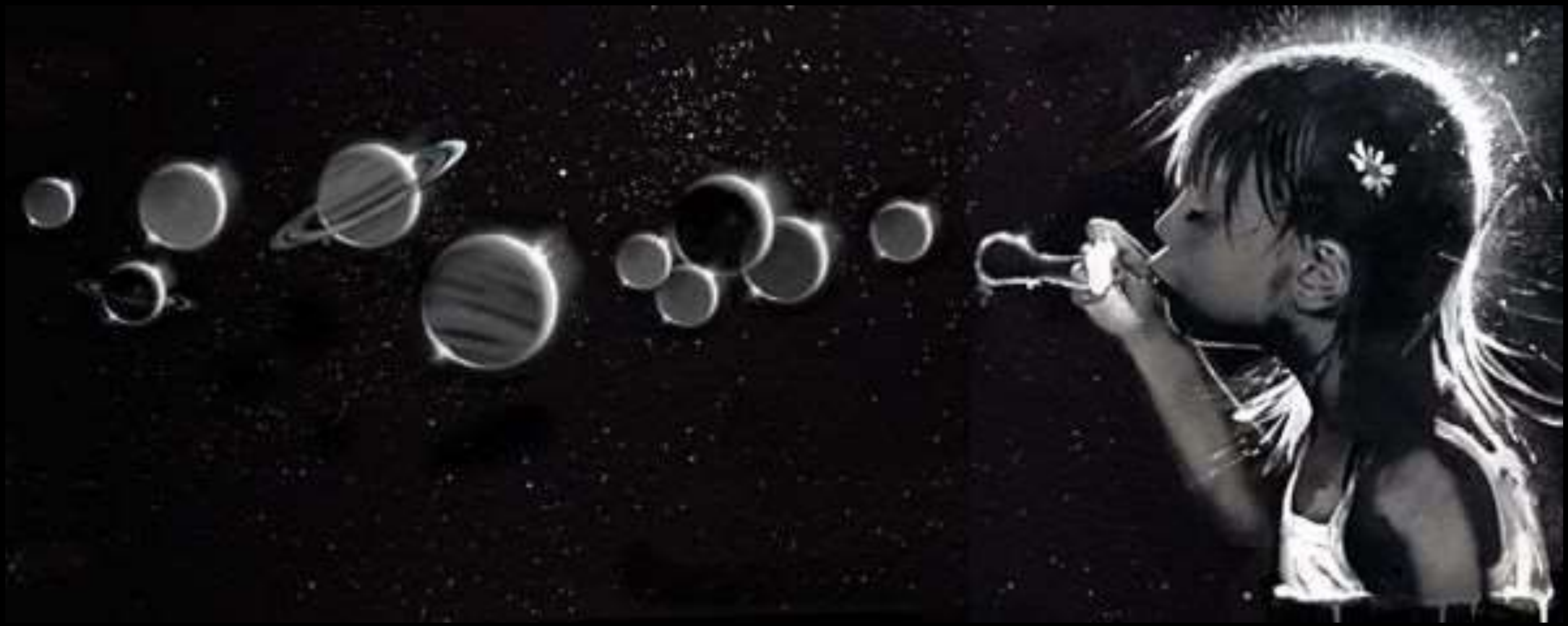
Space Telescopes and Solar System Science



