



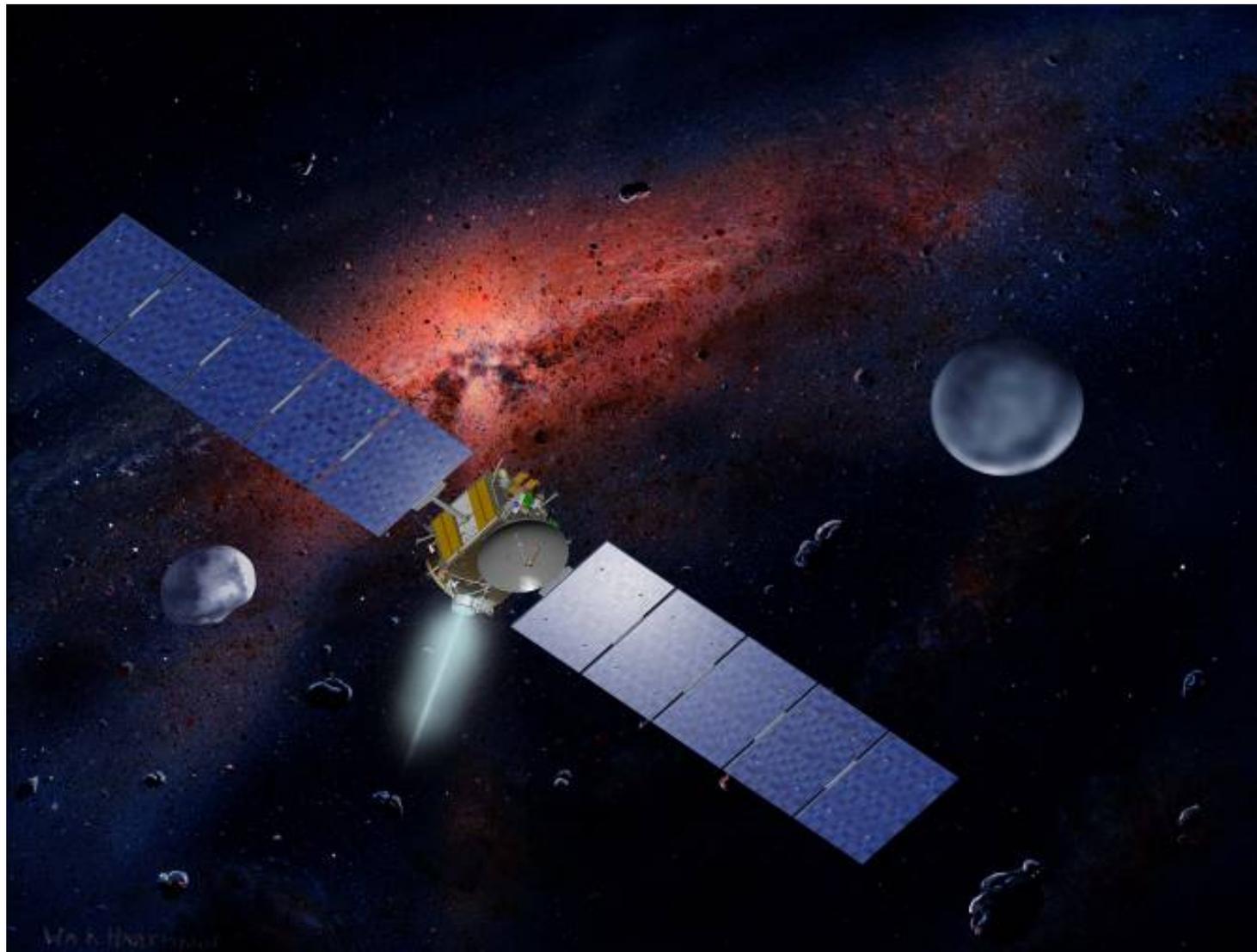
NASA's Dawn Mission Journey to the Asteroid Frontier

Lucy McFadden, Co-Investigator
University of Maryland
College Park, MD
January 12, 2009
SBAG update

