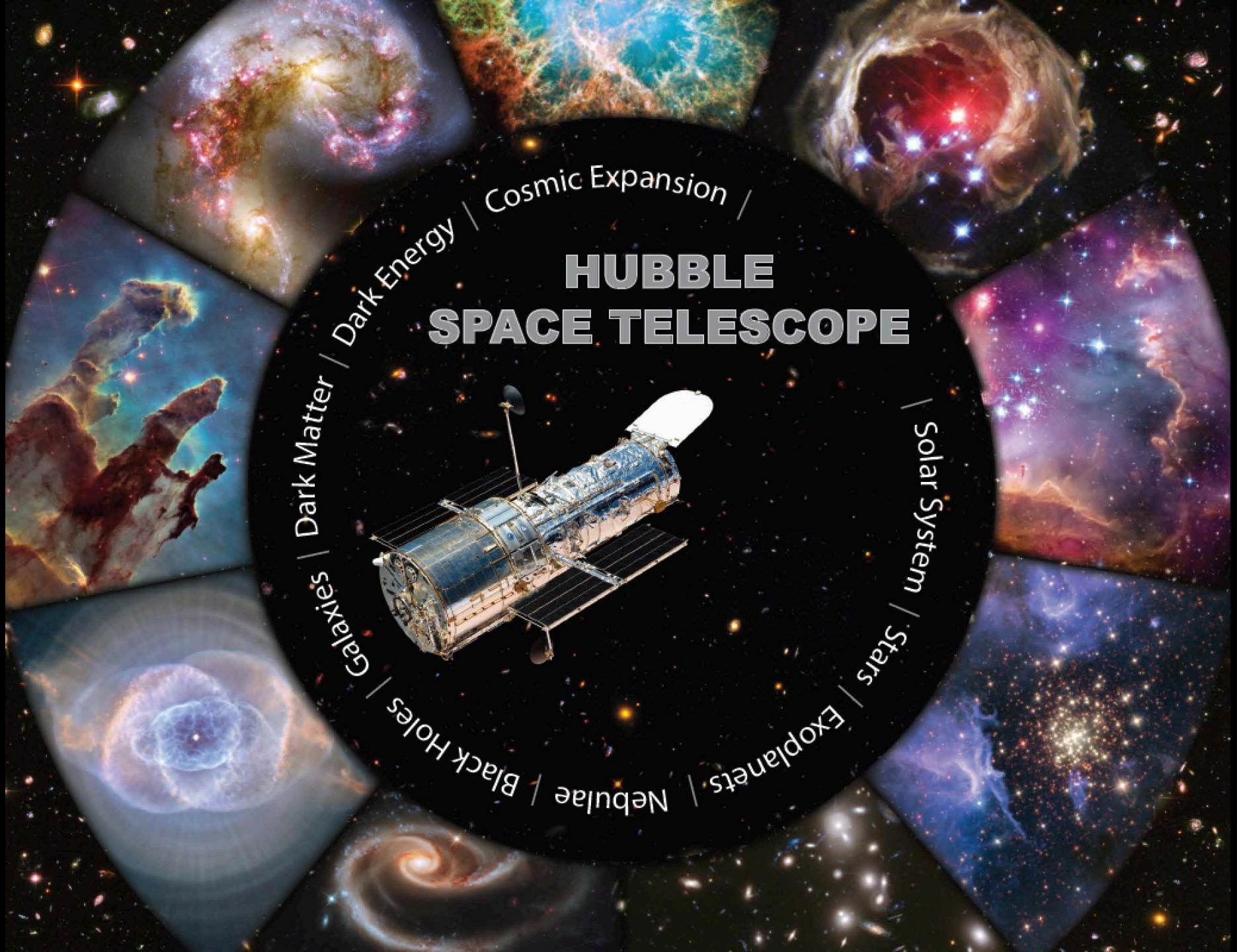

Cosmic Expansion
Dark Energy
Dark Matter
Galaxies
Black Holes
Nebulae
Exoplanets
Stars
Solar System
HUBBLE
SPACE TELESCOPE

The Hubble Space Telescope at 30!

Mission overview, discoveries, status, and future

Dr. Jennifer Wiseman
Hubble Space Telescope
Senior Project Scientist

NASA
Goddard Space Flight Center
Greenbelt, Maryland, USA
Jennifer.wiseman@nasa.gov

The Hubble Space Telescope mission is a NASA-ESA Partnership:

Launch date: 24 April 1990

Launch vehicle: Space Shuttle Discovery (STS-31)

Mass: 24,500 lbs (11,113 kg)

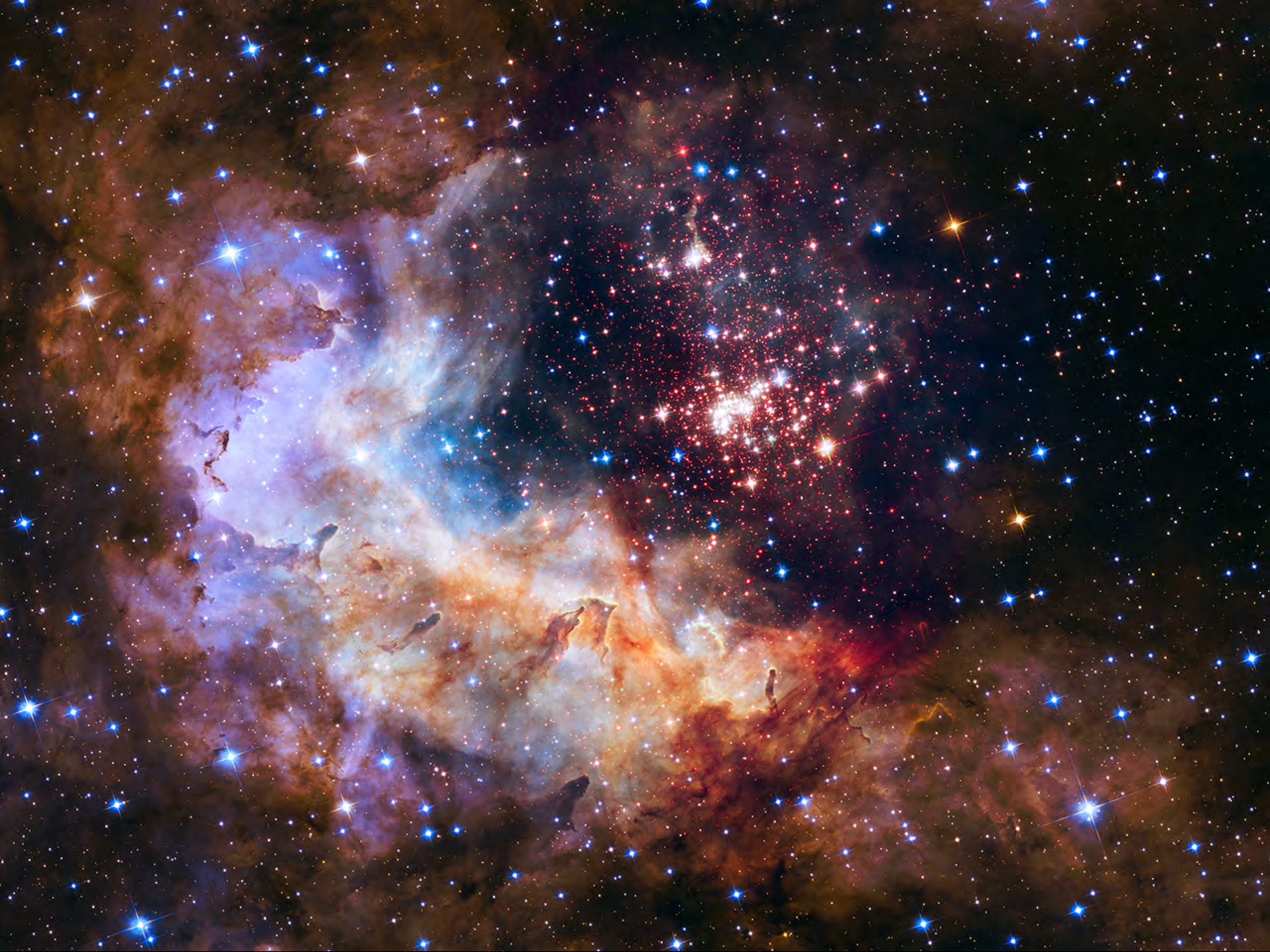
Maximum diameter: 14 ft (4.2 m)

