JPL Missions Overview

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Outline

• NASA’s Compelling questions
• What is JPL
• JPL Vision for Space Exploration
• JPL Current Missions
• Recent Scientific findings
• Mars Science Laboratory Mission Overview
End-to-end capabilities needed to implement missions

- Project Formulation - Team X
- Mission Design
- Real Time Operations
- Environmental Test
- Integration and Test
- Spacecraft Development
- Mars Rovers
- Large Structures - SRTM
- Ion Engines
Research and technology Development

• Technology to enable future missions: Examples:
  – Mapping Reflected energy Spectrometer (MaRS):
    • Next generation imaging spectrometer for Earth and planetary remote sensing
  – Laser Absorption Spectrometer (LAS):
    • Global scale profiling of tropospheric carbon dioxide
  – Lithium ion battery:
    • Large mass and volume savings with improved performance
  – Ion engine:
    • Long-life (>30,000 hours) mission-enabling characterization
  – Formation flying:
    • Simulation of mission-enabling technology for Terrestrial Planet Finder, Earth Science and astrophysics applications
  – Long wave detectors for astrophysics
    • Far infrared and sub-millimeter high sensitivity detectors
JPL long-term role in Vision for Exploration

- “Explore the solar system and beyond.”
  - Mars exploration program
  - Solar system robotic exploration: outer planets and their moons
  - Search for extra-solar planets
  - Origins program and astrophysics of galaxies and the universe
  - Deep space telecommunications and navigation support
- “Human presence across the solar system.”
  - Continuing and increasing support to ESMD Constellation program
- “Innovative technologies, knowledge and infrastructures.”
  - Continuing technology developments: telecommunications; planetary entry, descent and landing; navigation, guidance and control; deployable structures; power sources and energy storage; observational instruments; flight and ground computer hardware and software; robotics and autonomy
- “International and commercial participation.”
  - Continuing partnerships with commercial and international partners: e.g., MRO built by LMSSC, Huygens Titan lander (on Cassini) by ESA.
Eighteen spacecraft and five instruments across the solar system (and beyond).
Five major current JPL programs

1. Mars exploration: Follow the water
2. Life-friendly sites in the solar system
3. Extra-solar planets
4. Origins of galaxies and the universe
5. Our home planet, Earth
Five major current JPL projects

- **In operations:**
  - Deep Space Network
  - Mars:
    - Mars Reconnaissance Orbiter
    - Mars Exploration Rovers
    - Mars Odyssey
    - Mars Global Surveyor
  - Spitzer Space Telescope
  - Cassini Saturn orbiter
  - Earth Science:
    - Gravity Recovery and Climate Experiment (GRACE)
    - Jason ocean elevation
    - CloudSat

- **In development:**
  - Mars Science Laboratory (2009)
  - Space Interferometer Mission – SIM (2015)
  - Phoenix Mars polar lander (2007)
  - Juno Jupiter orbiter (2010)
  - Orbiting Carbon Observatory
JPL major accomplishments of 2006

- MRO in Mars orbit
- CloudSat launched
- Stardust returns comet samples
- MER rovers in tenth warranty period
- Topex/Poseidon completes 14-year mission
- GRACE detects Greenland and Antarctic ice loss
- Cassini detects water geysers on Enceladus
- Spitzer defines structure of Milky Way spiral arms
- SIM completes technology readiness gates
A permanent presence on Mars

With robotic explorers we have discovered that water flowed on the surface of Mars

Now we are searching for the evidence of carbon based compounds, the building blocks of life!
Comet Tempel 1 before and after Deep Impact

Excavating the interior of comets
Comet particle in Stardust’s aerojel, and 2 micron particle extracted from aerojel

interstellar grains brought back to earth
Spitzer sees center of the galaxy

Exploring the galaxy in the infrared

The Center of the Milky Way Galaxy
NASA / JPL-Caltech / S. Stolovy [Spitzer Science Center/Caltech]
Cassini’s Titan radar sees “great lakes” near Titan’s north pole
Looking ahead: Missions under development

- Phoenix 2007
- Dawn 2007
- Ocean Surface Topography Mission 2008
- Orbiting Carbon Observatory 2008
- MSL 2009
- Kepler 2008
- Aquarius 2009
- Juno 2010
- WISE 2009
- PlanetQuest Space Interferometer Mission, 2015
Mars Science Laboratory: Was Mars a Habitat for Life?

• Was Mars a habitat for life?
  – Largest Rover Mission to date to be Launched in 2009 arrive 2010
  – Will search for carbon based compounds – the building blocks of life as we know it
  – On board laboratory is the most advanced suite of instruments for scientific studies ever sent to the Martian surface
  – Enables a huge step in Mars surface science and exploration capability
    • Landing heavy payload on SFC needed for sample return
    • Precision landing to previously inaccessible sites
    • Demonstrate long-range SFC mobility (20km)
Mars Science Laboratory: Technology

- **Spacecraft**
  - Viking type 4.5 m Aeroshell for entry deceleration
  - Precision guided entry enabling 20km sfc target radius
  - Viking type parachute system deployed supersonically
  - Power Descent Vehicle with retrorocket landing engines
  - Skycrane to lower rover/lander to surface on tether
Mars Science Laboratory: Technology

• Rover: largest and most capable
  – 6 wheel mobility system
  – 850kg with an RTG power source
  – More than twice the size of MER
  – 20km range
  – Larger temp capability

Some of the Instruments
  – X-ray spectrometer
  – Chem-cam
  – Rock core driller and crusher
  – SAM: Laser and mass spec
  – RAD – Radiation detector
  – REMS – Weather monitor
Mars Science Laboratory: EDL

- **Cruise Stage Separation** E-10 min
- **Cruise Balance Mass Jettison**
- **Turn to Entry Attitude**
- **Entry Interface** E+0
- **Peak Heating**
- **Peak Deceleration**
- **Heading Alignment**
- **Deploy Supersonic Parachute**

Exo-atmospheric

- $h = \sim 10 \text{ km MSL}$
- $M = 2.0$
Mars Science Laboratory: EDL

Powered Flight – Includes Powered Descent, Sky Crane, Flyaway

Backshell Separation

Powered Approach

Constant Velocity

Constant Deceleration

Throttle Down MLEs

Rover Separation

Sky Crane

Electrical Bridle Cut

Flyaway

2000 m above MOLA areoid

E+314 s
E+341 s
E+356 s

X-Band Tones
UHF 2 kbps
http://mars.jpl.nasa.gov website for images