Dawn



9th Discovery Mission



Dawn



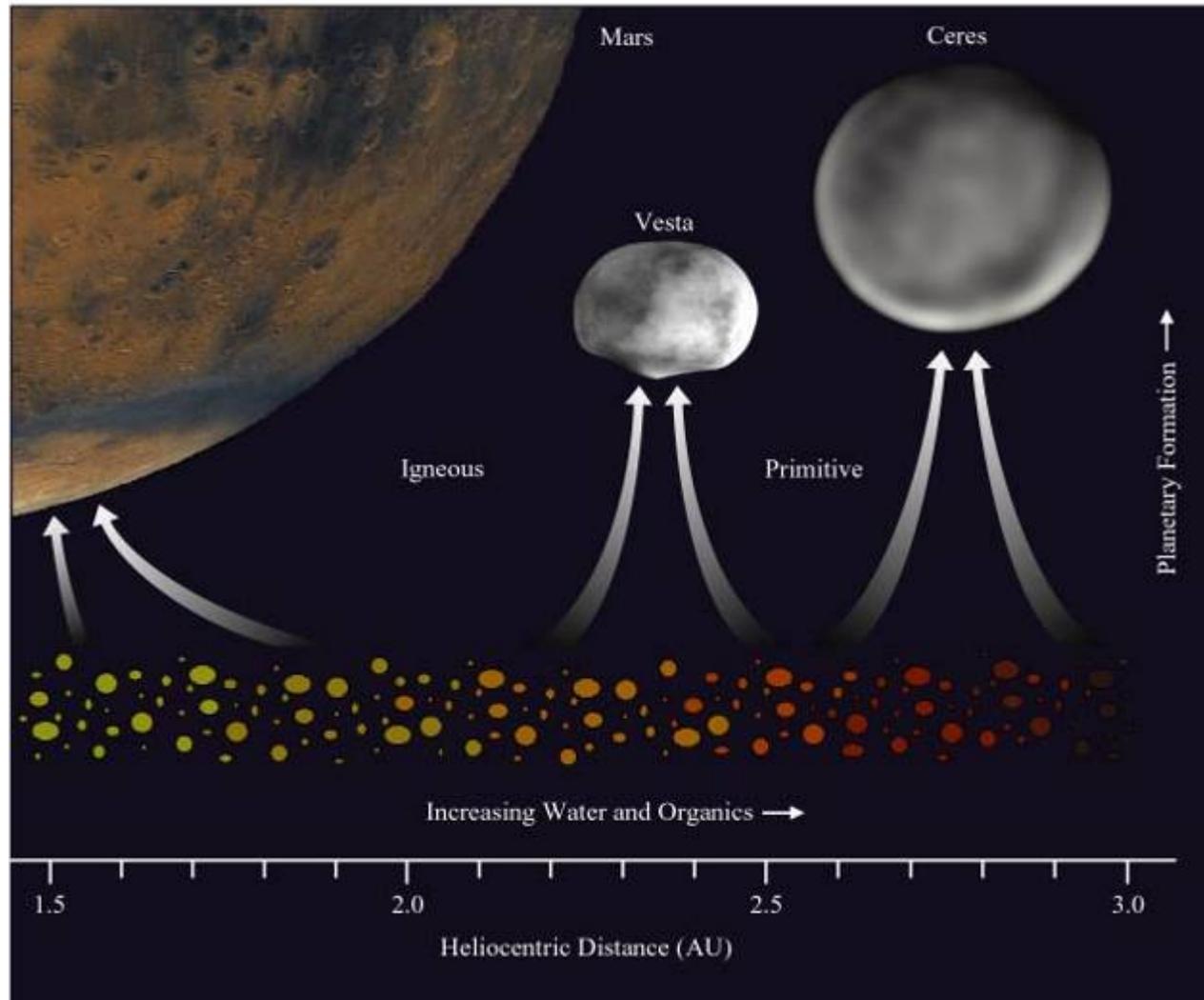


Dawn Explores the Earliest Epochs



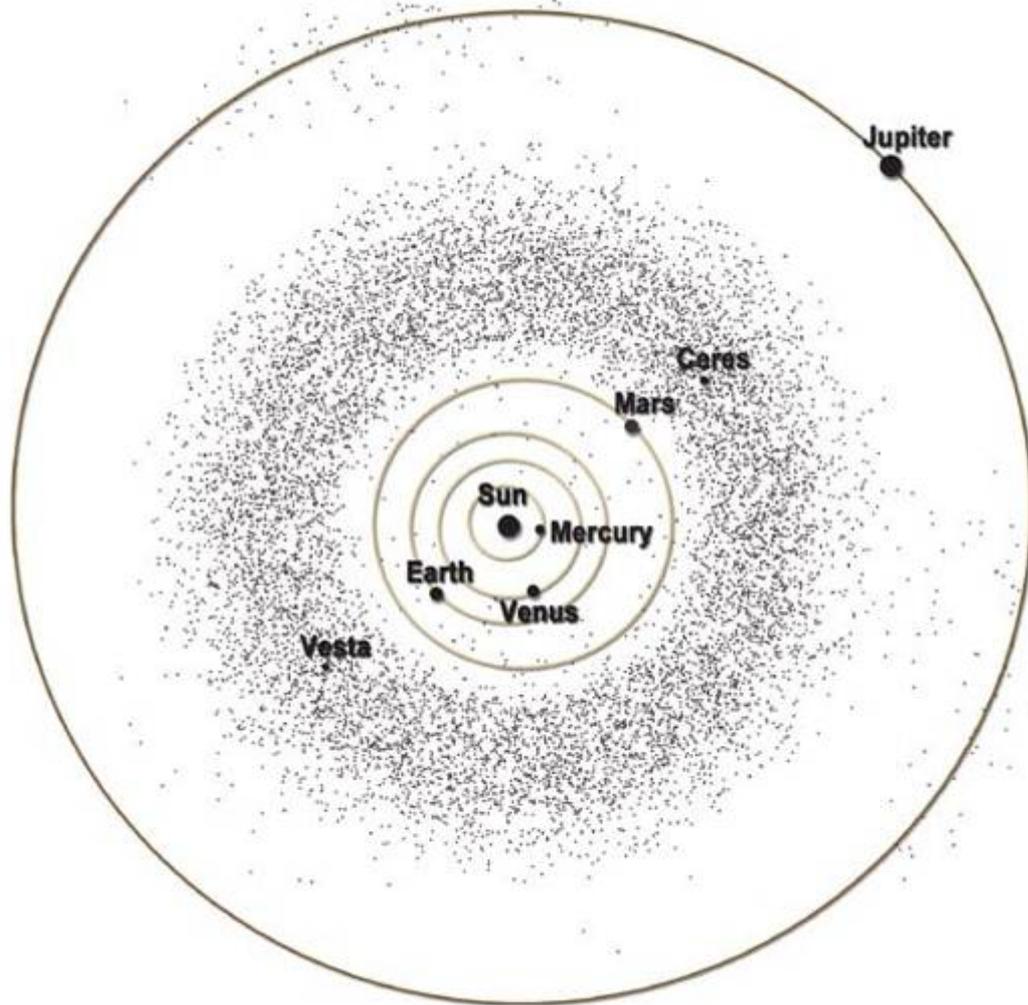
Vesta and Ceres are intact survivors of the earliest epoch of planetary formation.

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The Asteroid Belt



Dawn



Launched Sept. 27, 2007

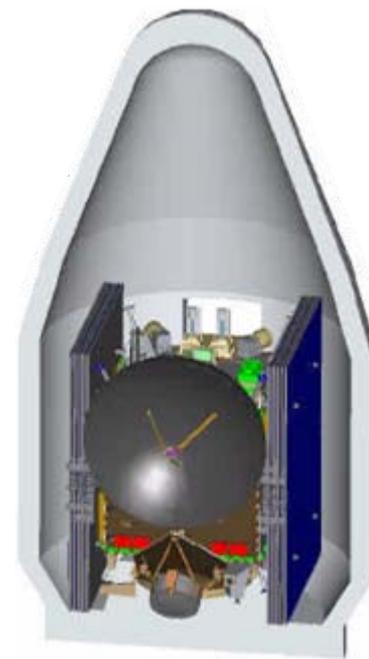


Dry mass: 745 kg

Wet mass: 1240 kg

Solar array power (1 AU): 10.3 kW

Solar array power (3 AU): 1.3 kW



Delta II 7925H-9.5

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Ion Propulsion System

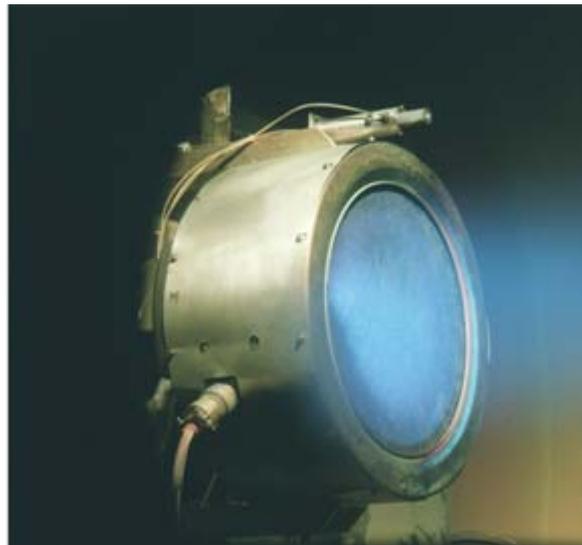


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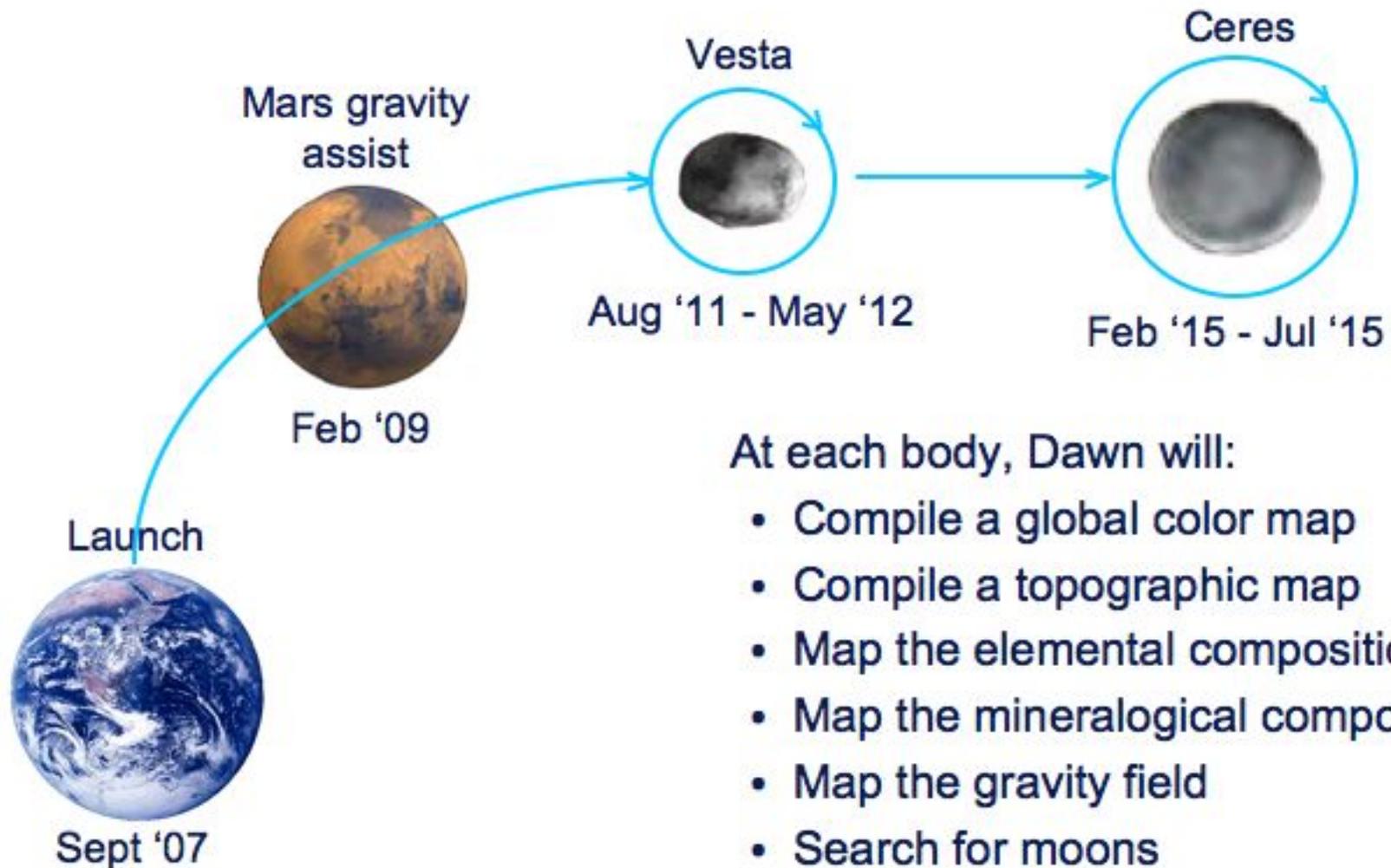


Deep Space 1

8-Year Journey made possible by ion propulsion. IPS will thrust for more than 50,000 hours.