Length: 43 ft (13 m)

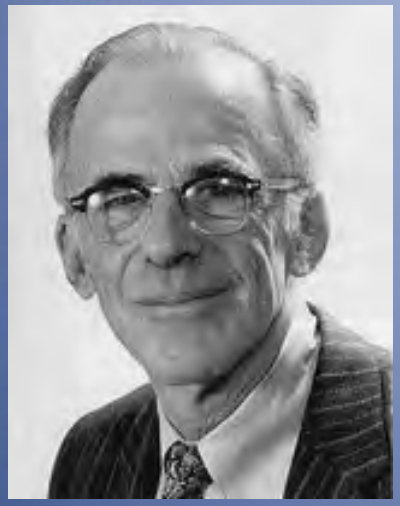
Orbit Height: 339 miles (545 km)

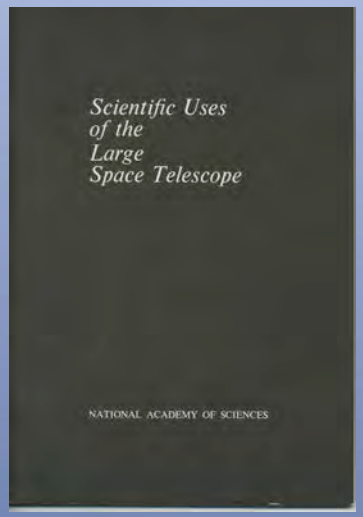
Orbit period: 96-97 minutes

Orbit velocity: 16,800 mph (27,037 kph)



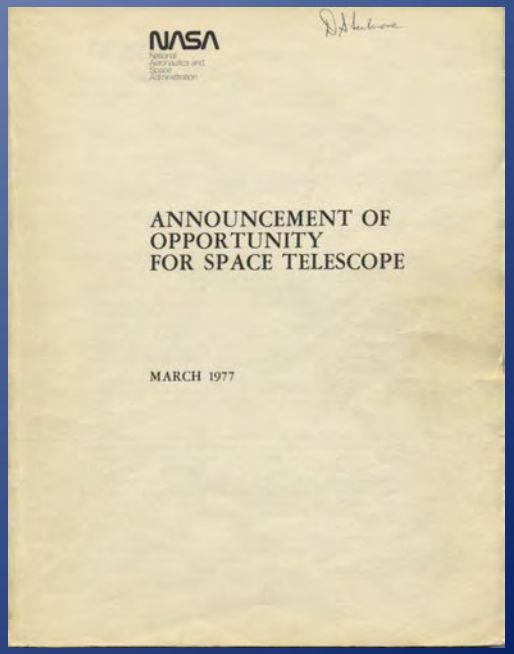
Why a Space Telescope?



