Goddard Space Flight Center

HST/GSFC Project Report

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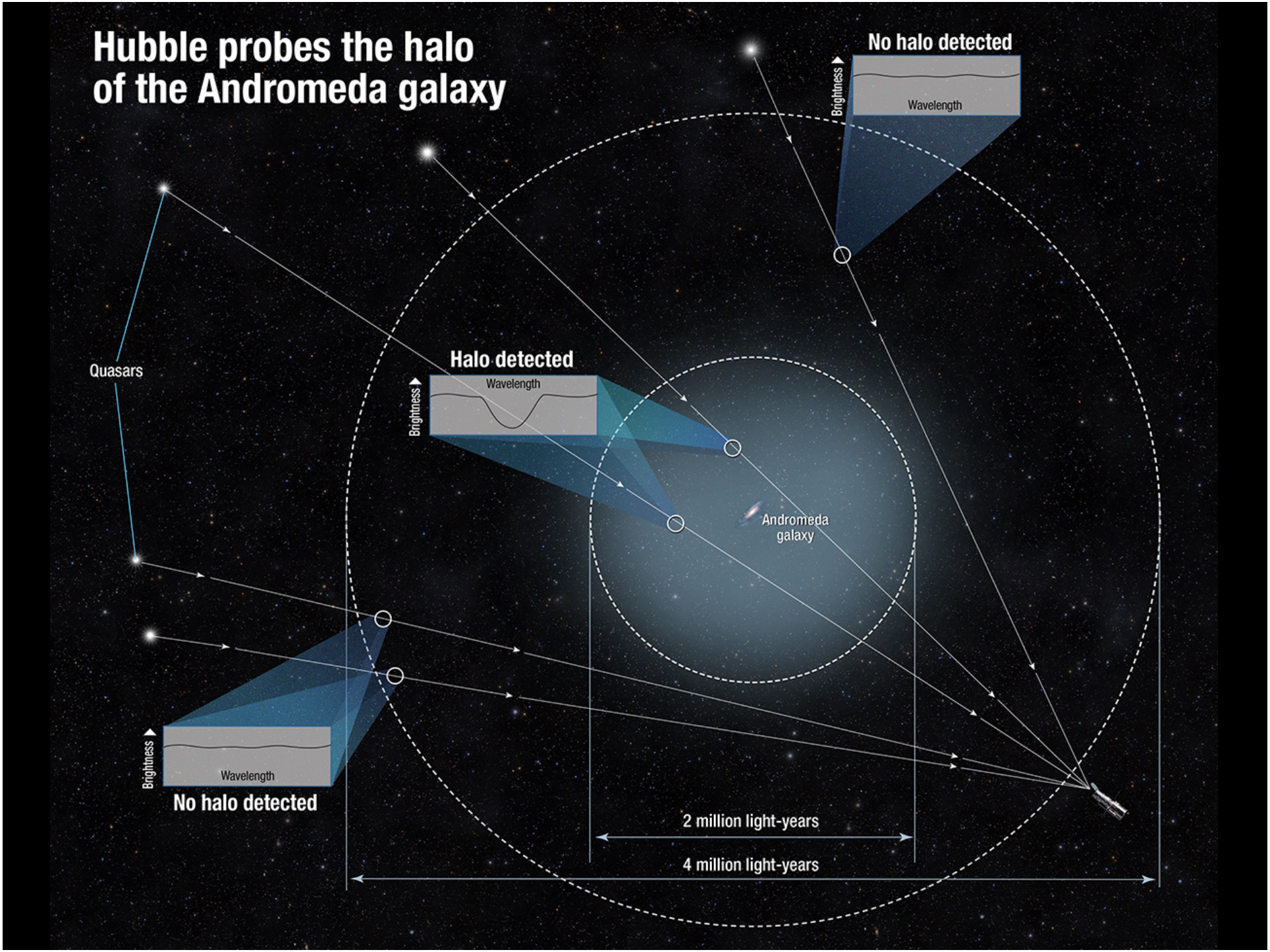
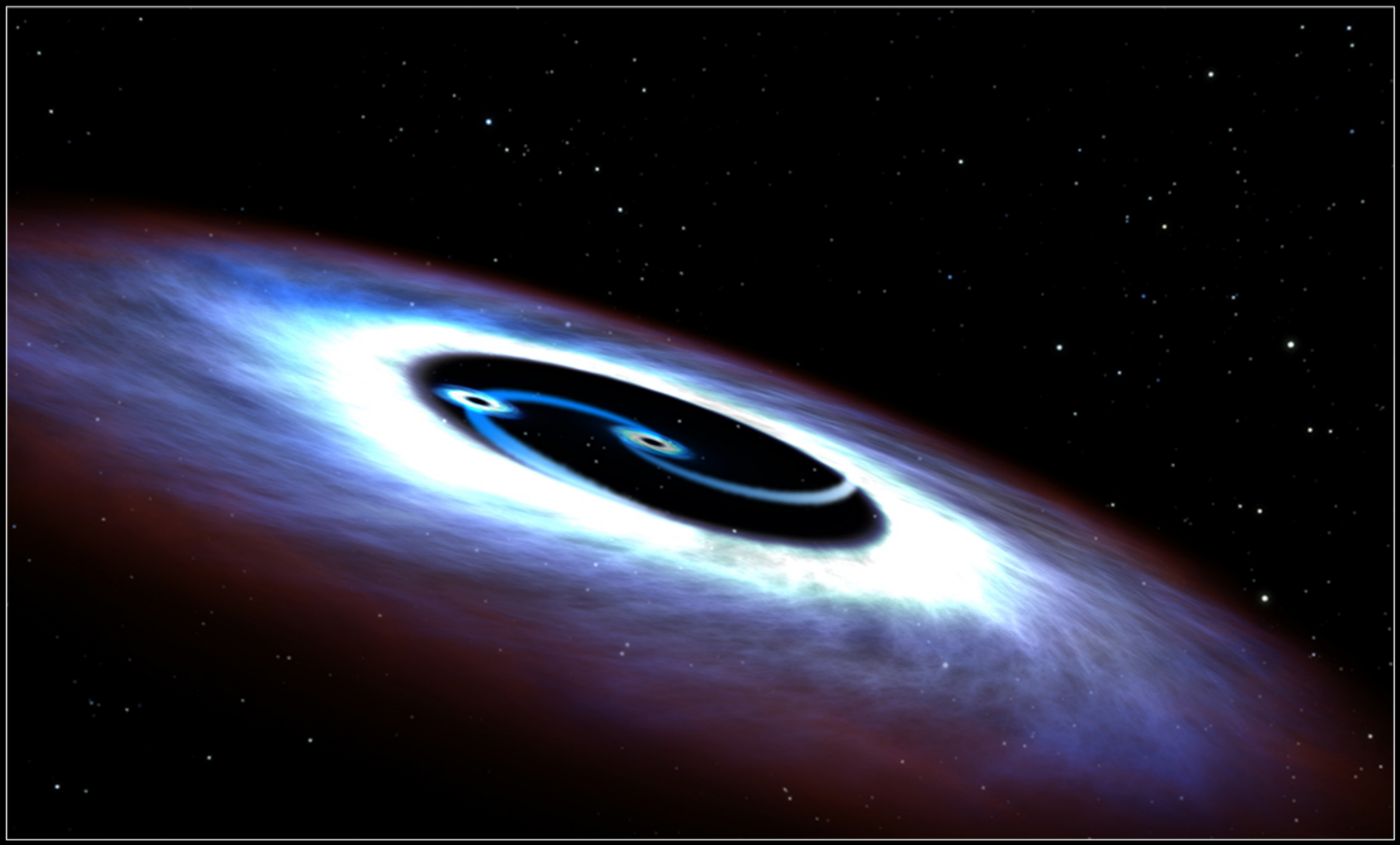
Space Telescope Users Committee Meeting November 5, 2015