Dawn Mission Itinerary

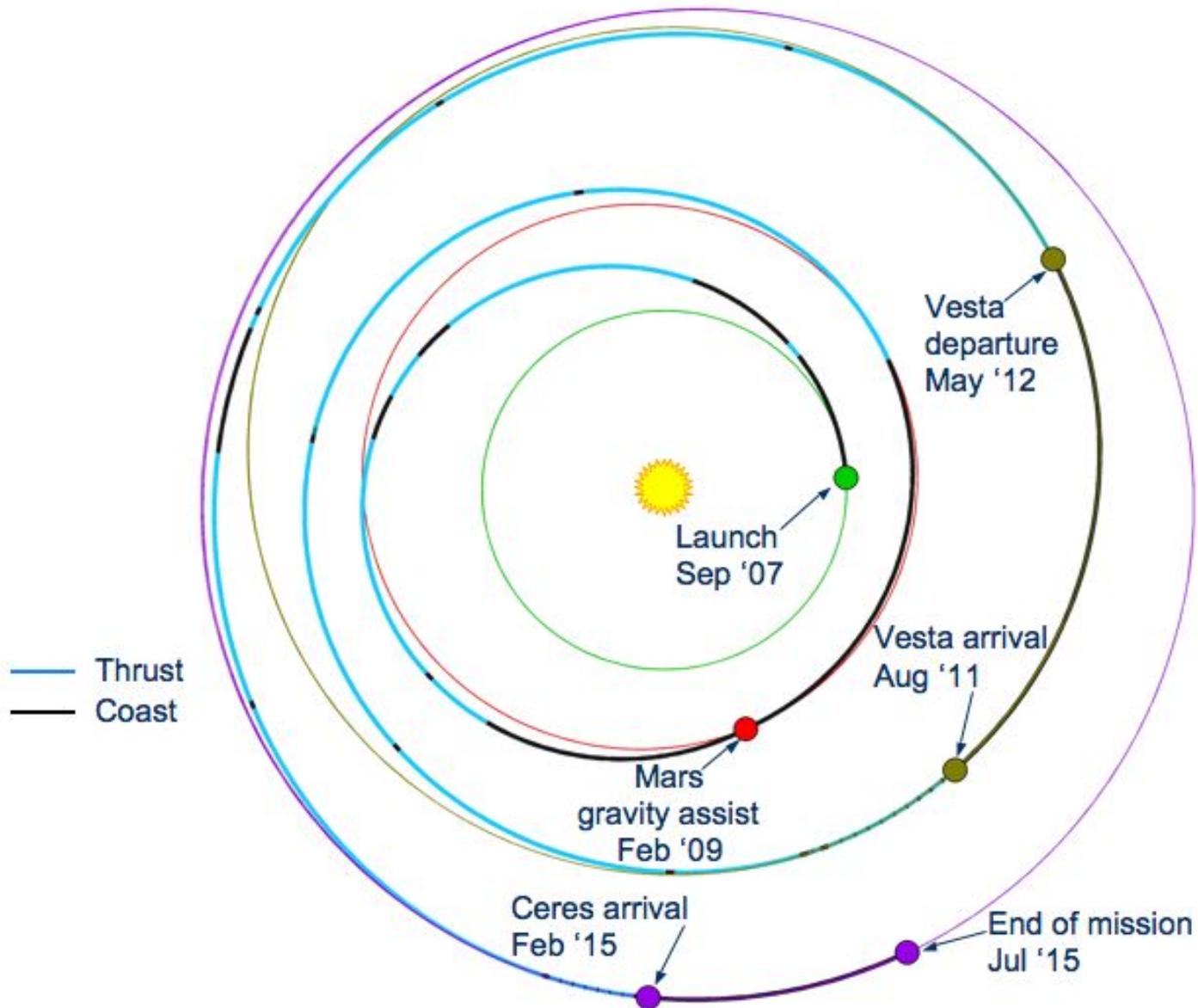


At each body, Dawn will:

- Compile a global color map
- Compile a topographic map
- Map the elemental composition
- Map the mineralogical composition
- Map the gravity field
- Search for moons



Interplanetary Trajectory



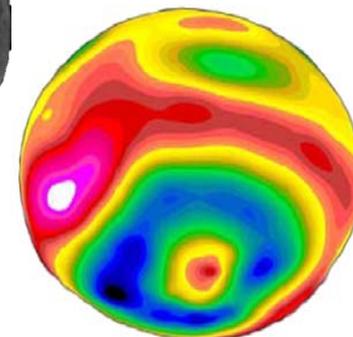


Science Return - Data Sets



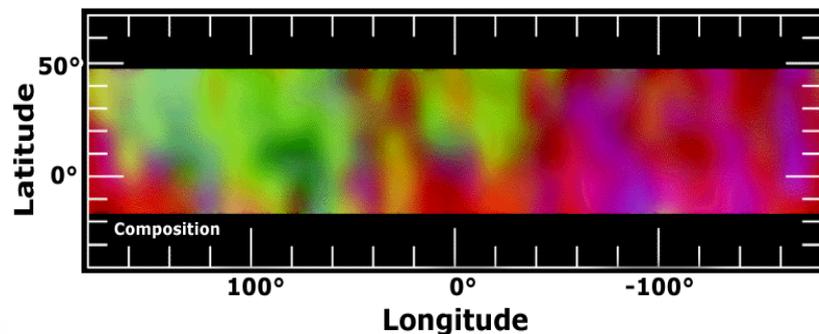
■ Framing Camera

- Near-global image mosaics in three filters
- Three clear maps in different view angles for topography



■ VIR

- Spatially-averaged high-spectral resolution near global coverage
- High-spatial/high-spectral coverage of sparse global grid and selected targets



Dawn

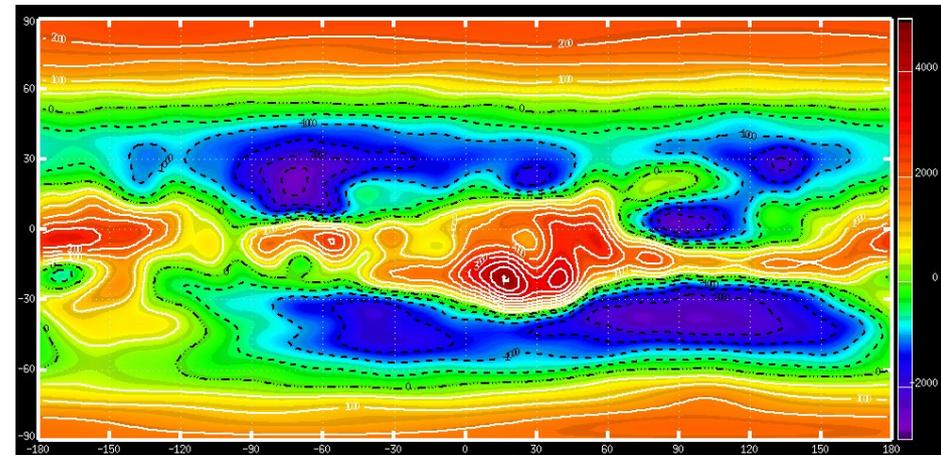
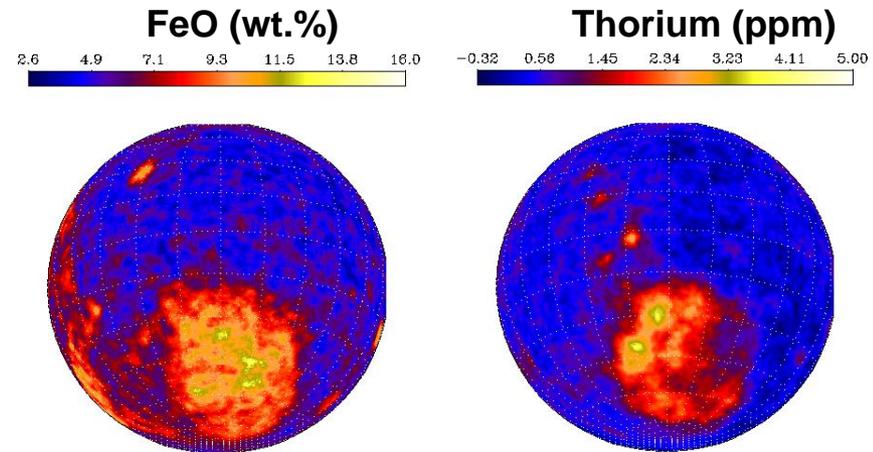


Science Return - Data Sets



■ GRaND γ -ray/ Neutron Detector

- Maps of major and selected minor element abundance with greater than 36 pixels (Vesta) and >10 pixels (Ceres)
- Hydrogen abundance map for Ceres (and possibly Vesta)



Gravity

- Coefficients of spherical harmonic expansion to degree 9 (Vesta) and 5 (Ceres)

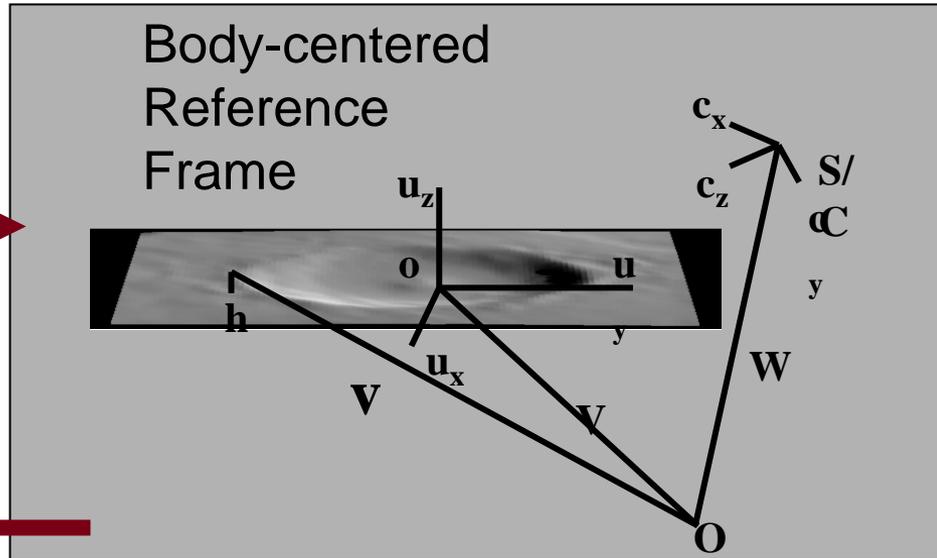
Dawn



Science Return Integrated Data Products



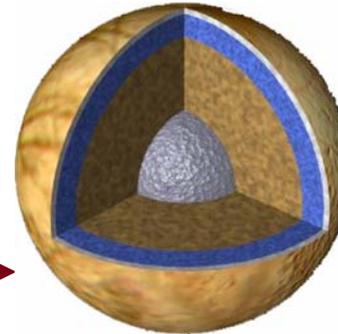
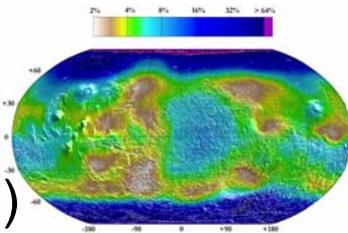
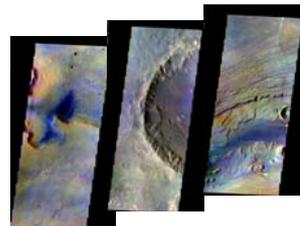
- Topographic shape model and grids
- Higher resolution local elevation grids
- Gravity map