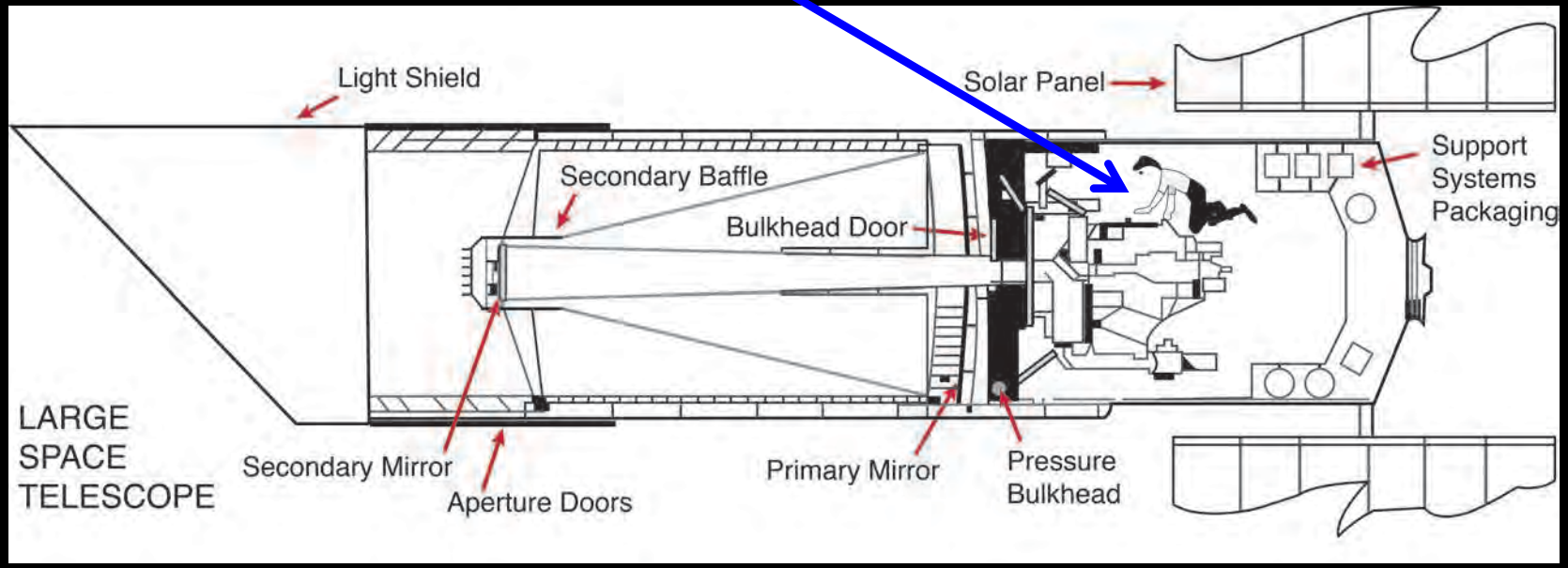


"Chairman Spitzer's Little Black Book" of 1969 Reporting Results of NAS Study

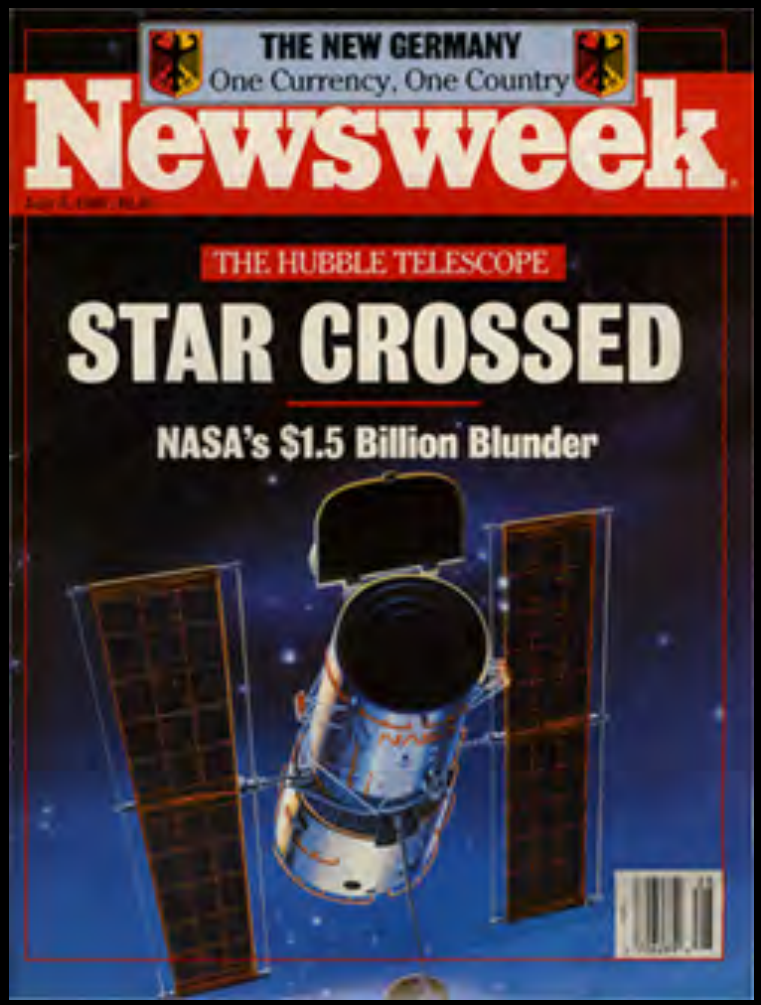
1977: First NASA Announcement of Opportunity for Scientific Participation In Hubble Mission Under Leadership of Nancy Roman

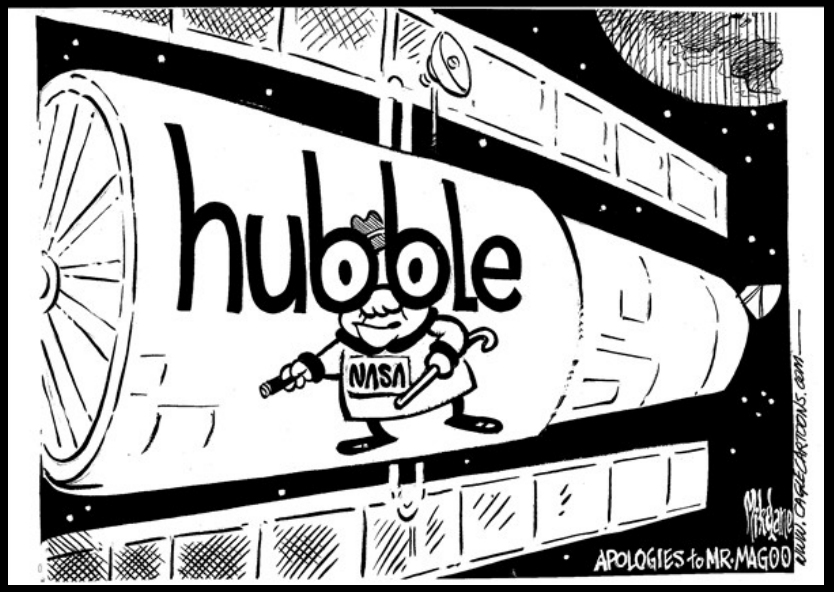


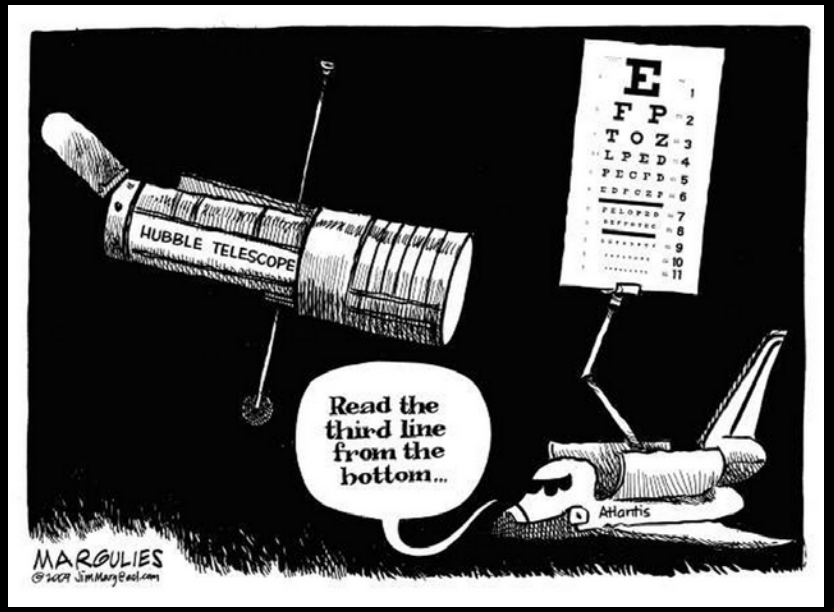
For a while, in the 1960's….