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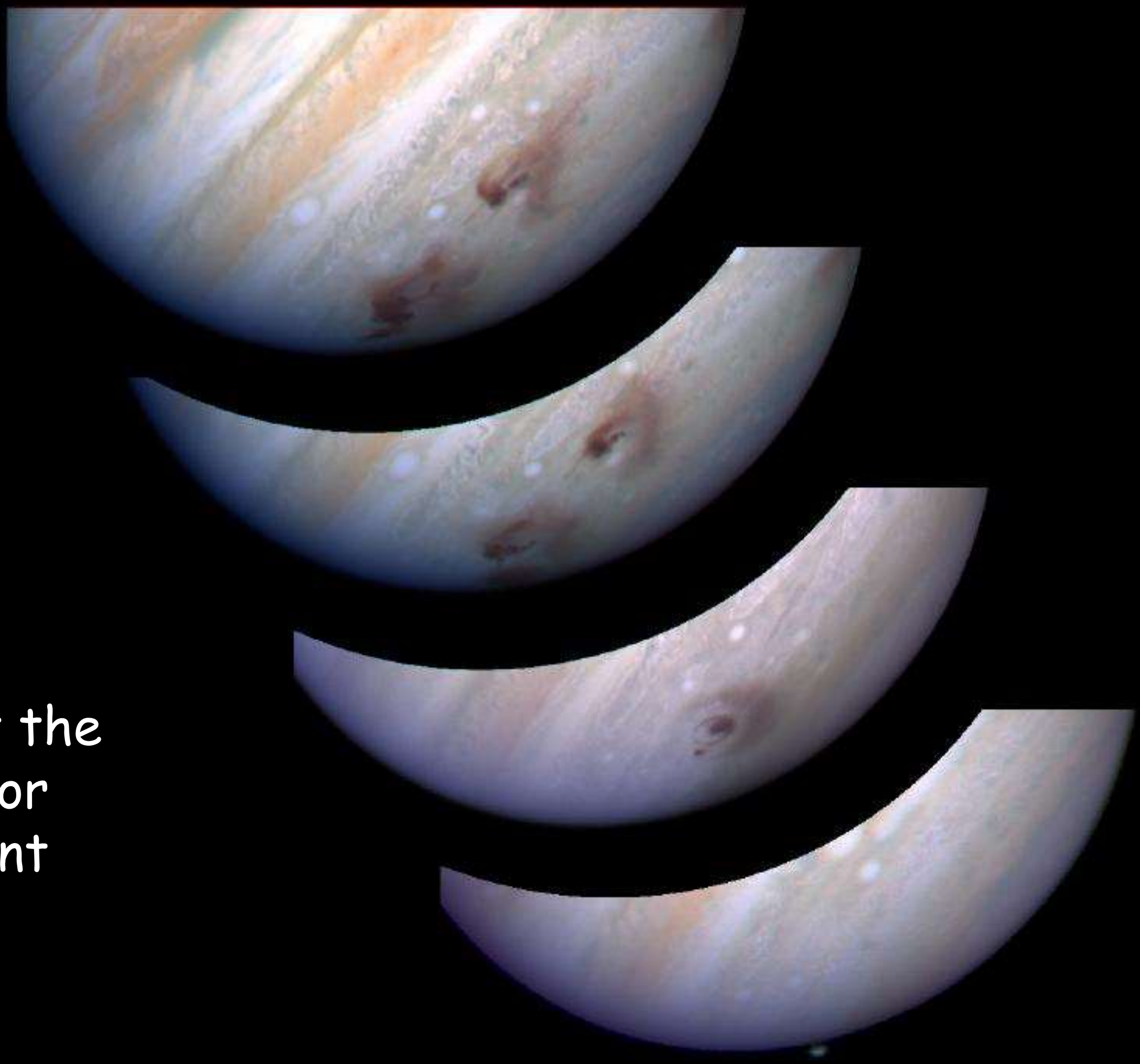
Space-based telescopes have contributed greatly over the decades to solar system science.

Scientific discoveries too many to list here – more than 100 individual press releases at the STScI web site.

A few examples will be shown that demonstrate the value of having a permanent facility in space:

Comet S/L 9 Fragment Impacst with Jupiter (1994)