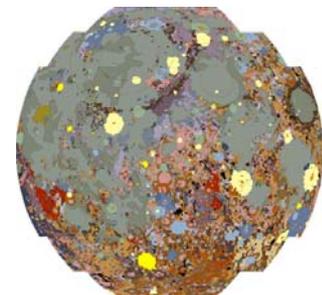
Registration of:



- Image mosaics
- Mineral composition maps
- Elemental abundance maps (deconvolved)



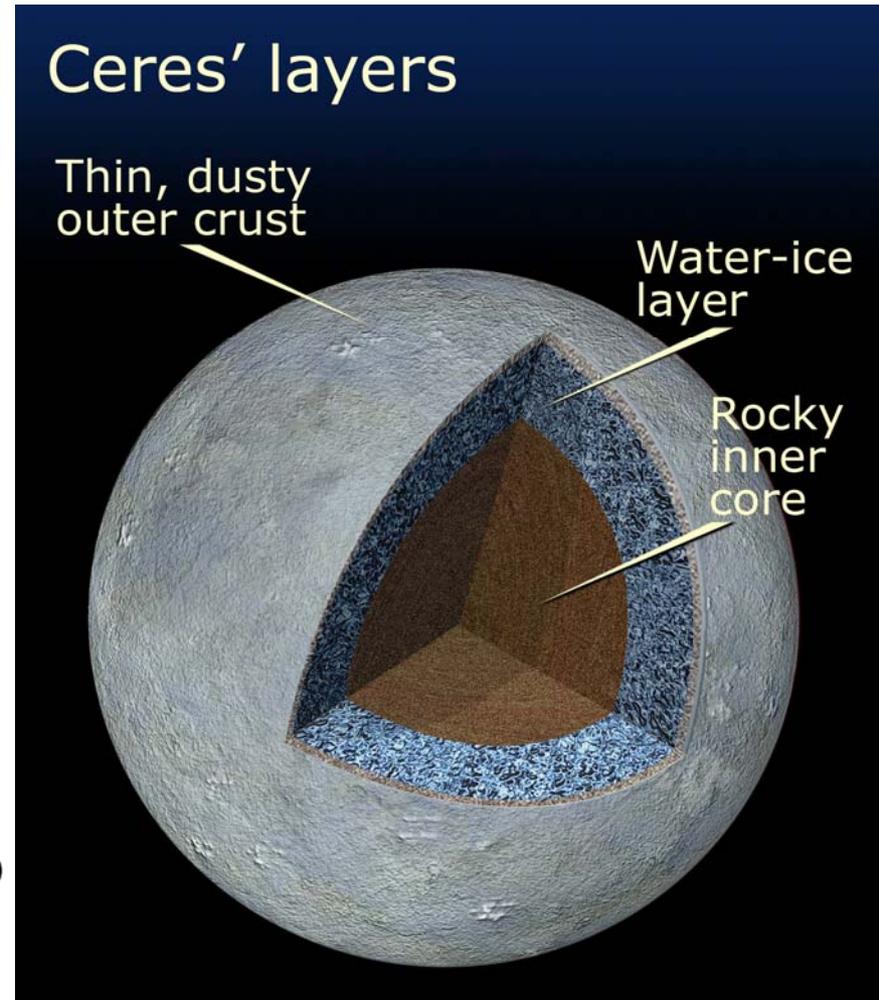
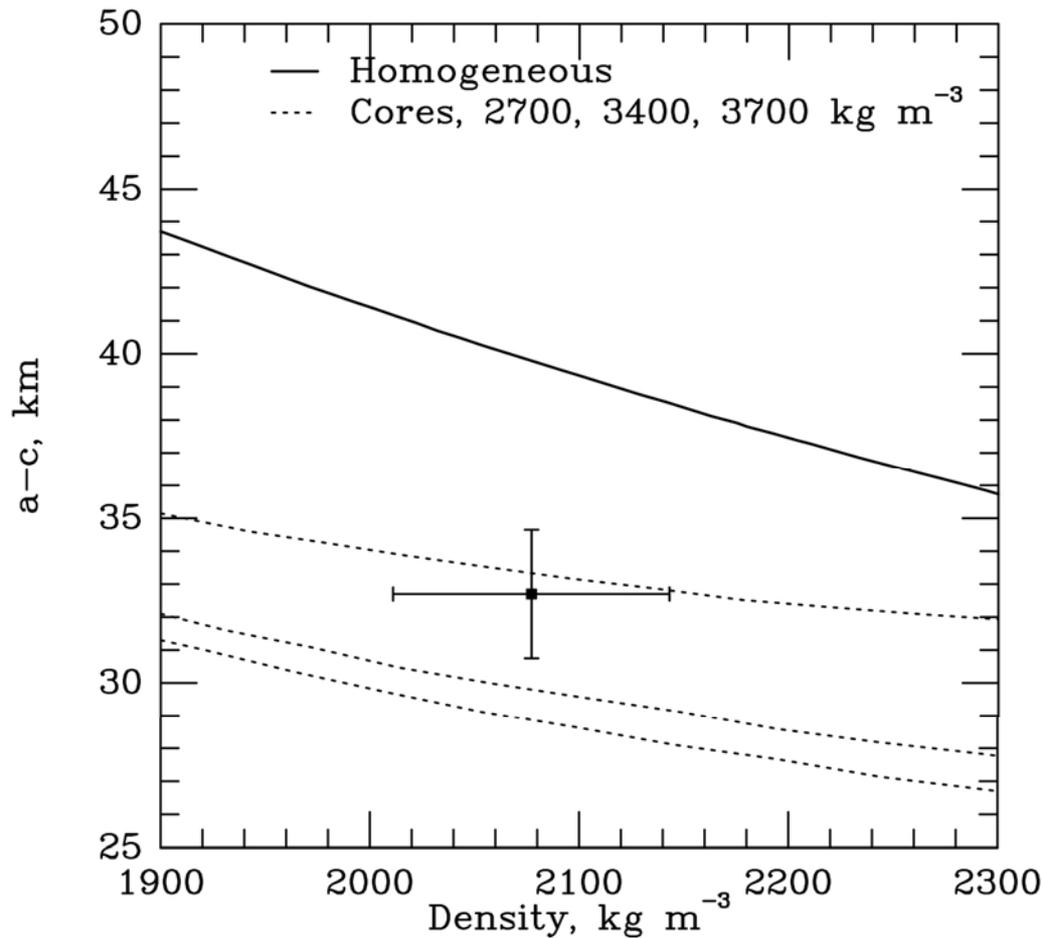
- Density model
- Integrated geological map



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Mission has motivated new knowledge