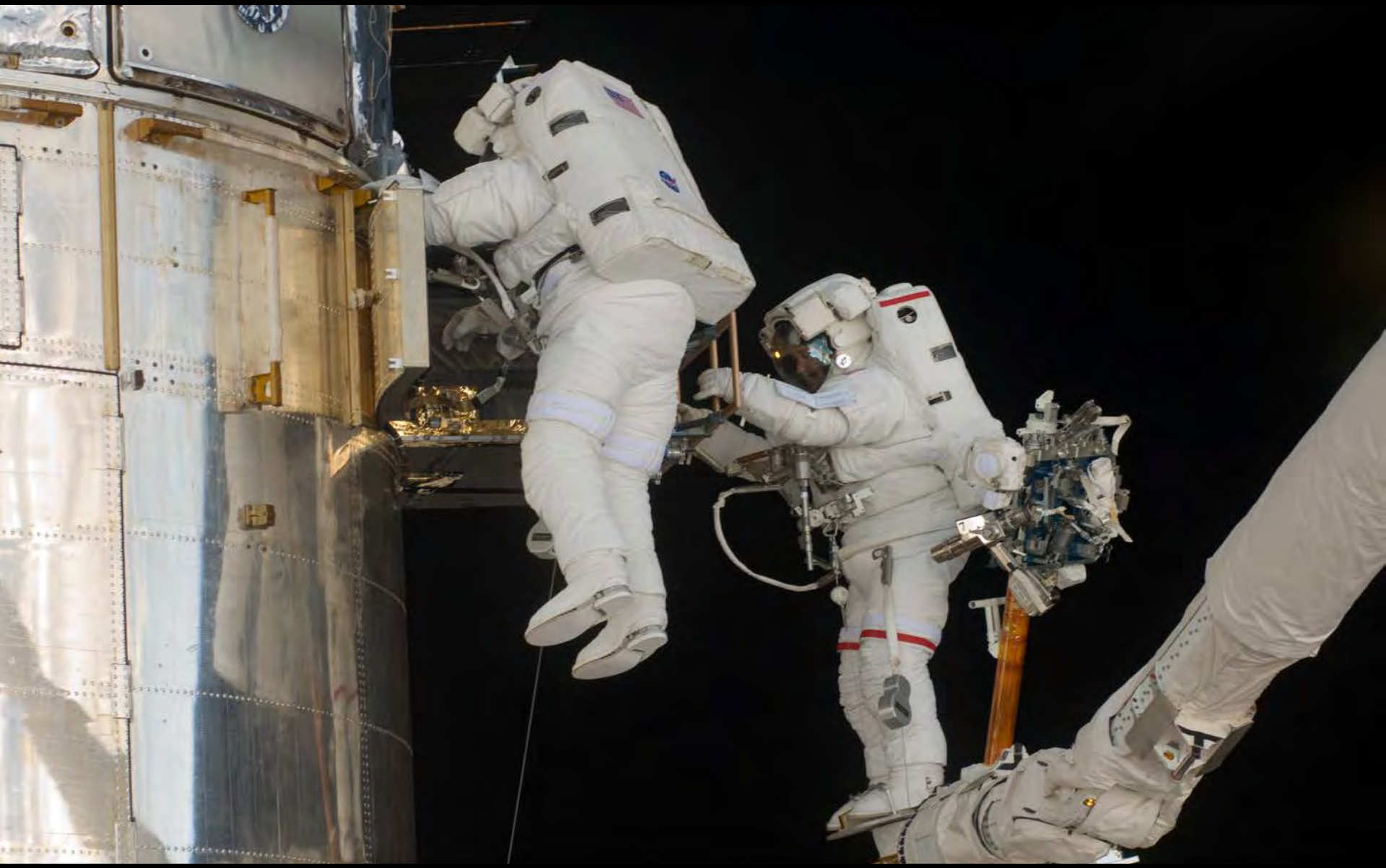

STS-31, Discovery
April 24, 1990


THE NEW GERMANY
One Currency, One Country
Newsweek
THE HUBBLE TELESCOPE
STAR CROSSED
NASA's $1.5 Billion Blunder


hubble
NASA
APOLOGIES to MR. MAGOO


HUBBLE TELESCOPE
Read the third line from the bottom...
Atlantis
MARGULIES

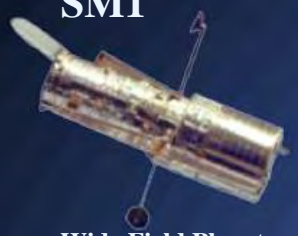
Astronaut Servicing of the Observatory has enabled Repairs, Enhancements, and Mission Life Extension



HUBBLE MISSIONS

Launch!

SM1

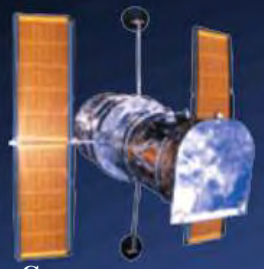


Wide Field Planetary Camera 2
COSTAR
Gyros
Solar Arrays

SM2

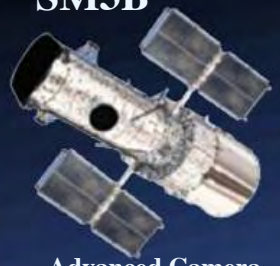
Imaging Spectrograph
Near Infrared Camera
Fine Guidance Sensor

SM3A



Gyros
Advanced Computer
Fine Guidance Sensor

SM3B

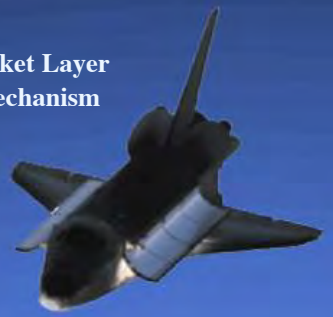


Advanced Camera
Solar Arrays
Power Control Unit
NICMOS Cooling System

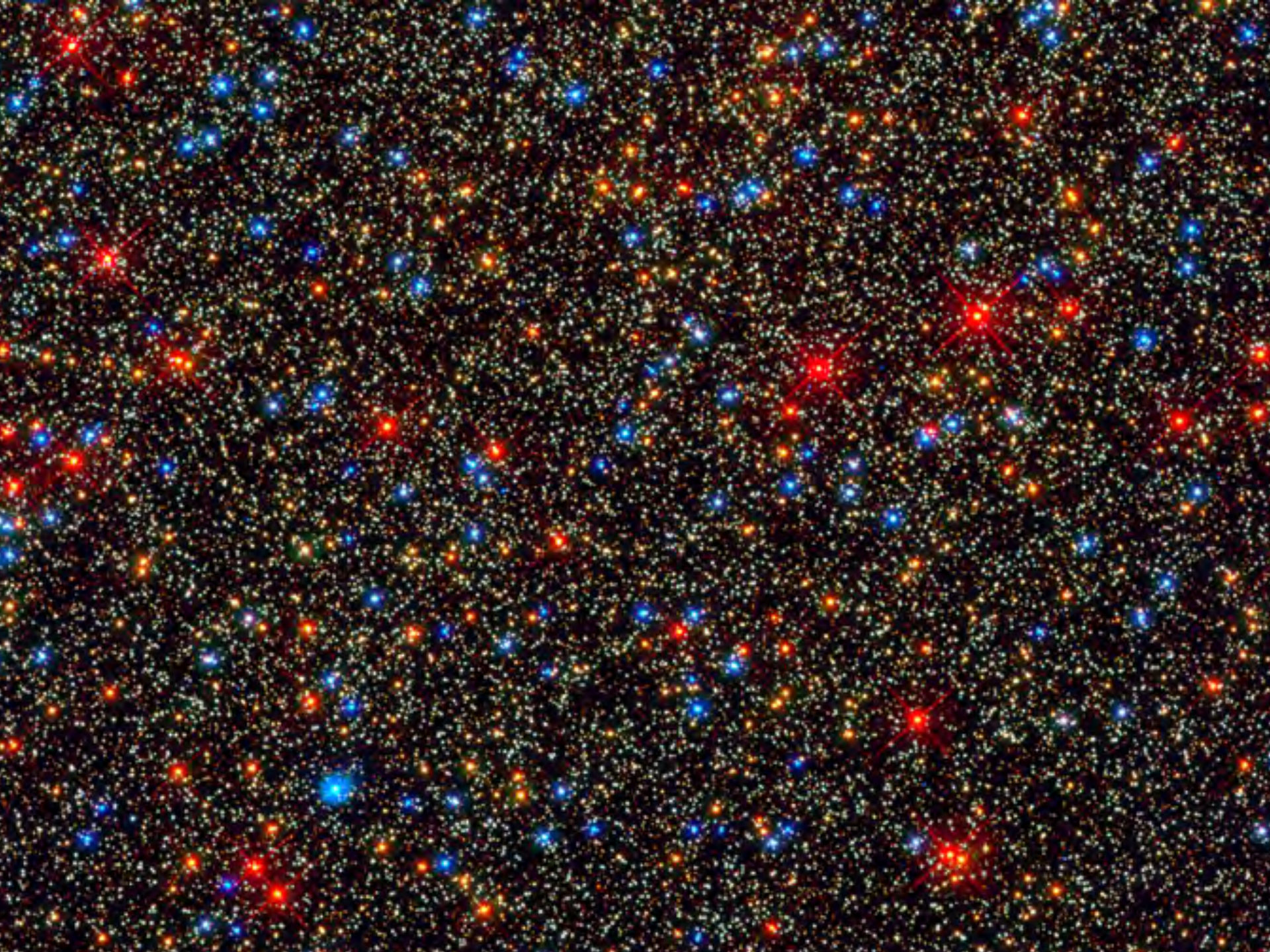
SM4

Gyros
SIC&DH
Wide Field Camera 3
Cosmic Origins Spectrograph
Batteries
Fine Guidance Sensor
STIS Repair
ACS Repair
New Outer Blanket Layer
Soft Capture Mechanism

De-Orbit Mission?

