Planetary Science Division Update

Presentation at the
Outer Planets Assessment Group

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November 9, 2007

Outline

- Flagship studies
- Administrative
- Mission Status and Plans
- Research & Analysis
- NAC recommendations

Flagship: Key Decision Points

- Flagship studies submitted to Hq and decision briefing discussion with Alan has been scheduled
  - Expect the decision to move forward with one or two of the missions based on cost, risk, and scientific merit
  - Our next steps in coordination with ESA's *Cosmic Visions* will also be discussed
- All the studies have been outstanding community efforts and we thank everyone involved for their enormous effort
  - Next steps are important and it will be essential that everyone gets on board with the results of the upcoming decision
- ESA's *Cosmic Vision* study missions announced
  - PSD will support US scientists involved in all ESA selected missions
  - Working out the details now

Administrative

- A new Discovery Program Scientist has been selected
  - Dr. Mike Kelly (Georgia Southern University)
- A new NASA Post-Doc has accepted to come to PSD - Dr. Sarah Noble
- Successful Hq directed workshops
  - Discovery @15
  - Satellites of the Outer Solar System
  - Next: Planetary Atmospheres (Nov. 6-7, 2007)

Planetary Missions

Events, Status, and Plans

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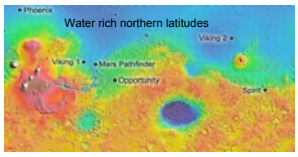
Phoenix Mission On Its Way!

Mission Features

- PI is Peter Smith, U of Arizona
- Two analytical *in-situ* sample analysis instruments:
  - Thermal Evolved Gas Analyzer (TEGA)
  - Microscopy, Electrochemistry & Conductivity Anal (MECA)
- Both instruments use robotic arm for samples
- 3 imagers: Mars Descent Imager (MARDI), Surface Stereo Imager (SSI) and Robotic Arm Camera (RAC)
- Meteorological suite to measure Martian winds, temperature, and pressure

International Involvement

- Canadian Space Agency, Max Plank Institute



Science

- Goal #1: Study the history of water in all its phases with paleo-hydrological, geological, chemical, and meteorological methods
- Goal #2: Search for habitable zones by characterizing the subsurface environment in the permafrost region, measuring concentration of organic molecules, performing water chemistry on wet soils (water provided), and by microscopic examination of soil grains

Status

- Successfully Launched August 4, 2007
- Arrives at Mars May 25, 2008

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Dawn On Its Way!

Mission Features

- PI is Chris Russell, UCLA
- Orbit Vesta then Ceres in asteroid main belt
  - Arrives Vesta in October 2011
  - Arrives Ceres in February 2015
- Science Instruments:
  - Framing Camera (DLR/MPS)
  - Mapping Spectrometer (ASI)
  - Gamma Ray/Neutron Detector (LANL)
  - Gravity Science (JPL)

Status

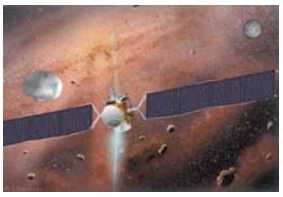
- Launch date: *Sept. 27, 2007*
- Launch Vehicle: Delta 2925 Heavy
- Operational life: 8 years

International Involvement

- ESA member state organizations developing instruments, spacecraft components (solar array: Netherlands) and analyzing data

Science

Dawn's goal is to characterize the conditions and processes of the solar system's earliest epoch by investigating in detail two of the largest protoplanets remaining intact since their formations.



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EPOXI & NExT

- **EPOXI - Combined DIXI and EPOCh use of** *Deep Impact*
  - **EPOCh: Extrasolar Planet Observations and Characterization - L. Drake Deming (PI), NASA GSFC** — Observations using *Deep Impact's* High Resolution Imager will either lead to the discovery of additional low mass (down to one Earth-mass) planets or will set limits on the existence of such planets that will be useful for constraining theories of planet formation.
  - **DIXI: Deep Impact eXtended Investigation of Comets - Michael A'Hearn (PI), University of Maryland** — Uses the existing *Deep Impact* spacecraft for an extended flyby mission to a second comet, Boethin, that will return data advancing our understanding of the nature of comet nuclei.
- **Stardust NExT: A Mission of Opportunity to complete the exploration of Tempel-1 - Joseph Veverka (PI), Cornell University**
  - Uses the *Stardust* spacecraft to perform an extended flyby mission to comet Tempel 1 which will provide the first look at the changes to a comet nucleus after a perihelion passage.