Ceres' Albedo features



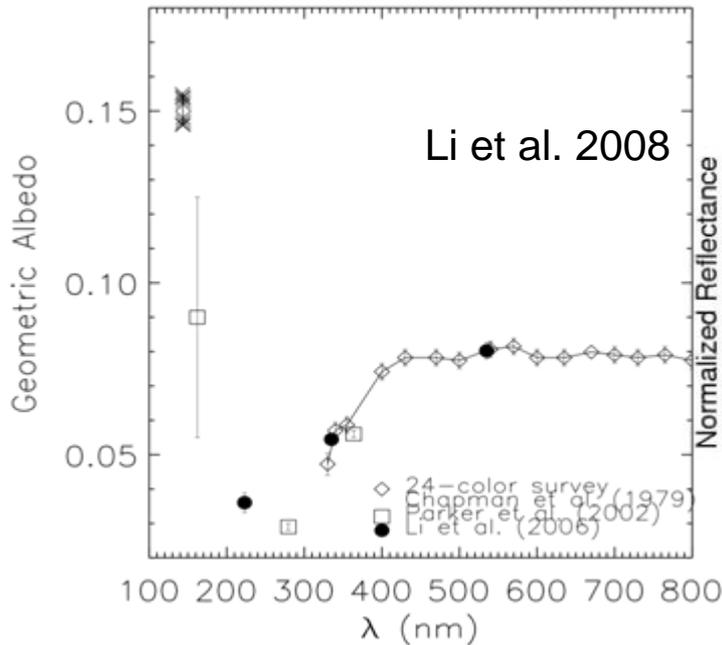
Ceres *HST* ACS/HRC

Dec. 30, 2003 15:46UT

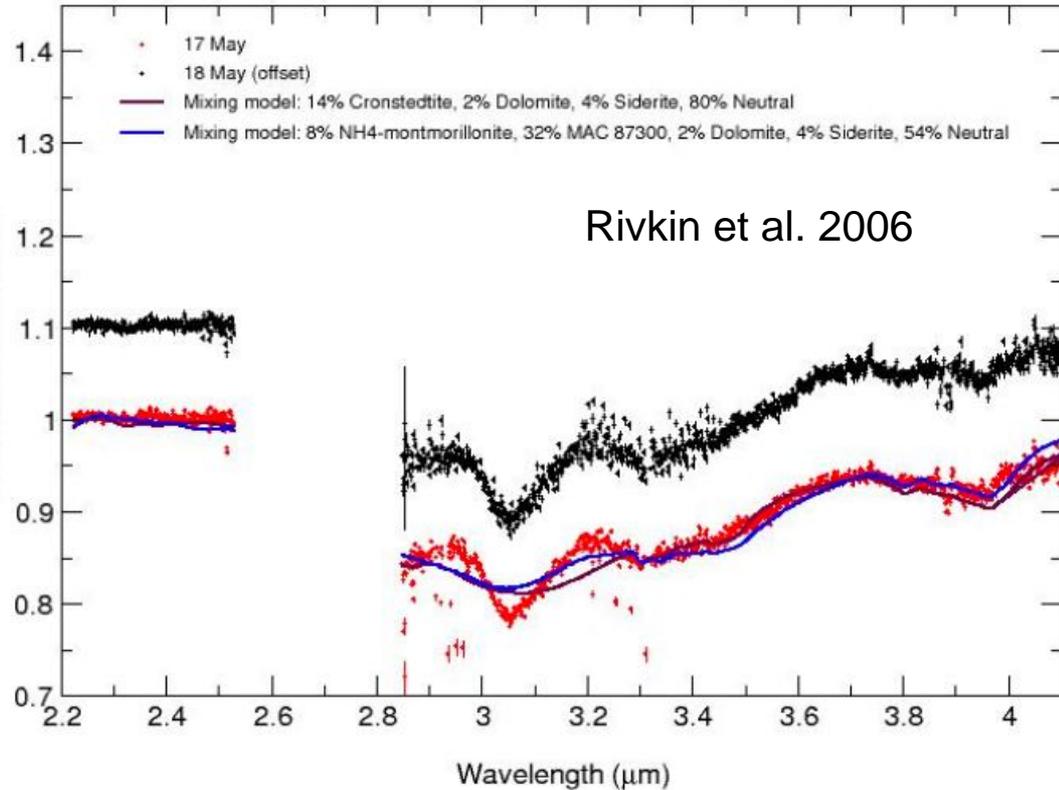
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New Spectral Features found in Ceres



UV spectrum of Ceres. The crosses are the new data points from HST/ACS/SBC. The uncertainties are $\sim <20\%$. The absorption band at 280 nm appears to be confirmed.



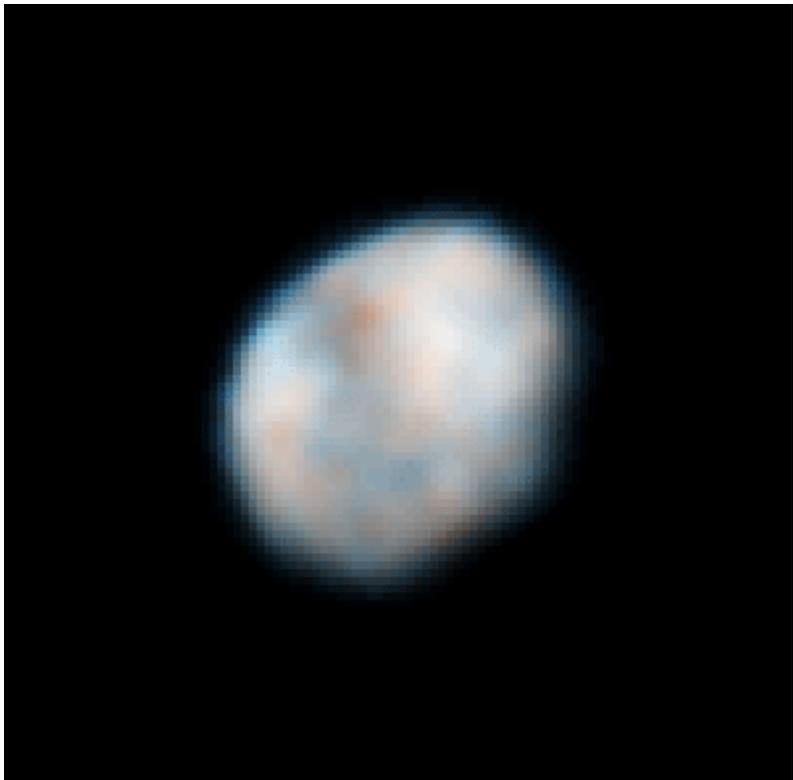
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Vesta



Dawn



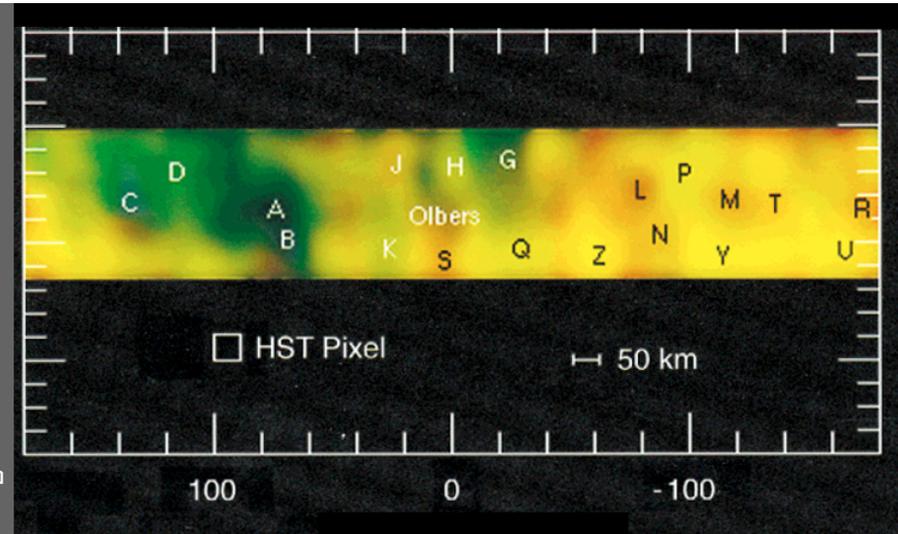
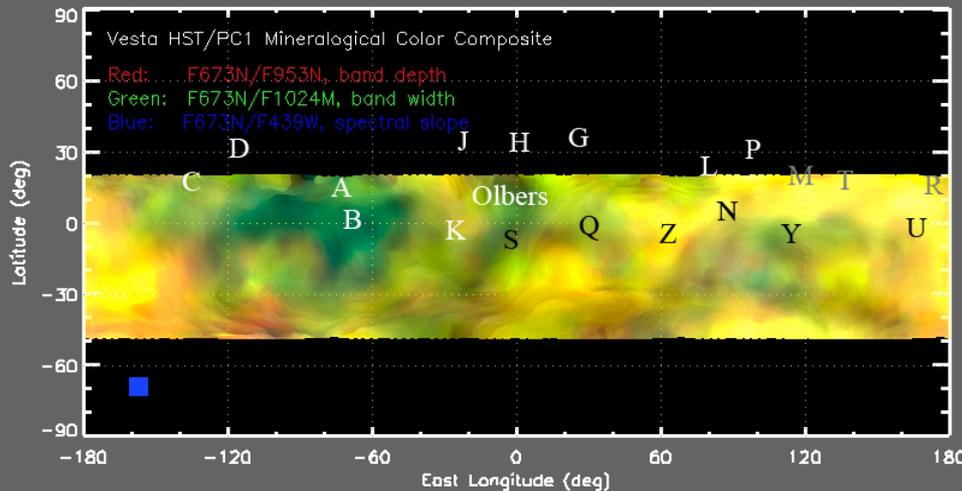


Vesta albedo and color maps Hubble Space Telescope



Li et al. 2007

Binzel et al. 1997



- Dark greenish color indicates single pyroxene component that formed **close to the surface**.
- Bright yellowish color indicates mixing with several pyroxene or with olivine formed **below the crust**.



Mission Status



- Spacecraft coasting optimally and scheduled to do so until June, 2009.
- Trajectory Correction Maneuver #1 (TCM-1) Nov. 20, 2008.
 - Trajectory refinement in progress.
 - TCM-2 is cancelled.
- Mars Flyby scheduled for February 17, 2009
 - Instrument sequences are complete and tested.
- Instrument Sequence Planning for observations of Vesta beginning.
- Monthly science telecons, weekly tag-up and sequence planning and review.
- Watch NSPIRES for Participating Scientist Program early 2009.