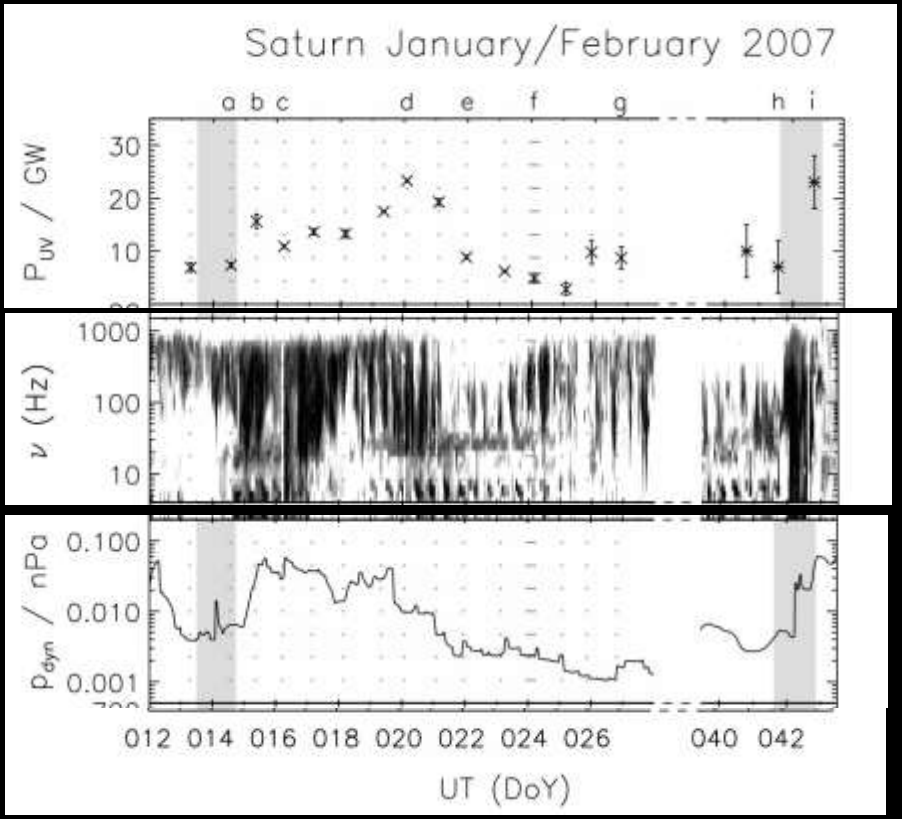


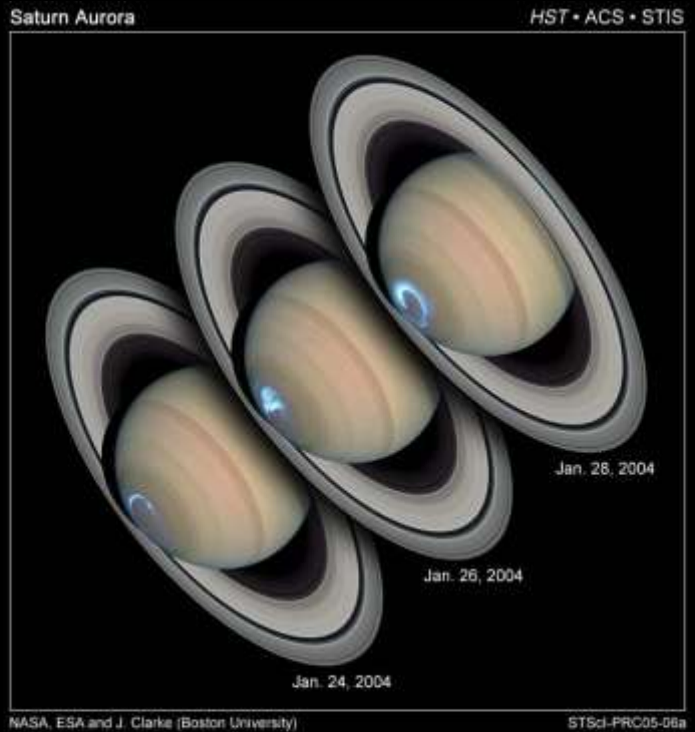
Highest resolution images captured by HST – required that the mission be in orbit for this unexpected event