Project Perspective

Going Beyond 25 Years of Discovery

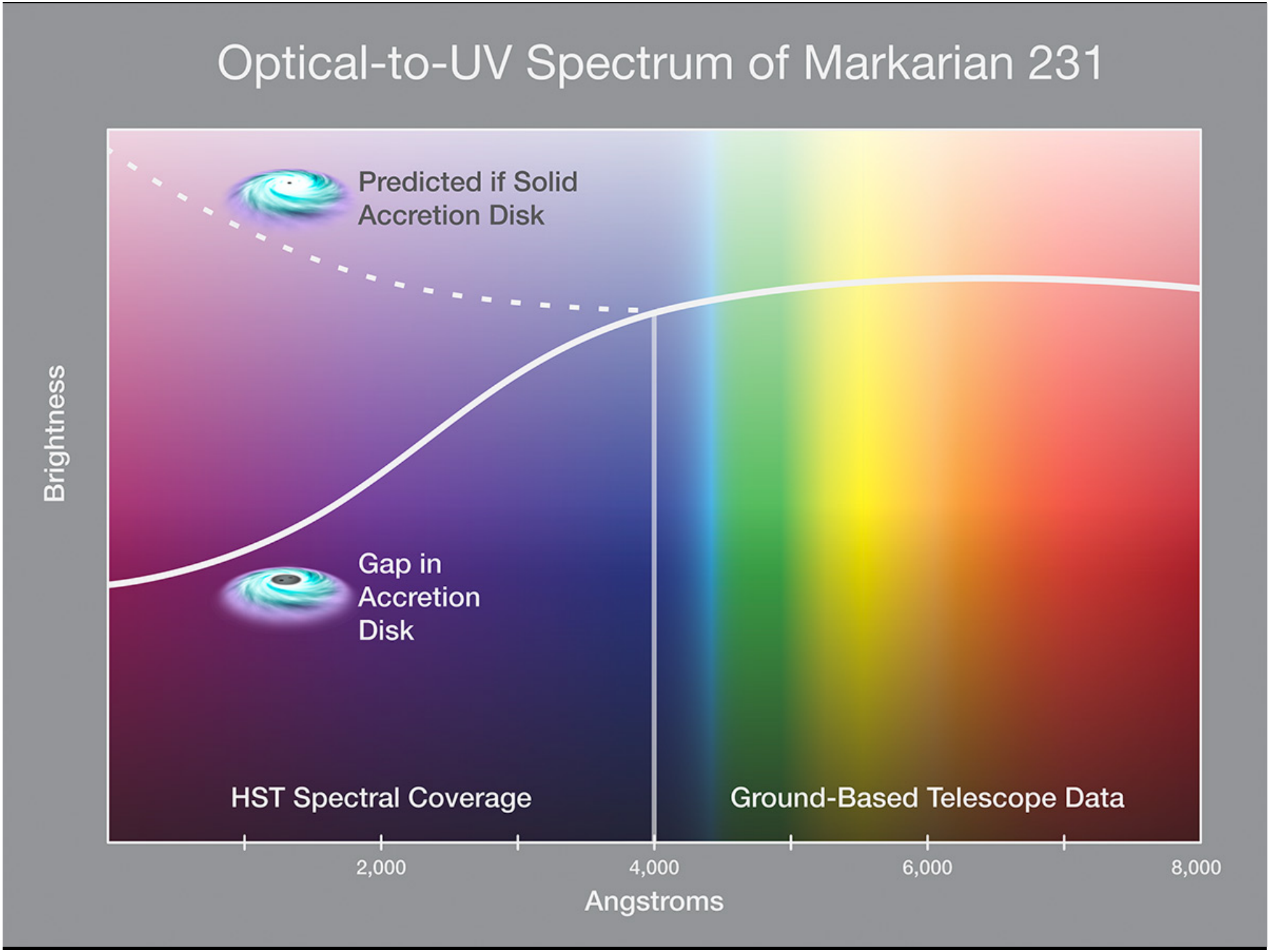
- A tremendous Silver Anniversary continues
- Scientific productivity and operational efficiency is outstanding
- Innovative Science Initiatives:
  - UV initiative successful and continuing
  - Frontier Fields
  - Mid-Cycle proposals
  - Outer Planet Atmospheres Legacy (OPAL) program
- 2016 Senior Review: planning and preparation underway
- Spacecraft systems are performing very well
- Instruments are in great shape
- Planning for HST/JWST era
- Hubble 365


Hubble probes the halo of the Andromeda galaxy
No halo detected
Brightness
Wavelength
Quasars
Halo detected
Brightness
Wavelength
Andromeda galaxy
Brightness
Wavelength
No halo detected
2 million light-years
4 million light-years



Artist's View of a Binary Black Hole

NASA and ESA ▪ STScI-PRC15-31a


Optical-to-UV Spectrum of Markarian 231
Predicted if Solid Accretion Disk
Gap in Accretion Disk
Brightness
HST Spectral Coverage
Ground-Based Telescope Data
2,000
4,000
6,000
8,000
Angstroms