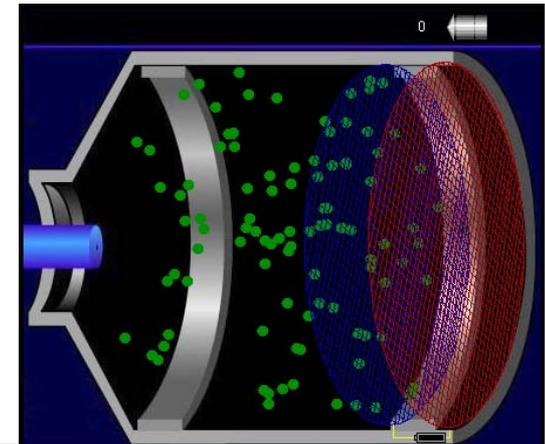
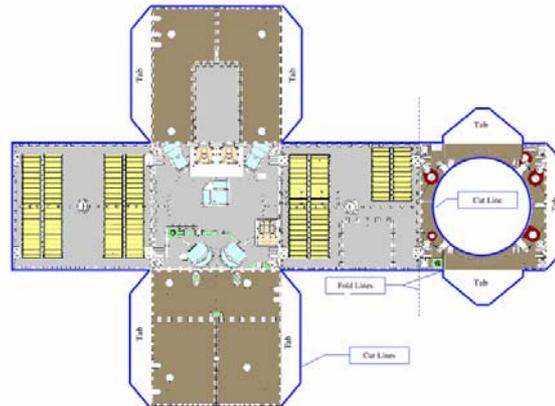
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<http://dawn.jpl.nasa.gov>

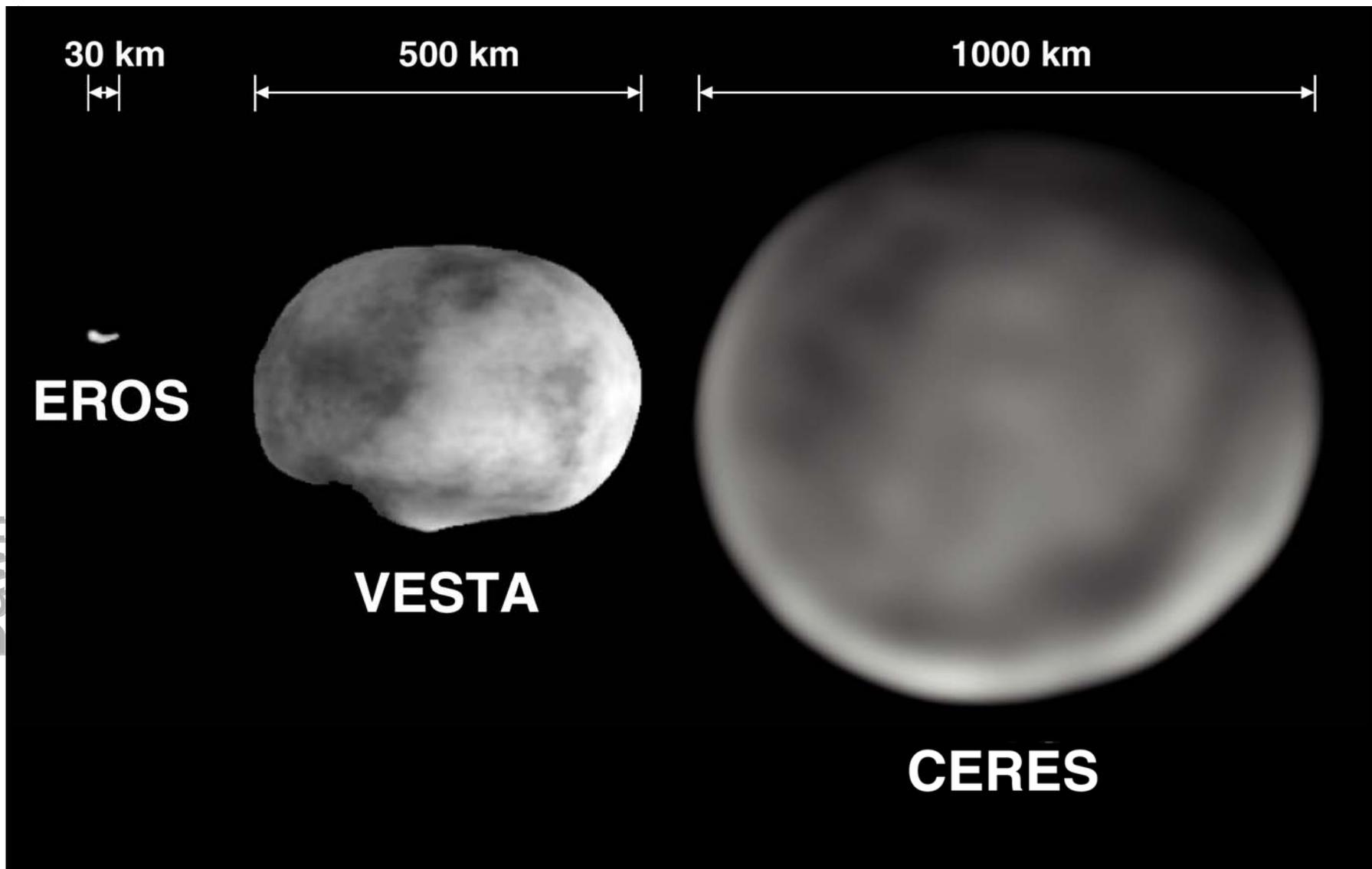


- Where is Dawn now? http://dawn.jpl.nasa.gov/mission/live_shots.asp
- History and Science of Dawn
 - http://dawn.jpl.nasa.gov/DawnClassrooms/1_hist_dawn%5Cindex.asp
- Ion Propulsion simulation
 - http://dawn.jpl.nasa.gov/mission/ion_engine_interactive/index.html
- Dawn for Kids
 - <http://dawn.jpl.nasa.gov/DawnKids/activities.asp>
- Mars Gravity Assist Educator Workshop
 - <http://dawn.jpl.nasa.gov/getInvolved/index.asp?page=overview>





Back-up Slides





Asteroid Flyby targets to scale

Longest dimension

Lutetia 95km

Mathilde 60km

Ida-56km

Eros-36km

Gaspra-18km

Steins-6km

AnneFrank-5km

Braille-2km



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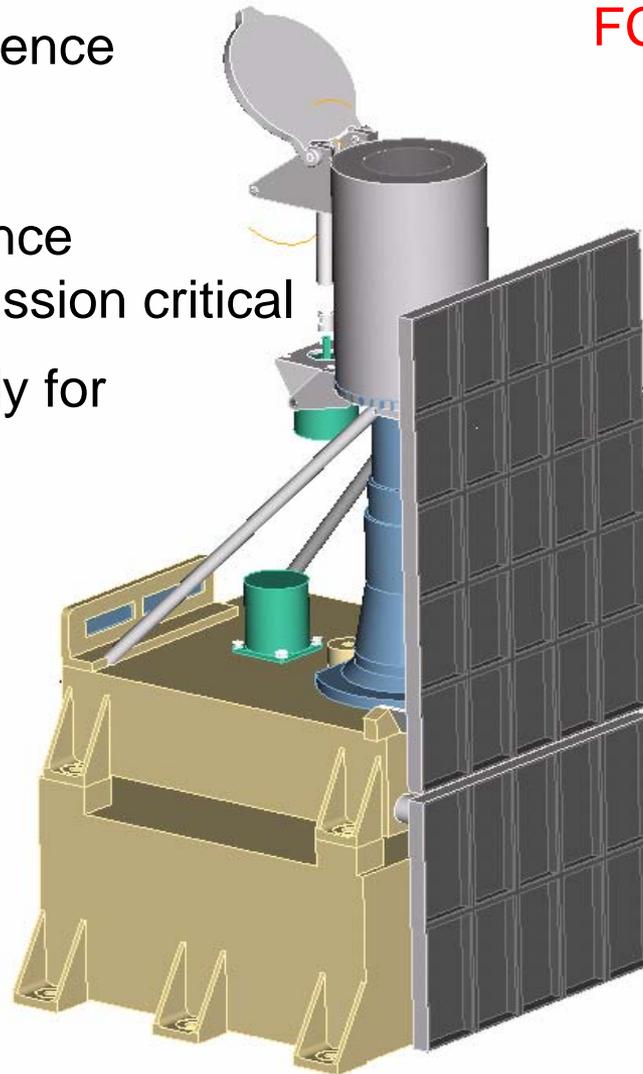
Framing Camera

Supports: Imaging Science
Navigation
Topography
Gravity Science

These functions are mission critical

Two identical units to fly for
100% redundancy

- 1024 x 1024 pixels
- frame-transfer CCD
- 14 μm pixel size
- F/8 system
- $5.5^\circ \times 5.5^\circ$ FoV
- 93 μrad iFoV (1 pixel)
- 7 filters + clear channel



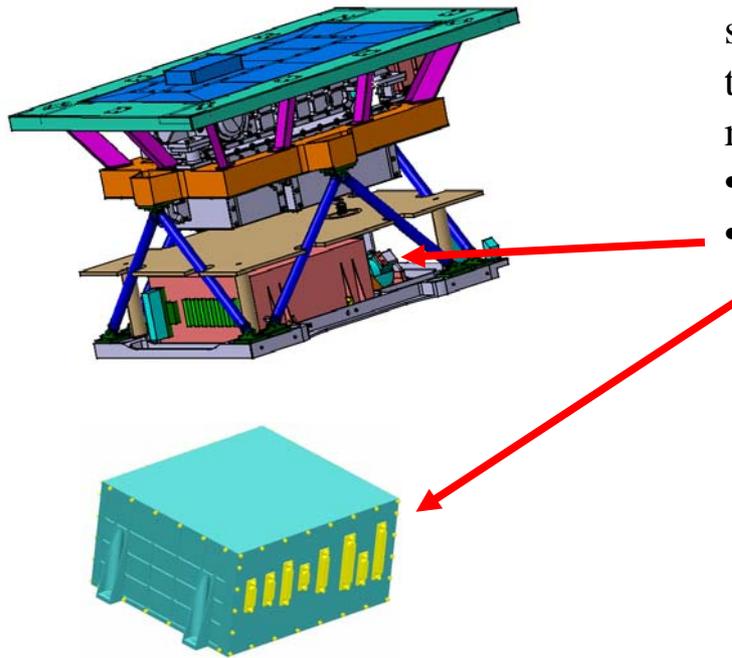
FC current design (left)
FC EM (below)