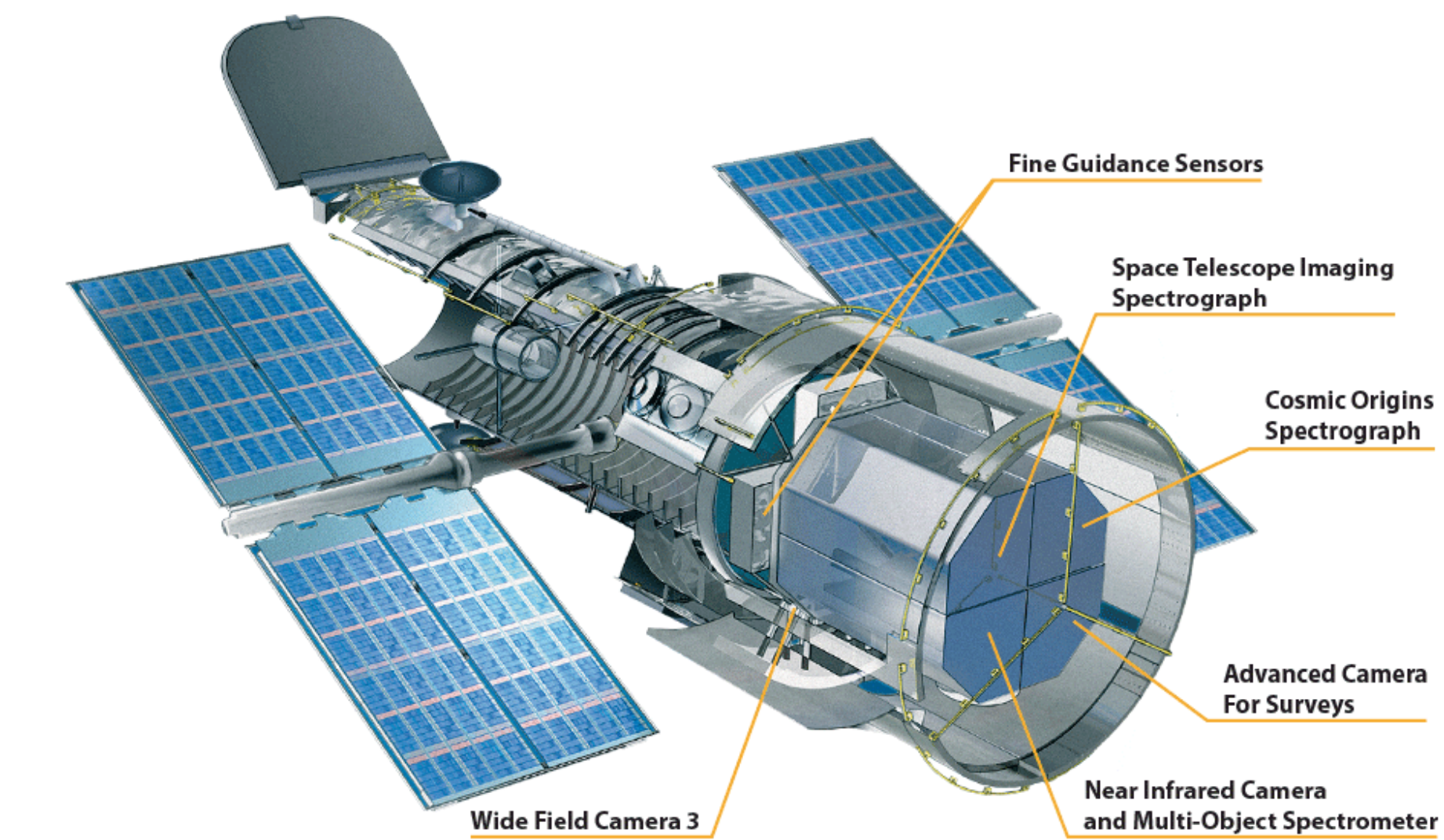


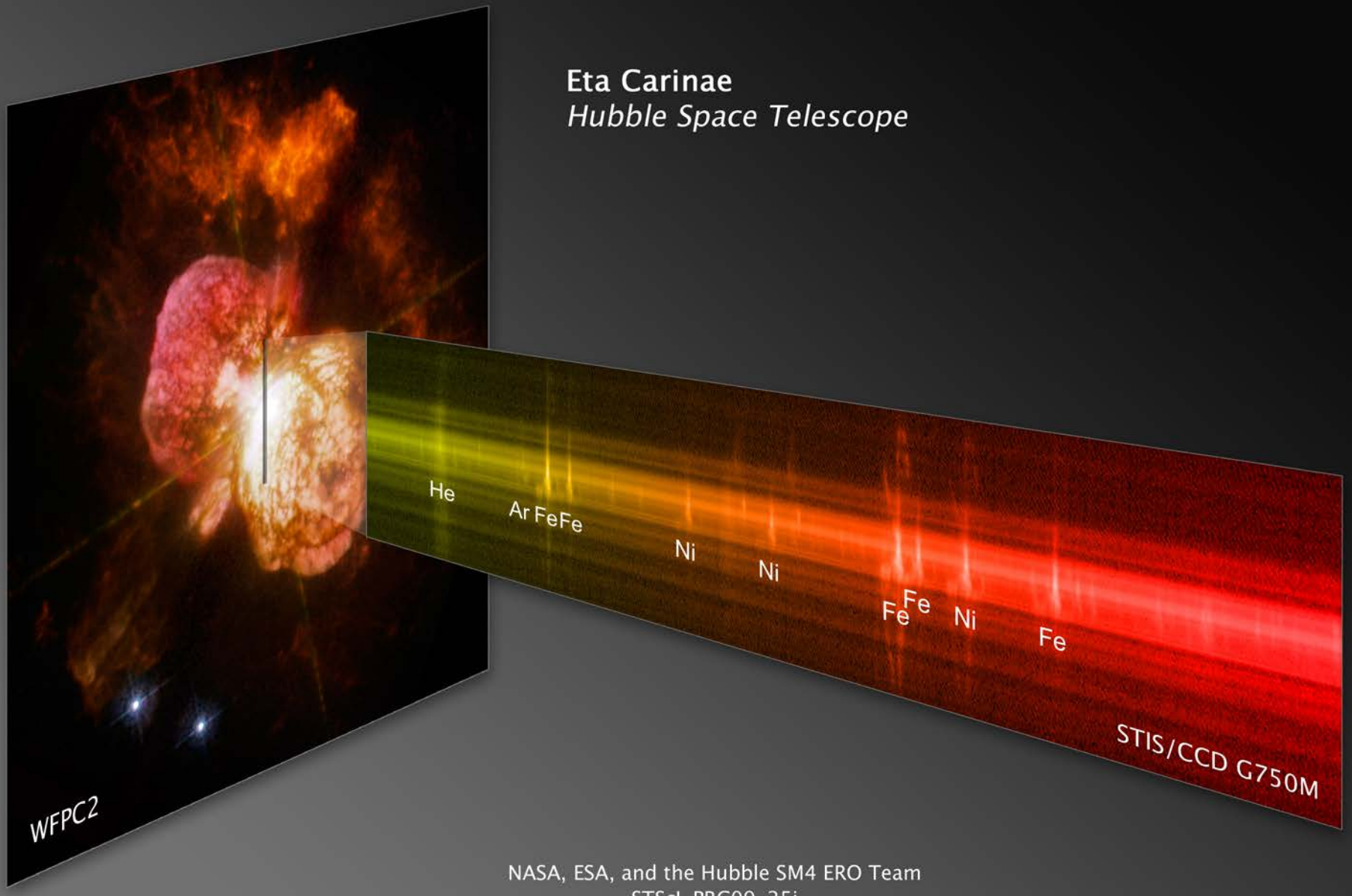
1990 1993 1997 1999 2002 2009 2030's?




