Auroras on Jupiter are generated by interactions between the solar wind and Jupiter’s magnetosphere.

Juno arrived at Jupiter in June 2016 and began measuring properties of solar wind.

HST has begun a several month long campaign to observe the auroras.
About Us

A free-standing science center, operated by the Association of Universities for Research in Astronomy (AURA) for NASA

Located at The Johns Hopkins University; collaborates with, and has science staff affiliated with the University

Total staff ~650: Scientists, Engineers, Programmers, Educators, Outreach Experts, Business Resource Specialists
The Hornig Report - 1976

“Whereas the operation of the ST and its associated systems is best carried out by NASA, optimum scientific use of the ST requires the participation of the astronomical community.”

“An institutional arrangement, which we call the Space Telescope Science Institute (STSI), is needed to provide the long-term guidance and support for the scientific effort, to provide a mechanism for engaging the participation of astronomers throughout the world, and to provide a means for the dissemination and utilization of the data derived from the ST.”

“We recommend that the STSI be operated by a broad-based consortium of universities and non-profit institutions... The consortium would operate the institute under a contract with NASA.”

For Hubble and the James Webb Space Telescope, this is accomplished through a longstanding partnership between STScI, JHU, and GSFC.
Turning Great Science Ideas into Great Science Through Science Systems Engineering

First STScI Director
Riccardo Giacconi
Some of our Many Tasks for Hubble and JWST

- Champion Hubble science
- Science program selection
- Observatory planning and scheduling
- Science instrument commanding
- Observer support and documentation
- Anomaly resolution
- Instrument performance trending and characterization
- Development of new instrument modes
- General observer and archival research grant administration
- World-class education and public outreach office
- Archiving of science data and high-level science products
- Calibration of science data
Reaffirming the Role of the Science Centers

Testing and Refining the Model

“The astronomy science centers established by the National Aeronautics and Space Administration (NASA) to serve as the interfaces between astronomy missions and the community of scientists who utilize the data have been enormously successful in enabling space-based astronomy missions to achieve their scientific potential. These centers have transformed the conduct of much of astronomical research, established a new paradigm for the use of large astronomical facilities, and advanced the science far beyond what would have been possible without them.”

The model has been successfully applied to other Great Observatories
- The Chandra X-ray Center
- The Spitzer Science Center
The Expansion of the Universe is Accelerating

Hubble observations of Type Ia supernova at cosmological distances contributed to the discovery that the expansion of the universe is increasing with time.

This observation implies that the universe is not closed but must be flat or open.
Hubble’s Unprecedented Scale and Breadth of Science

**Breadth of Hubble Science**
- 13,900 publications to date
- 600,000 citations
- 2 new published papers per day
- 20% of all astronomy papers reference Hubble

**Distribution of Science Programs**
- Solar System, Exoplanets, Debris Disks - 15%
- Resolved Stellar Pops and Star Formation - 13%
- Hot and Cool Stars - 14%
- Intergalactic Medium - 12%
- Interstellar Medium - 12%
- Unresolved Stellar Pops and Galaxies - 12%
- AGN and Quasars - 6%
- Cosmology - 23%
STScI’s Role in the Development of JWST

1989 – NASA and STScI host a conference to plan the successor to Hubble. 130 astronomers and engineers gather at STScI for a 3-day workshop: "The scientific potential of an HST follow-up mission with enhanced flux collecting power and spatial resolution, and with spectral coverage extended through the near-infrared is enormous."

1993 – AURA appoints an independent “HST & Beyond Committee” to study possible missions and programs for future UV, optical, and infrared space astronomy.

1997 – A joint NASA-STScI study developed a mission concept and established that the Next Generation Space Telescope was feasible.
Over a 10 day period in late 1995, Robert Williams, then director of STScI, used his Director’s Discretionary time to point Hubble at a dark region of the sky in the constellation Ursa Major within the Continuous Viewing Zone (CVZ).

The HDF revealed…

(1) 3000 distinct galaxies, with a range of morphologies from irregular and spiral
(2) Including large numbers of galaxies at very high redshift
(3) Many with disturbed morphologies indicating that galaxy collisions and mergers were more common when the universe was young and that star formation peaked at 8-10 billion years ago

Discovery suggested that distant galaxies were more compact than anticipated and could be resolved to very high redshift
NASA’s Great Observatories are the Foundation of Astrophysics Decadal Surveys

- 1972 - Hubble
- 1982 - Chandra
- 1991 - Spitzer
- 2001 - JWST
- 2010 - WFIRST
The James Webb Space Telescope (JWST)

6.6 m diameter primary mirror, composed of 18, deployable segments protected from the sun by a large sunshield located at the Sun-Earth L2 point.
JWST Societal Impacts

Medical Spinoffs
Diagnosis of ocular diseases
Improvements in laser eye surgery

Commercial Spinoffs
Laser interferometry
Semiconductors

Science Spinoffs
Hubble electronics
Servicing Mission 4 repairs

Public Inspiration
JWST Cryogenic Mirror Testing
National Security Spinoffs
National Security missions
Earth Science missions

Public
Next generation space science leaders

Students
JWST STEM Engagement
JWST Science Themes

First Light & Reionization

Assembly of Galaxies

Birth of Stars & Protoplanetary Systems

Planets & Origins of Life
HST deep extragalactic surveys (HDF, HUDF, GOODS, AEGIS, COSMOS, CLASH, CANDELS) have probed galaxy assembly over 95% of the universe’s lifetime...