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Visible Infrared Mapping Spectrometer



VIR experiment is a compact imaging spectrometer housing two data channels in the same optical head . It is made of 2 modules

- Optical head
- Electronics box

REQUIREMENT	VIR VISIBLE	VIR IR
Spectral Range (μm)	0.25 - 1.0	0.95 - 5.0
Spectral Resolution ($\lambda/\Delta\lambda$)	50-170	30-170
Spectral Accuracy	0.6 nm	3 nm
Radiometric Accuracy absolute relative	< 20 % < 10 %	< 20 % < 10 %
Spatial Resolution (mrad)	0.250	0.250
Field of view (mrad)	64	64

VIR will allow to perform spectroscopic measurements of the Vesta and Ceres surface in the range 0.35-5.01 μm where most signatures of rock-forming minerals are present

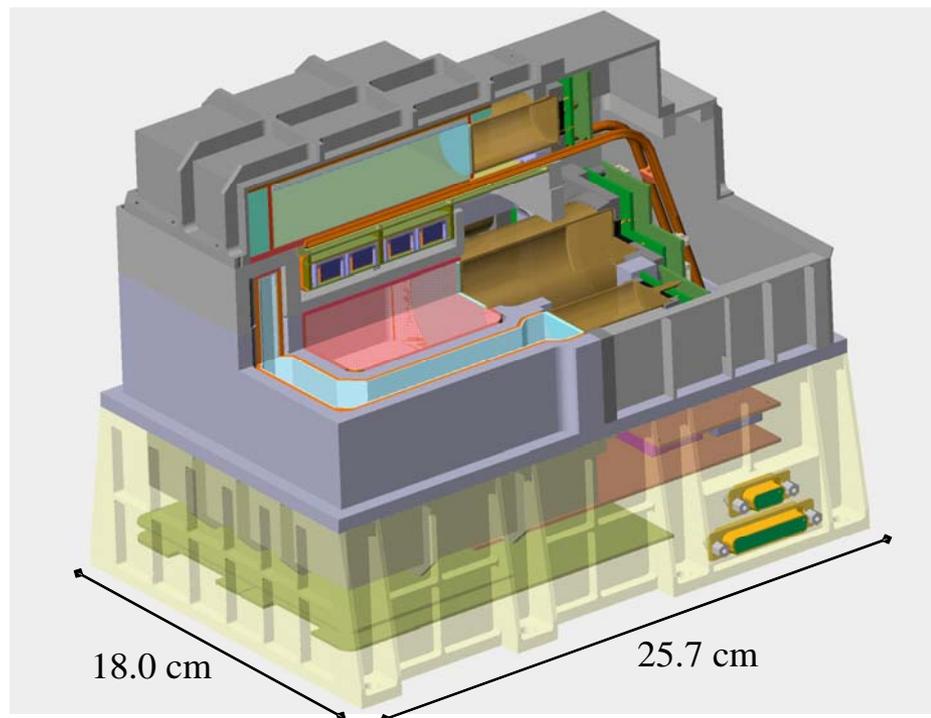
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GRaND



Cutaway view of GRaND



Features

- Neutron spectroscopy using Li-loaded glass and boron-loaded plastic phoswich
- Gamma ray spectroscopy using Bismuth Germanate and Cadmium Zinc Telluride (new technology)
- Design enables measurement and suppression of background from the space environment

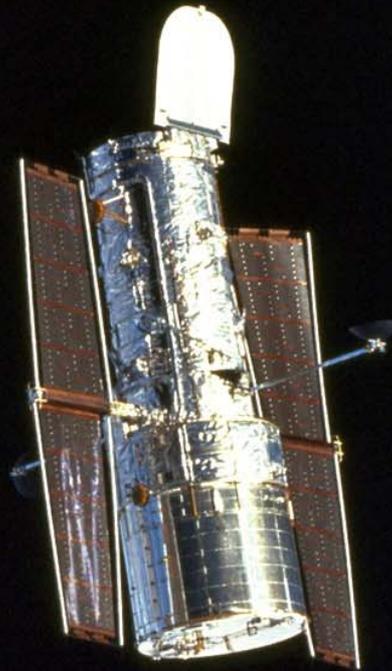
Operating modes

- Standby
- Operating
- Anneal

	CBE	Uncertainty
Mass (g)	10,100	900
Power (mW)		
Standby	1,400	420
Operating	11,200	1,680
Anneal	12,800	2,560
Data Rate (bps)	3,100	adjustable

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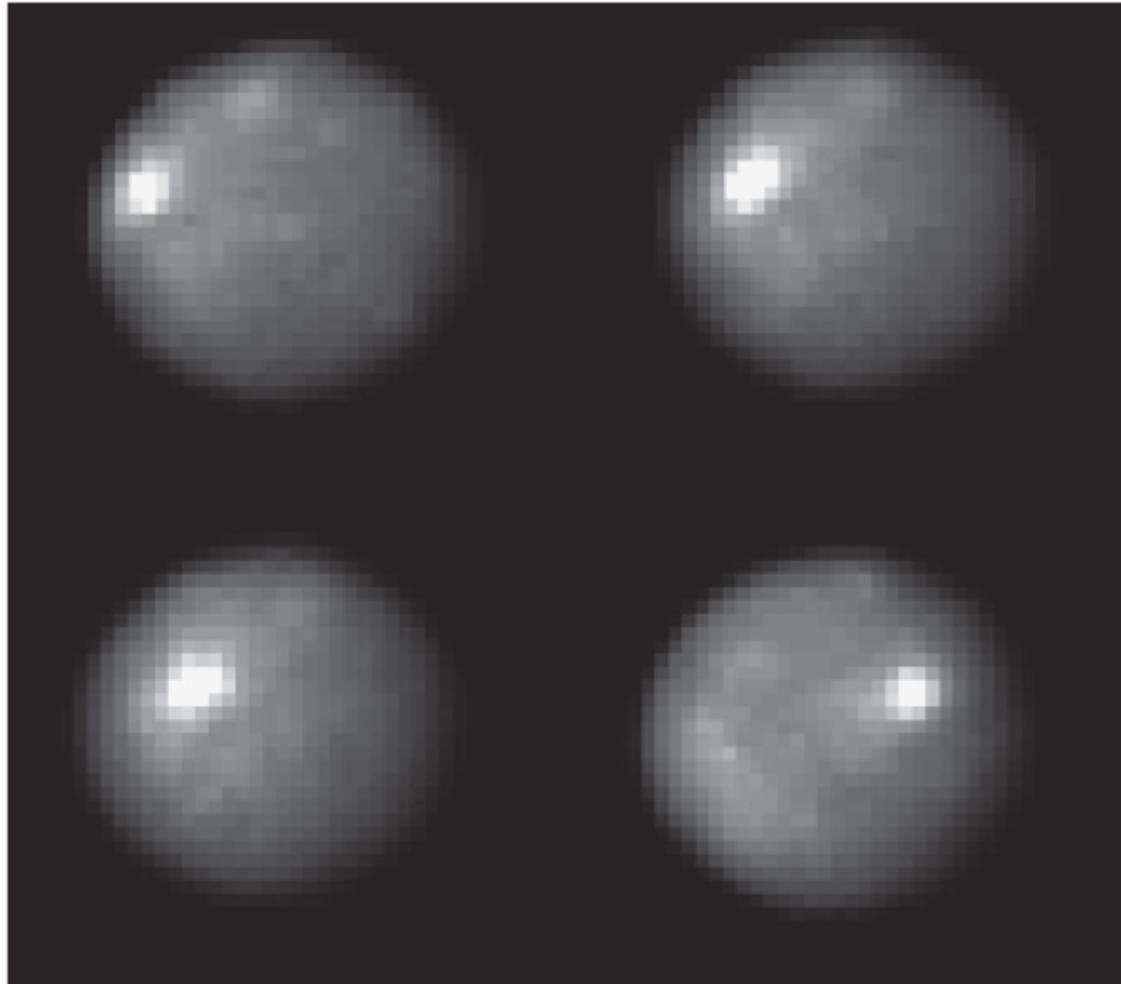
Recent Observations of Vesta And Ceres With Hubble Space Telescope