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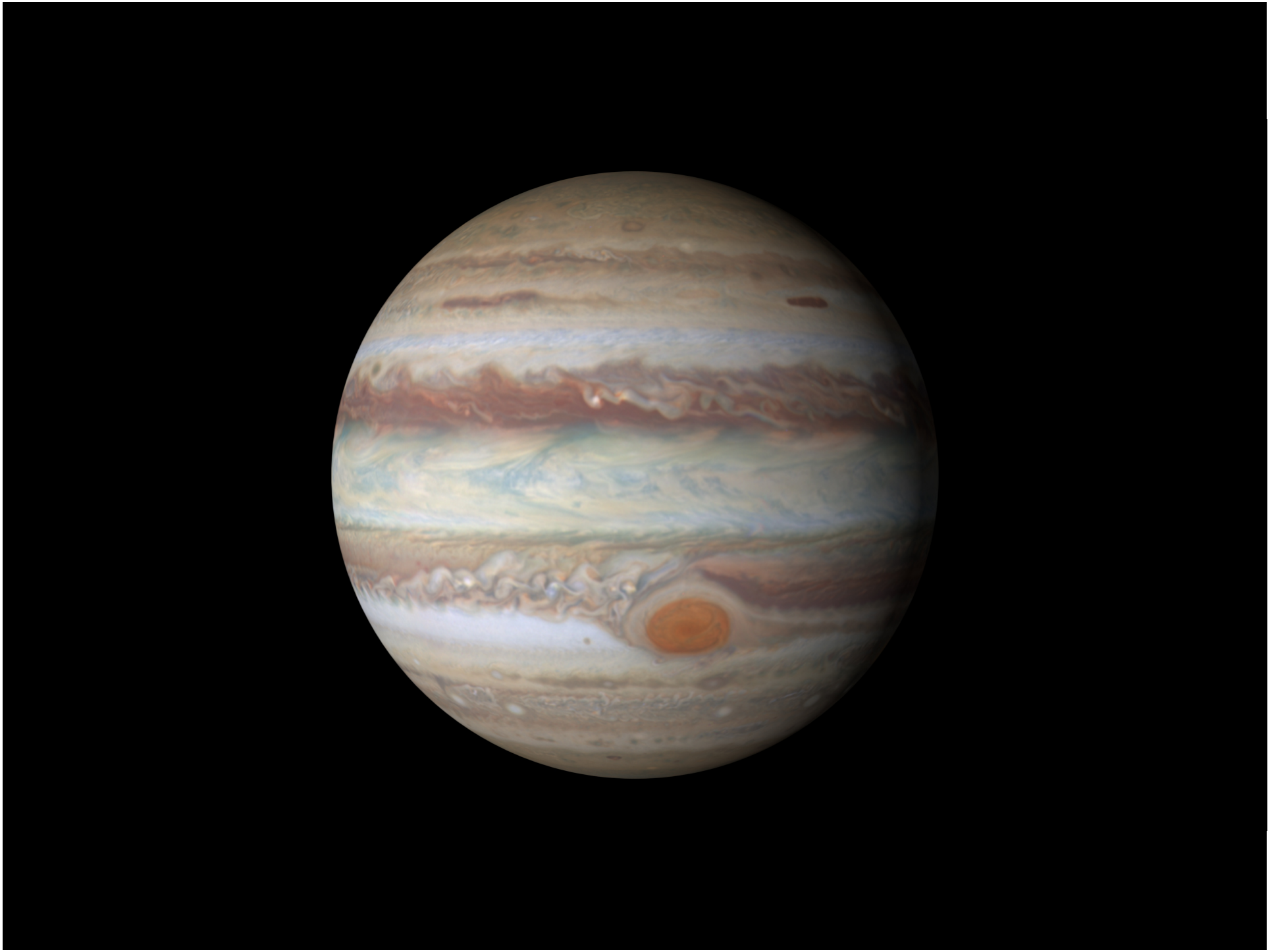

Recent Hubble science news releases covered the "Fab Four" of public enthusiasm!

(Solar System, Exoplanets, Black Holes, and Most Distant Galaxies…)