JWST deep extragalactic observations will enable observations of the first galaxies
Assembly of Galaxies: When Did the First Bulges Appear?

Ultra Deep Field 2012/XDF WFC3/IR 0.9-1.6 μm

IRAC Ultra Deep Field 3.6 μm (Labbe et al. 2015)

From J. Lotz
Assembly of Galaxies: Physics of Galaxy Mergers at z>1

NIRSpec

MIRI

[NII]/Hα shocks

Hα – HII regions

The Mice: Mortazavi & Lotz 2016, in prep

Star-formation, shocks
And kinematics of z>1 mergers with JWST spectroscopy

From J. Lotz
Birth of Stars and Protoplanetary Systems
The Embedded Phase of Star Formation

JWST spectroscopy will enable characterization of the physics and chemistry of few 10 to few 1000 AU scales.

How does matter flow from core to disk to star?

What are the properties of young disks?

From E. van Dishoeck
JWST will measure secondary eclipses for transiting exoplanets.

Bean et al. (2013)

Figure by S. Seager
Planets & Origins of Life: Characterizing Exoplanet Atmospheres

JWST will enable

- observations of $\text{H}_2\text{O}$, $\text{CH}_4$, CO, and $\text{CO}_2$ molecules in exoplanetary atmospheres. Detections of these molecules will provide constraints on planet/star metallicity and C/O abundance ratios, and therefore constraint planet formation mechanisms.
Planets & Origins of Life: Measuring Heat Transport

JWST will enable

- thermal mapping of the day and night-side temperatures. Such maps will constrain energy transport mechanisms.
2016 Milestones

- January 2016: ISIM Cryovac 3 Testing Complete
- February – April 2016: Installed 18 primary mirror segments and Aft optics system including fixed tertiary mirror and Fine Steering Mirror
- May 2016: Installed Science Instrument Package into Optical Telescope Element
**Early JWST Observations**

- **Director's Discretionary - Early Release Science**
  - Designed, executed by teams with broad representation of community; selected by peer-review
  - Spans key JWST observing modes and science areas. Coherent programs in multiple modes encouraged
  - Substantive, science–driven program of broad community interest in Cy 1, prep for Cy 2
  - 500 hours of telescope time divided among 12-15 teams
  - Data have no proprietary period
  - Among first obs to execute after commissioning
  - ERS teams responsible for delivery of science enabling products to community

- **General Observer Cycle 1**
  - Use GO programs from HST, Spitzer and Chandra, etc. as models
  - Flexible to accommodate programs with a range of sizes
  - Support archival research
  - Details TBD

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**JWST Science Timeline**

Current as of August 2016
Community Education: Workshops

- **International Conferences**
  - Exploring the Universe with JWST II (Oct 2016 in Montreal, Canada)
  - Science with Hubble and JWST V (Mar 2017 in Venice, Italy)
  - Mastering the Science Instruments and the Observing Modes of JWST (Sep 2017)

- **Proposal and Planning Workshops**
  - May 2017 at STScI (Baltimore, MD)
  - Jun 2017 at the 230th AAS Meeting (Austin, TX)
  - Oct 2017 at the 49th DPS Meeting (Provo, UT)
  - Dec 2017 at Caltech (Pasadena, CA)
  - Jan 2018 at the 231st AAS Meeting (National Harbor, MD)

- **Topical Science Workshops**
  - Nearby Galaxies (Jan 2017 in Pasadena, CA)
  - Transiting Exoplanets II (Jul 2017 in Baltimore, MD)
  - Galaxy Evolution (Jul 2017 in Baltimore, MD)
  - Protoplanetary and Debris Disks (Oct 2017 in Baltimore, MD)
  - Solar System (Nov 2017 in Baltimore, MD)
Find out more about JWST…

JWST Observer on Facebook

#JWST on Twitter
Step 1: Determine what percentage of stars have planets

Step 2: Find the long-lived stars with planets in the habitable zone

Step 3: Find these kinds of star-planet systems within 50 pc of the Sun

Step 4: Measure the atmospheric composition of these potentially habitable planets

Step 5: Achieve high-performance coronagraphy in space

JWST/NIRSpec

Transits 10x Earth mass (and hot) Thick Atmosphere

Water & Methane

TESS Yield ~300 nearby Earth and Super-Earths

Batalha, N., et al. (2014) JWST white paper