your iPad continuously for about a year and a half on a single charge.