Above Earth’s turbulent and filtering atmosphere, Hubble achieves sharp images

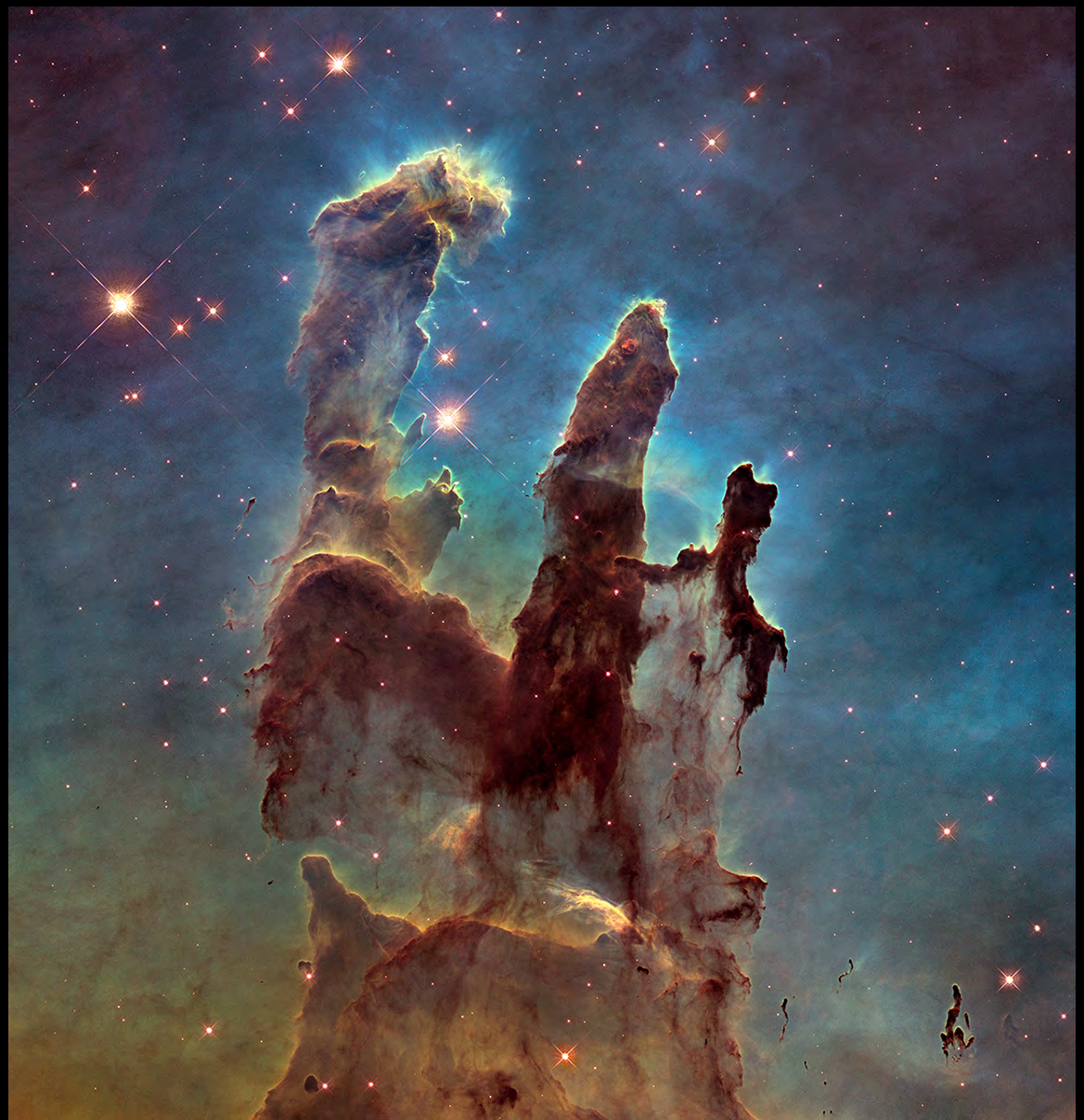
Hubble is in good technical condition and is at the peak of its scientific return.
It is a full observatory, with a powerful suite of cameras and spectrographs.





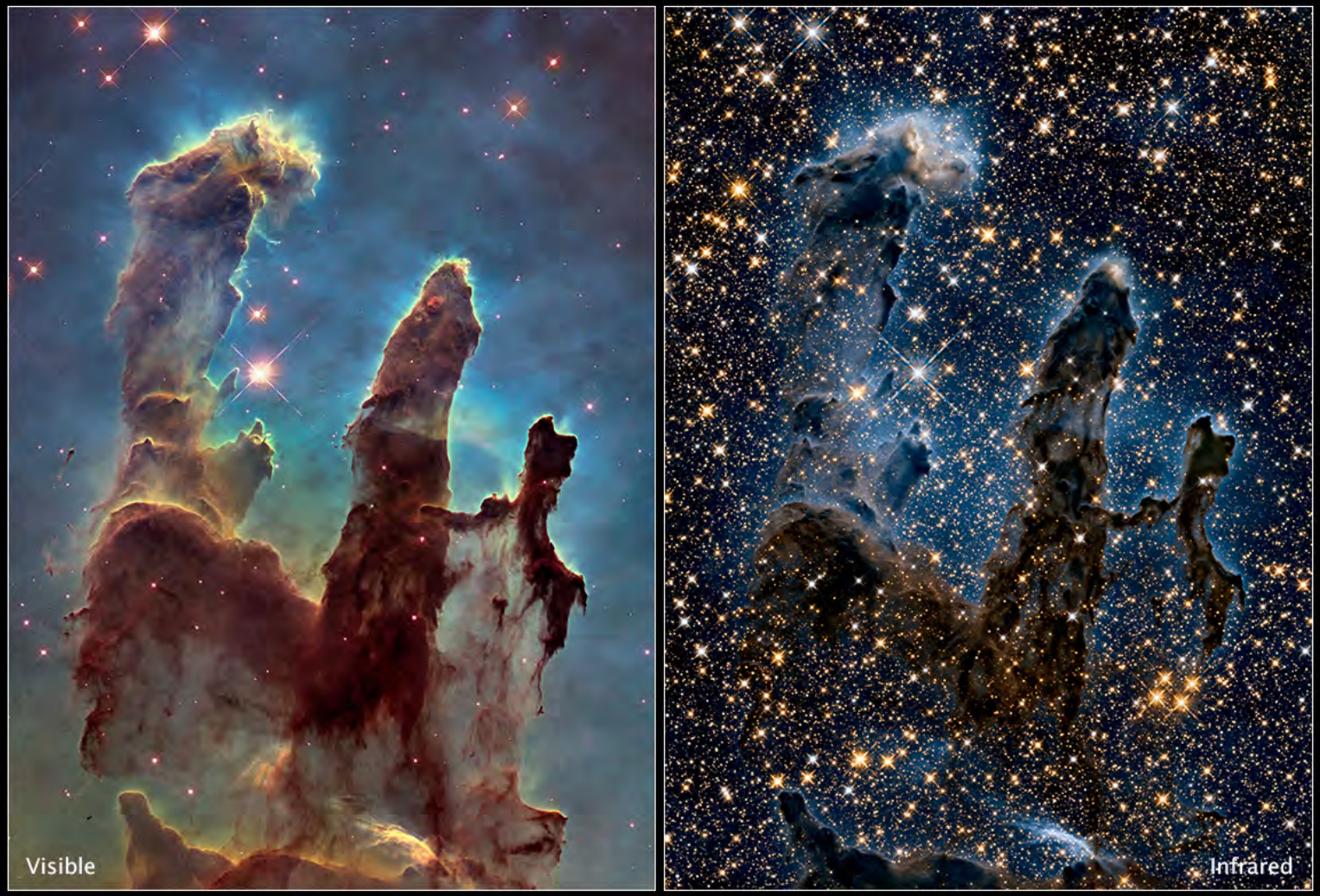
NASA, ESA, and the Hubble SM4 ERO Team
STScI-PRC09-25i