Jupiter and Saturn Aurora

Collaborations with Cassini at Saturn, JUNO at Jupiter

HST UV images capture the big picture of auroral activity

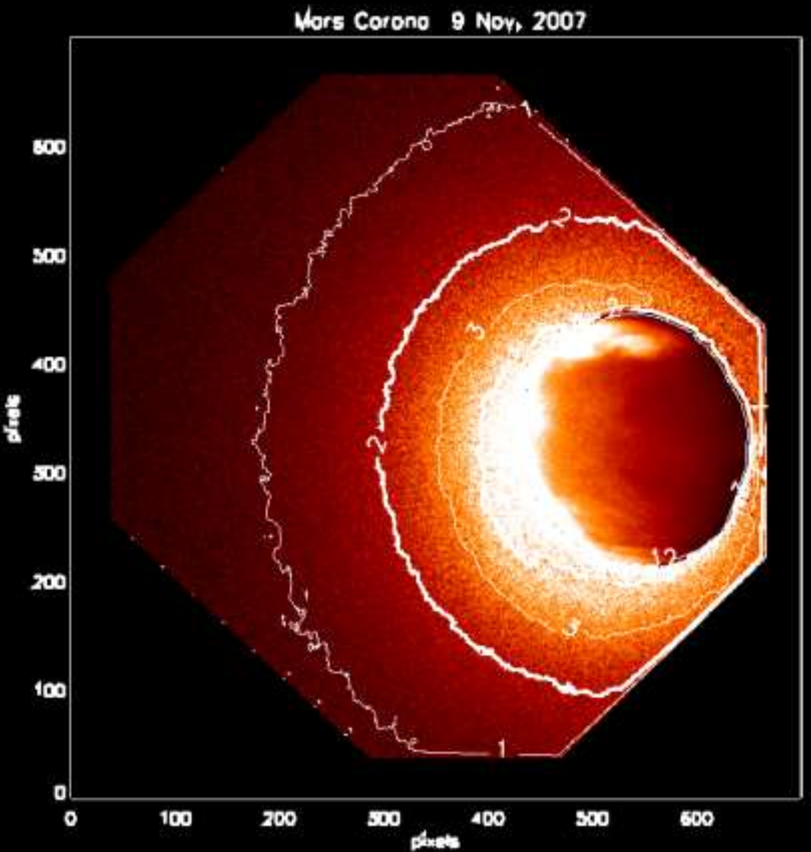


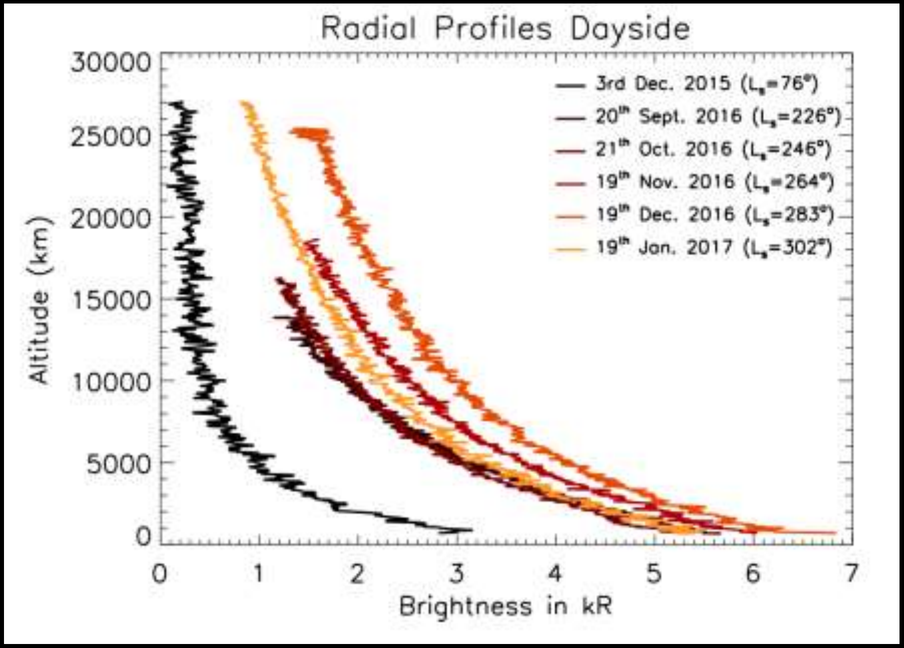


Clear correlations between the arrival of solar wind shocks and auroral activity

Martian exosphere and escape of water into space

HST images capture large scale structure, including hot atoms at high altitudes





Order of magnitude change in H escape flux over a Mars year, discovered with HST and now studied in detail with MAVEN

The future - there have been a series of studies over the years of solar system science from space.

One example:

SOLAR SYSTEM SCIENCE OBJECTIVES WITH THE NEXT UV/OPTICAL SPACE OBSERVATORY.

NASA Cosmic Origins Program Request for Information: Science Objectives and Requirements for the Next NASA UV/Visible Astrophysics Mission Concepts. White Paper to be submitted by 10 August 2012.

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Table 1. Examples of solar system science investigations that can be explored with a UV/O space observatory. Note that since most investigations requiring spectroscopic data also require spatially resolved spectra, an integral field spectrometer is a appropriate spectroscopic instrument choice. Wavelength regimes are ultraviolet (UV), optical (O), and near infrared (IR).