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HST Observatory Status

10/31/15

Subsystem		Summary
Science Instruments (SI)	G	• WFC3 performance excellent; Channel Select Mechanism (CSM) movement and dust particles monitored – CSM movements have been significantly reduced – Most recent particle observed in June 2015, first since August 2013 • COS – FUV detector sensitivity monitoring continues following completion of sensitivity ARB closure 4/2011 – Moved to 3rd position on February 8, 2015; planning underway for 4th position (expected in 2017) • ACS and STIS repaired instruments (SM4) performing nominally • NICMOS in standby following decision to not restart following Cycle 19 proposal evaluations
Electrical Power System	G	• Performance of batteries is excellent; benchmark set to 510 Amp Hours • Solar Array 3 performance remains excellent; section 1 ~2 amp loss in June 2015 • 12/22/12 Software Sun Point (SWSP) safemode entry; first unplanned entry since 2007 • Solar Array Drive Electronics (SADE) investigation following 2/15/13 SWSP completed; no further actions
Pointing Control System	G	• Gyro 5 failed on 3/7/14; 1-2-4 gyro configuration; Gyro 6 powered off 3/13/14; Gyro 3 removed from control loop and powered off in 2011; all gyros configured to operate on secondary heater controller • Gyro 4 motor current increased from 120mA to 190mA in 9/2011, has remained stable at ~178 mA • Attitude Observer Anomaly (AOA) (ARB report 10/2011) mitigation completed 11/2012 • FGS-3 is degraded; use is minimized to preserve bearings; FGS-2R2 Clear Filter operations began 1/2015
Data Management System	G	• SI Control and Data Handling (C&DH) has had 7 lockup recoveries since 6/15/09; most recent was 10/20/14 • SI FSW enhanced to protect detectors in event HV left on from SI C&DH lock up event • Science Data Formatter (SDF) input cycling modified to reduce thermal load • Solid State Recorders (SSRs) 1&3 have each experienced a single lock up while in the South Atlantic Anomaly (SAA); Alert monitors detect condition to minimize data loss
Communications	G	• Multiple Access Transponder 2 (MAT2) coherent mode failed (12/24/2011); Two-way tracking unavailable • Joint Space Operations Center (JSpOC) now the source for the operational ephemeris via Conjunction Avoidance Risk Assessment (CARA) team and the Flight Dynamics Facility
Thermal Protection System	G	• Condition of Multilayer Insulation (MLI) observed during SM4 was as expected • New Outer Blanket Layers (NOBLs) installed on Bays 5,7, and 8 during SM4

Mission Operations – Gyro Run Time Performance

10/31/15

Post SM4 RGA	Status	Flex Lead	Total Hours 2015/243
G1	On	Standard	21700
G2	On	Standard	22722
G3	Off – AOA 2011	Enhanced	22353
G4	On – Max Hrs	Enhanced	67169
G5	Failed 2014	Standard	51497
G6	Off	Enhanced	35945

Previous Flex Lead Failure Runtimes

Date of Failure	Gyro	Flex Lead	Total hours at failure
1992.281	G6	Standard	21504
1997.099	G4	Standard	29304
1998.295	G6	Standard	42768
1999.317	G1	Standard	39600
1999.110	G3	Standard	47088
2007.243	G2	Standard	55584
2014.066	G5	Standard	51497

Mean runtime hours for all 22 HST operational gyros	40,152
Mean runtime hours for 6 current onboard gyros	36,906
Mean runtime hours for the 7 HST flex lead failure gyros	44,555
Maximum runtime hours (current G4)	67,169
Minimum runtime hours (SM3A G5, rotor restriction)	13,857

Mission Operations

- **Gyro 4 performance has been out of family since May 2015**
  - Gyro-4 experienced a large -134 arcsec/hr bias rate shift on September 19
    - Resulted in failure of 4 orbits of guide star acquisitions
    - Mitigation steps have been implemented to minimize future science loss
  - If Gyro-4 fails, Gyro-6 will be powered on and three gyro science using Gyros 1, 2, and 6 will continue with Gyro-3 held in reserve.

- **Life Extension Initiatives**
  - Spacecraft Flight Software Release 4.1 incorporates non-linear scale factor for gyro calibration
  - Spacecraft Flight Software Release 4.2 will feature a diagnostic recorder
  - Cosmic Origins Spectrograph flight software will be updated in 2016
    - Enhances 4th and 5th life time positions, and extended operations
    - Anticipate need to switch to 4th position in 2017
  - Technical refresh of the GSFC 2002 vintage Sun (Oracle)-based control center systems is complete

Contract/Budget Status

- **Budget Outlook**
  - Executing FY16-FY21 at $98.3M per year (reviewed annually)
  - Senior Review in 2016 is a Delta Review from the 2014 edition
  - Committed to operating HST as a Great Observatory through 2020 and beyond
- **Science Operations Contract Status**
  - Current contract period of performance is through April 30, 2016
  - Request for Proposal for continued operations through April 30, 2021 was released in September
  - AURA's proposal is expected to be received on November 5
- **General Observer / Archival Research**
  - Cycle 22 and Cycle 23 awarded value was $28.9M
  - Cycle 23 includes ~200 orbits available as part of Mid-Cycle Call program
  - Current goal is to maintain at least flat cycle values through JWST activation period

Discussion

- **Questions?**