Hubble has “panchromatic” capabilities: Observes in ultraviolet, visible, and near-infrared light



M16 ▪ Eagle Nebula

Hubble Space Telescope ▪ WFC3/UVIS/IR



NASA and ESA

STScI-PRC15-01c

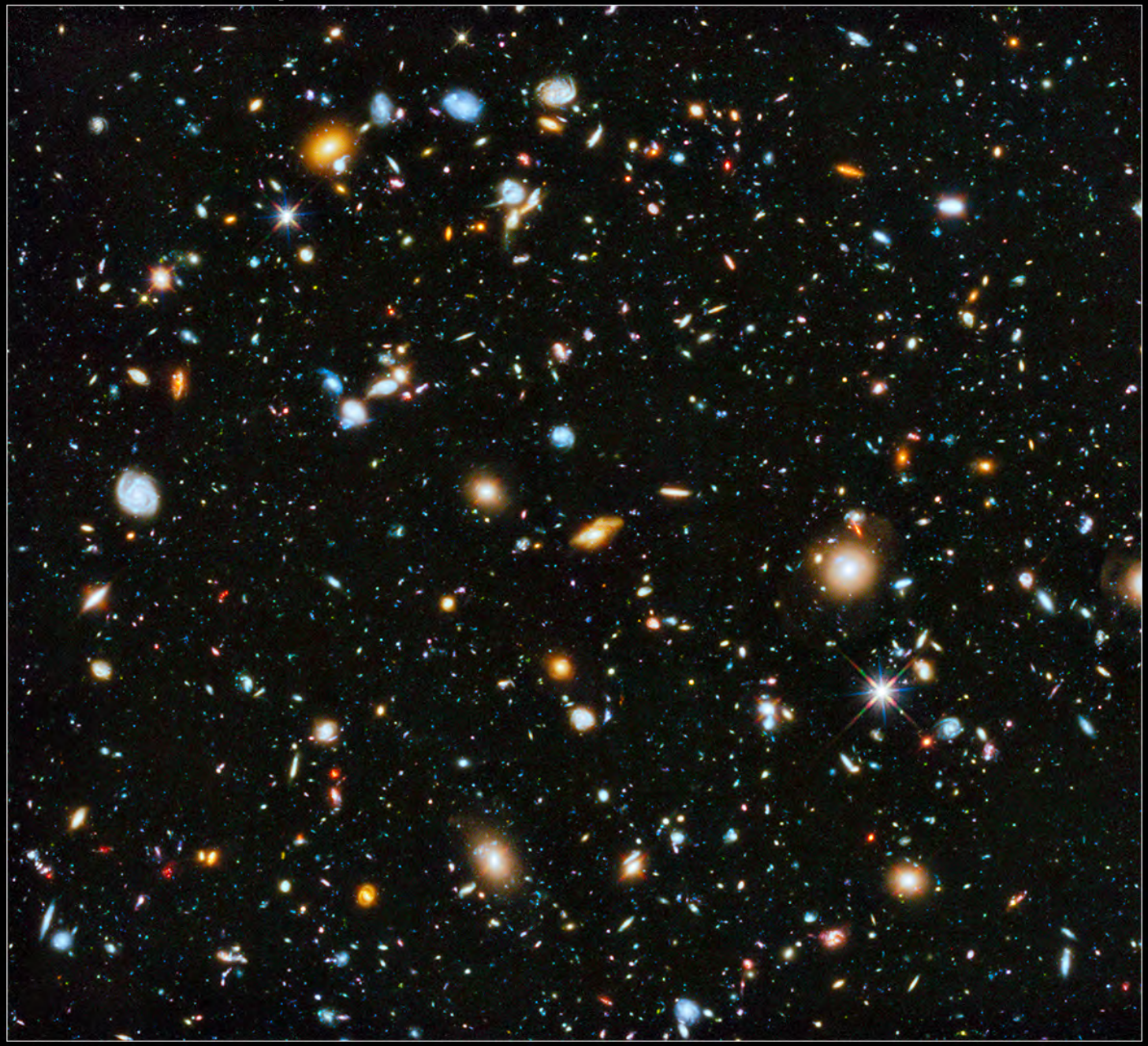
Hubble provides the *only* general ultra-violet light observing capabilities now or in the near future!

Visible light

Visible and ultraviolet light

Hubble Ultra Deep Field 2014

HST • ACS • WFC3



NASA and ESA

STScI-PRC14-27a

Hubble's Scientific Impact

- Observations made since launch: >1,300,000
- Scientific papers published: >15,000

Major Discoveries:

- **Verified the existence of black holes in galaxies**
- **Verified accelerating expansion of Universe (Dark Energy)**
- **Discovered the Most Distant galaxies in the Universe**
- **1st measurements chemical composition of exoplanet atmospheres**
- **Established expansion rate of Universe to high accuracy (this is still being refined)**
- **Discovered "proto" planetary disks around other stars**

Hubble Is Investigating Big Questions And Discoveries About the Universe that were Originally Unanticipated

What is Dark Energy?

What is Dark Matter?