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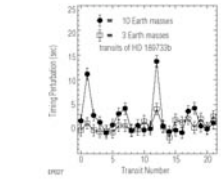
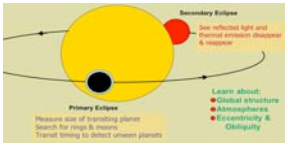
EPOCh Science





- Observe 3 stars known to have transiting hot Jupiters (continuously 1-2 months/star)
- Detect:
  - Timing perturbations due to exterior, smaller planets
  - Eclipses due to exterior smaller planets
  - Secondary eclipses of hot Jupiters
- Search for rings and moons
- Characterize Earth as an astronomical object
  - Calibrate searches for true Earth-like planets
  - Imaging in all filters
  - Near IR spectra

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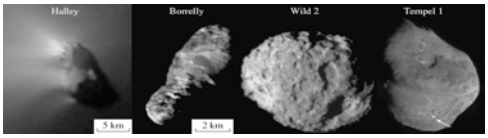
DIXI Science

- Why are cometary nuclei so different?
- How do active areas and jets work?
- Are other nuclei so heterogeneous (topographically and chemically) as Tempel-1?
- Earth flyby - 31 Dec 2007, encounter with comet Boethin 5 Dec 2008



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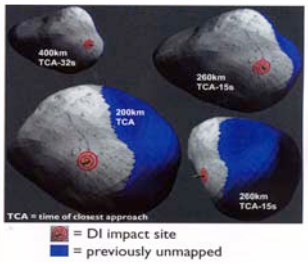
Stardust-NExT Mission

Revisit Comet Tempel-1



- Document surface changes between two perihelion passages
- Extend geologic mapping to elucidate nature of layering and constrain models of interior structure
- Extend study of smooth flows to understand sources and origin
- Image the DI-crater to:
  - Understand crater formation on comets
  - Derive further information of the structure of the outer layers of the nucleus

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Planetary Mission Events

2007	2008	2009	2010	2011	2012	2013	2014	2015
Feb 28, NH @ Jupiter	Jan. 14 MESSENGER @ Mercury		LRO Science Mission	March 3 MESSENGER @ Mercury				
	Chandrayan	April Dawn @Mars		Juno	Discovery			Discovery
June 5, MESSENGER @ Venus	Phoenix Lands	MSL		Discovery			New Frontiers 3	July NH @ Pluto/Charon
Dawn	Oct. 6 MESSENGER @ Mercury	Sept. 29 MESSENGER @ Mercury		Mars Scout 2				
Phoenix	LRO-LCROSS			Fall Dawn @ Vesta		MSO		Summer Dawn @ Ceres

- Planetary Division launches (green)
- Planetary mission events (red)
- Exploration Systems Mission Directorate (blue)

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Selected Phase-A Full Missions

- **GRAIL: Gravity Recovery and Interior Laboratory - Maria Zuber (PI), MIT** — Produce a uniform, global, high-quality gravity field mapping of the Moon that will allow for unprecedented modeling of its internal structure and thermal history.
- **OSIRIS: Origins Spectral Interpretation, Resource Identification, and Security - Michael Drake (PI), University of Arizona** — Survey asteroid 1999 RQ36 and provide return of uncontaminated surface sample to Earth.
- **Vesper: Venus Chemistry and Dynamics Orbiter - Gordon Chin (PI), NASA GFSC** — Advance our understanding of the atmospheric composition and dynamics of Venus, especially its photochemistry.
- Down-selection to be announced *December* 2007

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Mars Scout Selections

- **MAVEN: Mars Atmosphere and Volatile EvolutioN** - Bruce Jakosky (Univ. of Colorado) - Mars climate and habitability and improve understanding of dynamic processes in the upper atmosphere and ionosphere.
- **TGE - The Great Escape** - Jim Burch (SWRI) - Determine basic processes in Martian atmospheric evolution by measuring the structure and dynamics of the upper atmosphere.
- Mission down-selection to be announced January 2008
- Mission of Opportunities include:
  - Mars Organic and Oxidant Detector - J. Bada (UC at San Diego)
  - Mars Organic Molecule Analyzer - L. Becker (UC Santa Barbara)
  - Co-I for Raman-LIBS ExoMars instrument (Alian Wang, WashU)

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Other Mission Studies

- Initiated billion $ box studies and more:
  - Comet Sample Return - APL
  - Venus (emphasis on needed technologies) - JPL
- National Academy's NOSSE study on "guiding principles for the determination of the mission set in the New Frontiers call" continuing
  - Next meeting November 14-16, 2007 at LPI
- National Academy's mid-term grade for how the Planetary Science Division is addressing the Solar System Decadal is nearing completion