Investigation	Category	Data type (wavelength regime)	Sampling scales	Campaign duration	Resolution: R = spectral, θ = spatial
Giant planet zonal winds and vortices	Atmospheres	Imaging (O)	Hours, single target rotation period	Years	$\theta \leq 0.05''$
Cloud/storm evolution and variability	Atmospheres	Imaging, spectroscopy (O, IR)	Hours, days	Days, years	$R \geq 2500$ $\theta \leq 0.05''$
Occultations	Atmospheres	Photometry, spectroscopy (UV, O, IR)	Milliseconds	Hours	$R \geq 100$–1000
Aurorae, magnetospheres	Atmospheres/ space science	Imaging, spectroscopy (UV)	Minutes, hours	Years, hours	$R \geq 500$ $\theta \leq 0.05''$
Volcanic trace gases	Atmospheres/ geology/ astrobiology	Spectroscopy, imaging (UV, O, IR)	Days	Years	$R \geq 500$–10000
Volcanic plumes	Geology	Imaging, spectroscopy (O, IR)	Days, hours	Years	$R \geq 2500$ $\theta \leq 0.025''$
Cryovolcanism	Geology/ astrobiology	Imaging, spectroscopy (UV, O, IR)	Days	Years	$R \geq 2500$ $\theta \leq 0.025''$
Mutual events, lightcurves	Small bodies	Photometry (O)	Milliseconds, minutes	Hours, months	$R \geq 5$ $\theta > 10''$
Cometary evolution	Small bodies	Imaging, spectroscopy (UV, O, IR)	Hours	Days	$R \geq 5$ $\theta \leq 0.05''$

Decadal Survey process 2009-2010 - experience with study and support of telescope missions:

Conclusions from discussion with the panels:

- Space telescopes do great science, past experience very positive

- Telescopes both provide discovery and complement *in situ* missions

- The decadal survey contained a highly positive section about the importance of space telescopes to accomplish scientific goals

Decadal Survey 2009-2010 - experience with study and support of telescope missions

- The possibility was discussed of a space telescope that would concentrate on solar system observations

- Such a mission would be shared among different scientific areas and different panels

- Each of the panels supported a telescope mission, but none were willing to prioritize a shared facility above a concentrated mission to one of their favorite objects

First-rate solar system science can be accomplished with a modest aperture: 1 - 2 meters with modern technology would work as well as HST

Why not propose a Discovery mission?

This has been attempted. Discovery selection criteria emphasize focused science, and telescope missions cover a wide range of topics.

All prior astrophysics telescope missions (Copernicus, IUE, HST, SIRTF, Chandra, JWST, etc.) have been non-PI missions mandated by HQ for this same reason. Only exception is Kepler.

History of use of Space Telescopes for Planetary Science:

- Key planetary science is done with space telescopes using facilities from the Astrophysics Division at NASA

- This has worked well in many cases in the past - but it depends on Astrophysics having the facilities and making time available for planetary observations

- What is the status of present and future Astrophysics Space Telescopes?

UV / Optical:

- HST - working very well, 27 years operating, lifetime unknown

- Kepler – highly successful – concentrated on detection of exoplanets by transit detection – now in extended K2 mission

IR:

- Spitzer – launched in 2003, prime mission over, continued operation warm

- JWST - launch in late 2018 - highly capable but limited lifetime, i.e. limited overlap with solar system missions and limited total observing time

- WFirst - in development - to be launched in 2020's

Astrophysics Division has community studies ongoing for potential future missions:

Habitable Exoplanet Imaging Mission (HABEX) – UV/optical/near-IR 4-6 m telescope with coronograph and possible starshade – would concentrate on exoplanet characterization but support general astrophysics and SS science

Large UV/Optical/IR Surveyor (LUVOIR) – 8-18 m diameter telescope, larger than JWST with broad wavelength range and ambitious science goals

Future capability and schedule unknown - nothing likely to be developed before JWST is launched and working

Questions for CAPS:

- Is the status quo still the right way to go?

- If not, what actions should the Solar System division take?

- Should a study be undertaken of the science, feasibility, and cost of a solar system space telescope in preparation for the next decadal survey?