McFadden et al. 2007



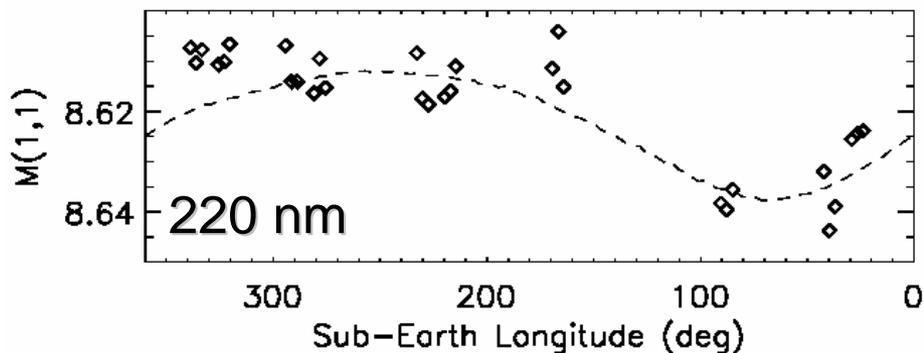
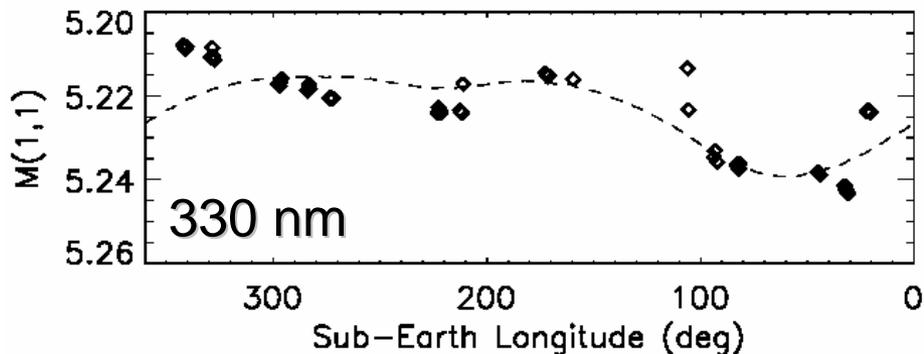
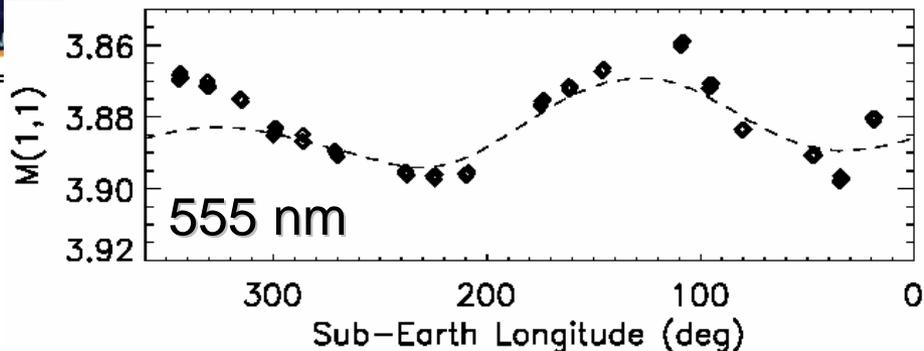
And now for a dwarf planet



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Ceres Lightcurve- Li et al. 2005



1. Lightcurve magnitude, amplitude, and shape are all consistent with earlier observations
2. Amplitude is small (0.04 mag), however should be totally due to albedo variations
3. Different shapes at three wavelengths – color variations

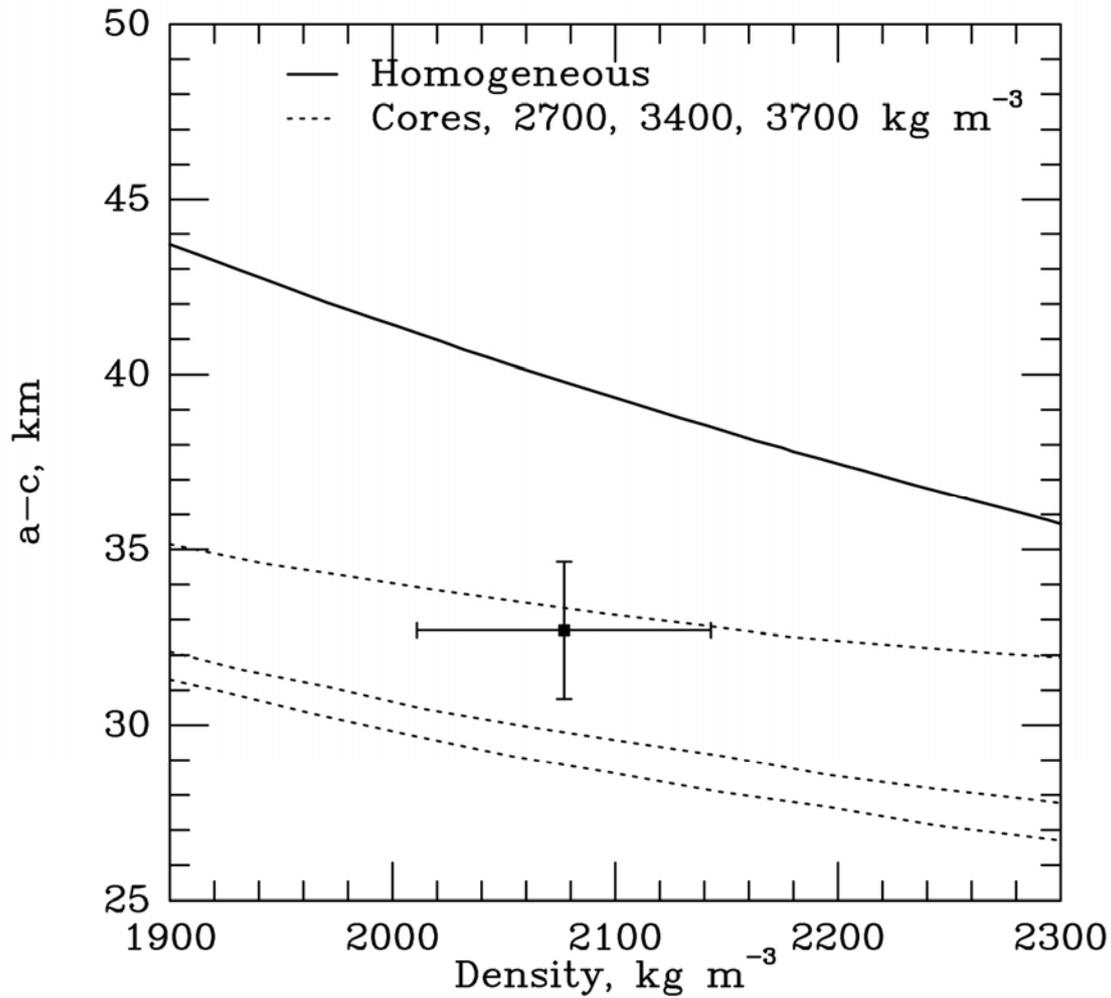
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Ceres too is differentiated



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Thomas et al. 2005



Exploring New Worlds



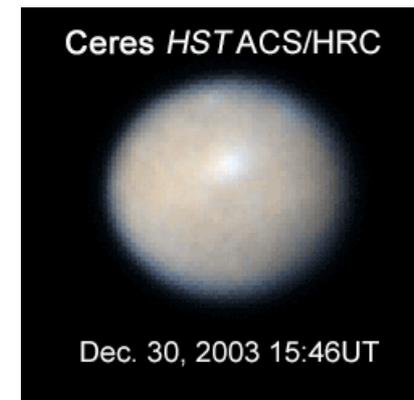
Dawn's Itinerary: Launch Sept. 27, 2007

The Dawn Spacecraft will travel

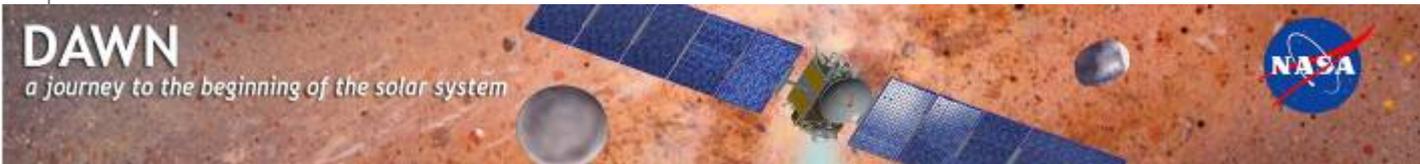
- 6.3 billion kilometers (almost 4 billion miles)
- In almost ten years
- To the asteroids, 4 Vesta and 1 Ceres.



Vesta



Dawn





Partners

- University of California, Los Angeles 
 - Scientific Leadership
- JPL – Jet Propulsion Laboratory 
 - Management and Navigation
- Orbital Sciences Corporation 
 - Spacecraft design and build
- Los Alamos National Laboratory 
 - GRAND instrument
- DLR – German Aerospace Center 
 - Framing Camera
- Max Planck Institute for Solar System Research 
 - Framing Camera
- ASI – Italian Space Agency 
 - VIR
- New Roads School, University of Maryland, and McREL
 - Education and Public Outreach

Dawn





Learn More!

<http://dawn.jpl.nasa.gov>



Dawn



Meteoritic Samples from Vesta



Thin section of HED meteorite

From the analysis of meteorites . .

- The parent body of the HED meteorites (Vesta) melted and formed a central iron core
- Material derived from Vesta's interior flowed across the surface similar to flows on the lunar mare
- This would make Vesta the smallest known body that accreted and differentiated: the smallest of the terrestrial-type planets
- While the HED meteorites indicate that Vesta was initially dry, water may have condensed on the surface of Vesta after it cooled
- No meteorites are unambiguously associated with Ceres





Background of Ceres

First asteroid discovered in 1801

Biggest asteroid with a diameter about 1000 km

$a=2.77$ AU, $e=0.079$, $i=10.6^\circ$

Probably hydrated (Lebofsky 1981, Feierberg 1981) or ammoniated (King et al. 1992)

Target of Dawn, scheduled to orbit Ceres in 2015 for 5 months

Dawn