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Mars Missions Status and Plans

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MSL Cost Growth Resolution Plan

- June 2007: MSL estimated needs of approximately $75M to complete. Sources of growth included:
  - Instruments; SAM, CheMin, ChemCam, and Malin cameras (totals >$60M).
  - Mechanical Design of Rover body, Corer/drill, Sample Acquisition/Sample Processing and Handling
  - Actuator Design
  - Thermal Protection System testing
  - Parts Procurements
  - Fabrication Services/Labor
- $62M of capacity created by Science Mission Directorate for MSL:
  - $26M in descopes to MSL (well above the defined science floor)
    - MARDI (decent imaging camera) was descoped
    - ChemCam was cost capped (laser induced chemical analysis) - resulting in LANL claimed it would not be delivered
  - $36M new funds from Mars Program reserves
    - This is the max available funding considering other MEP liens (see later)
  - JPL Technical Authority and MSL's Standing Review Board understood and accepted these changes
- Recent developments: both MARDI and ChemCam cost issues have been resolved and will now be delivered to MSL

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Mars Sample Return

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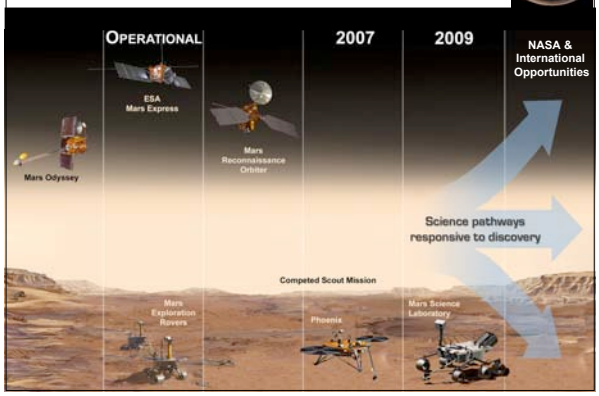
Current Mars Mission Status



MSR is a High Priority Mission

- Sample return is critical to solar system exploration:
  - Increased emphasis on returning samples from various bodies in the solar system within PSD - Stardust success!
  - Interest in Lunar sample missions increasing at NASA
- MSR remains a MEP and US NAS priority.
  - MEP budget cuts in 2005/06 "pushed" MSR well beyond 2020
  - NRC's *Astrobiology Strategy for the Exploration of Mars* reinforced importance of sample return in astrobiology as well as geology, geochemistry.
    - Most recent emphasis of MSR importance
- New Strategy: *Advance Mars Sample Return to 2020*
- Sample return must be thought of as a series of missions with the 2020 mission the first one
- In order to get started on MSR NASA is making plans to place a sample cache on MSL

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MSL Sample Cache

- A multi-center partnership between JPL and ARC:
  - JPL is responsible for initial concept design, integration in ATLO and V&V execution, integration into operations plans
  - ARC is responsible for detailed design, development, delivery and V&V support, and operations concept development with MSL science Team
  - SMD will fund the cache (*out of Alan's reserve!)*
- The following constraints are in effect:
  - The total mass impact to MSL cannot exceed 2 kg.
  - Cost cannot exceed $2M.
  - MSL's technical needs have priority.
  - MSL's project schedule has priority.
  - Cache is not part of the MSL Level-1 requirements or mission success criteria.

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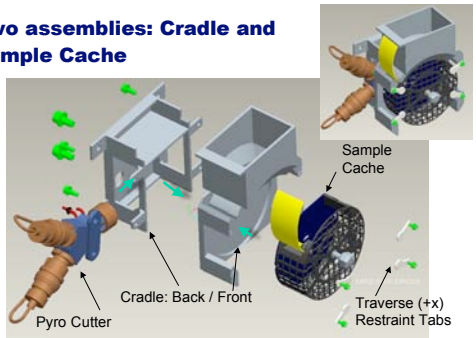
MSL SAMPLE CACHE

Two assemblies: Cradle and Sample Cache



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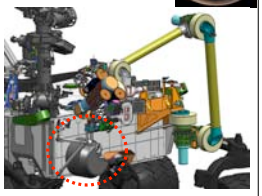
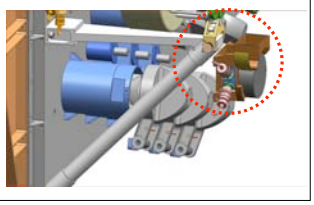
MSL SAMPLE CACHE

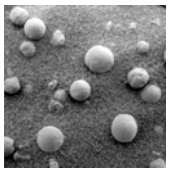


- **Entire assembly bolts to end of current bipod support, below robotic arm elbow.**
- **Located at end of robotic arm launch restraint bipod**



Examples of cacheable rock fragments

It should be relatively easy to cache some of these:



A rock fragment like this could be cacheable, but no guarantees. It might fall out of the scoop during pickup or leveling.

Testing will have to be done to find out how easy it is to cache a particular rock fragment of interest. Other fragments not visible at the surface might end up in the cache.

MER Microscopic Imager images 3 cm x 3 cm

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PSD R&A Program

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R&A Changes

- FY08 enhanced budgets - more than restoration!
  - Increased R&A by ~20%
- FY08 enhanced budget for Astrobiology
  - A 29% increase above last years budget
- New opportunities in ROSES 2007
  - D&MS Mission Concepts closes November 30th
  - Increase in the number of years a proposal can cover
    - C.2 Cosmochemistry - 5 Years
    - C.8 Lunar Advanced Science and Exploration Research (LASER) - 4 Years
    - C.16 Planetary Instrument Definition and Development (PIDDP) - 4 Years
    - C.22 Early Career Fellowships - 5 Years
- ROSES 2008 Changes:
  - DDAP to Planetary Mission Data Analysis Program (any PDS, ADS archive data plus data restoration!)
  - More 4 yr opportunities
  - Jupiter Data Analysis Program - expanded beyond NH
  - Rocket & Balloon opportunity will appear in Planetary Astronomy call

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New Mission Concepts Study Call

- Open up new vistas in planetary science
  - Determine if Discovery and Mars Scout can use Radioisotope Power System (RPS) capabilities
- Approach:
  - Call for concept mission proposals has been issued
  - Six month studies
  - Post (non-propriety) study results on the web
  - Analyze the final reports and modify future Discovery & Mars Scout calls accordingly
- Study requirements for the new mission concepts:
  - Stay within the cost cap of the programs (ie: Disco $425M)
  - Assume Stirling RPS units (~280 w) is GFE!
  - Must demonstrate a need for RPS capability

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NASA LUNAR SCIENCE INSTITUTE (NLSI)

- Establish a lunar science institute
  - Central Node at a ARC to open March 2008
  - Remote Nodes at Universities, other Centers, non-Profits
  - Funded from President's FY08 Lunar Initiative
- Provide for focused research *teams* larger than PI-led R&A
  - NLSI will establish research nodes through an upcoming proposal call
  - Address basic lunar science, lunar sorties and outpost applications (e.g., lunar astronomy)
  - Each Node to be initially funded 3 years, then up for renewals that can be up to 5 years.
  - Remote Nodes: $750K-$2M/yr, starting before the end of 2008
- ESMD science needs covered by funding one or more nodes

Planetary Mission Of Opportunity

- NASA making plans to release a MoO call in '08
  - Anticipate MoO call to be annual as the budget allows
  - Takes advantage of partnering that arises year-to-year
  - Must advance Planetary Division's strategic goals
- Funding coming from Discovery, Mars Scout, Lunar Research, & New Frontiers programs
  - If successful, future MoOs will not be tied to Mission AOs
- Request for information on active partnering with other organizations and space agencies on space missions
  - Request for information closed on Sept. 21, 2007
  - Received ~100 responses with ~25 for planetary
  - Currently analyzing the results and expect that the information will be used to develop planetary's portion of the MoO
- Expect a Spring 2008 release

Recent NAC Recommendations

Small Bodies Assessment Group

- Short title of proposed recommendation: **Create a Small Bodies Assessment Group**
- Short Description of Proposed Recommendation:
  - Recommend that NASA approve the formation of a Small Bodies Assessment Group under the Planetary Sciences Subcommittee.
- Background: A large community of space scientists focus their research on the smaller bodies of the Solar System, including asteroids, comets, dust particles, irregular satellites, Trojans, Centaurs, and Trans-Neptunian Objects (TNOs).
- The interests of this community have been represented, to date, by the Outer Planets Assessment Group (OPAG); however, the interests of OPAG focus on the giant planets and their major satellites.
- Establishment of SBAG will ensure full participation of the Solar System small-bodies community in NASA planning
- PSD is ready to implement this recommendation when delivered by the 9th Floor