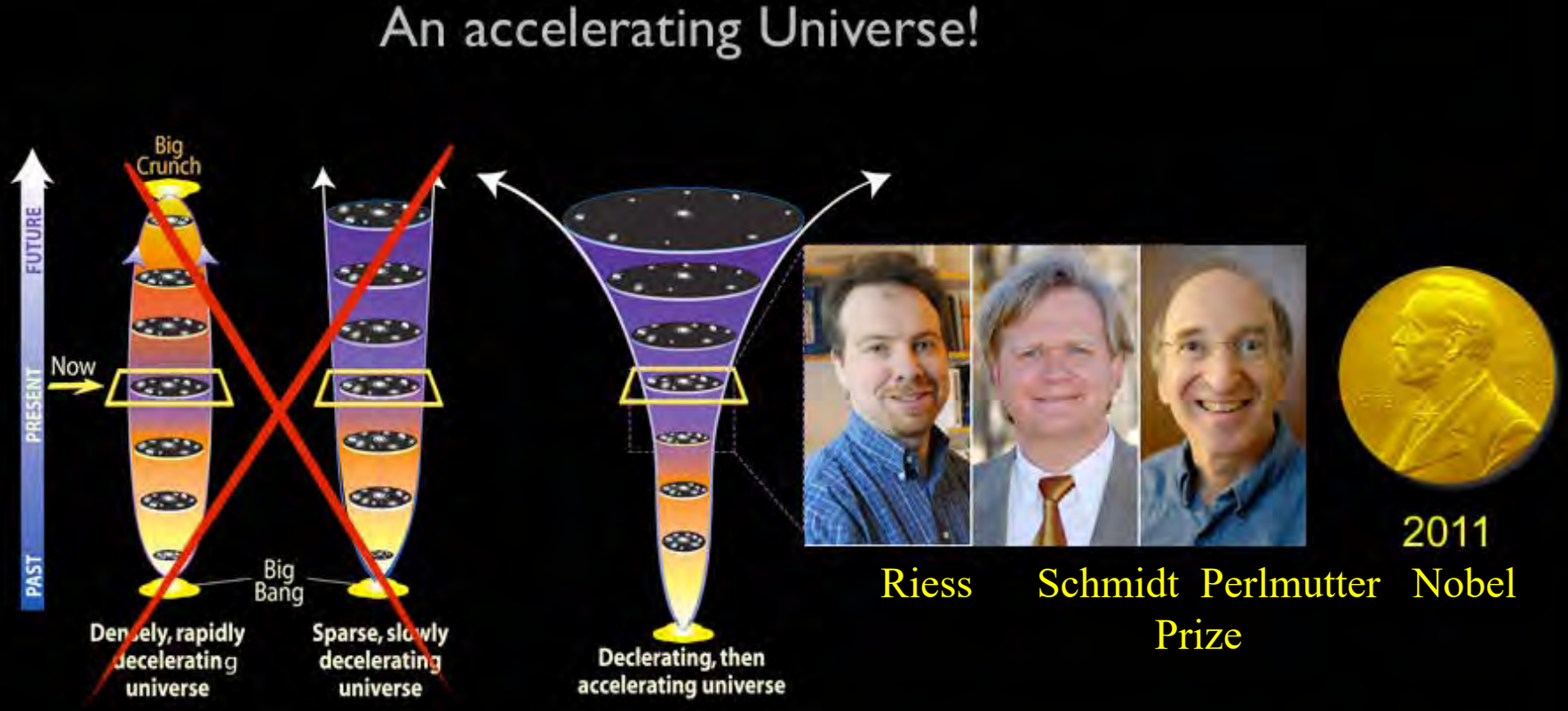
Are there other planets like Earth?

Dynamic Solar System

Radiation from Gravitational Wave sources

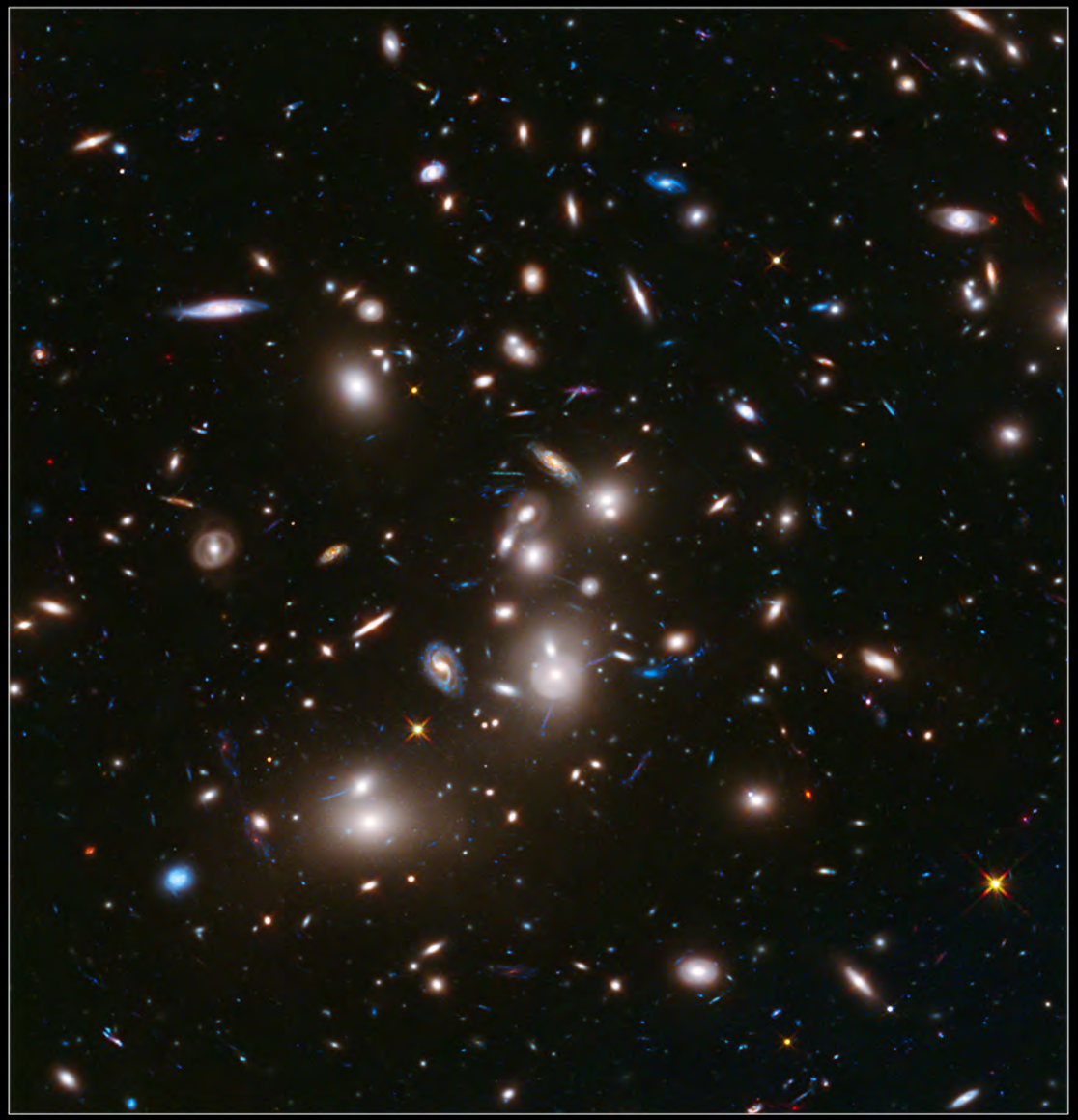
The Expansion of the Universe is Accelerating !!

HST has played a key role in detecting the *acceleration* of the expanding universe and in the study of "Dark Energy"

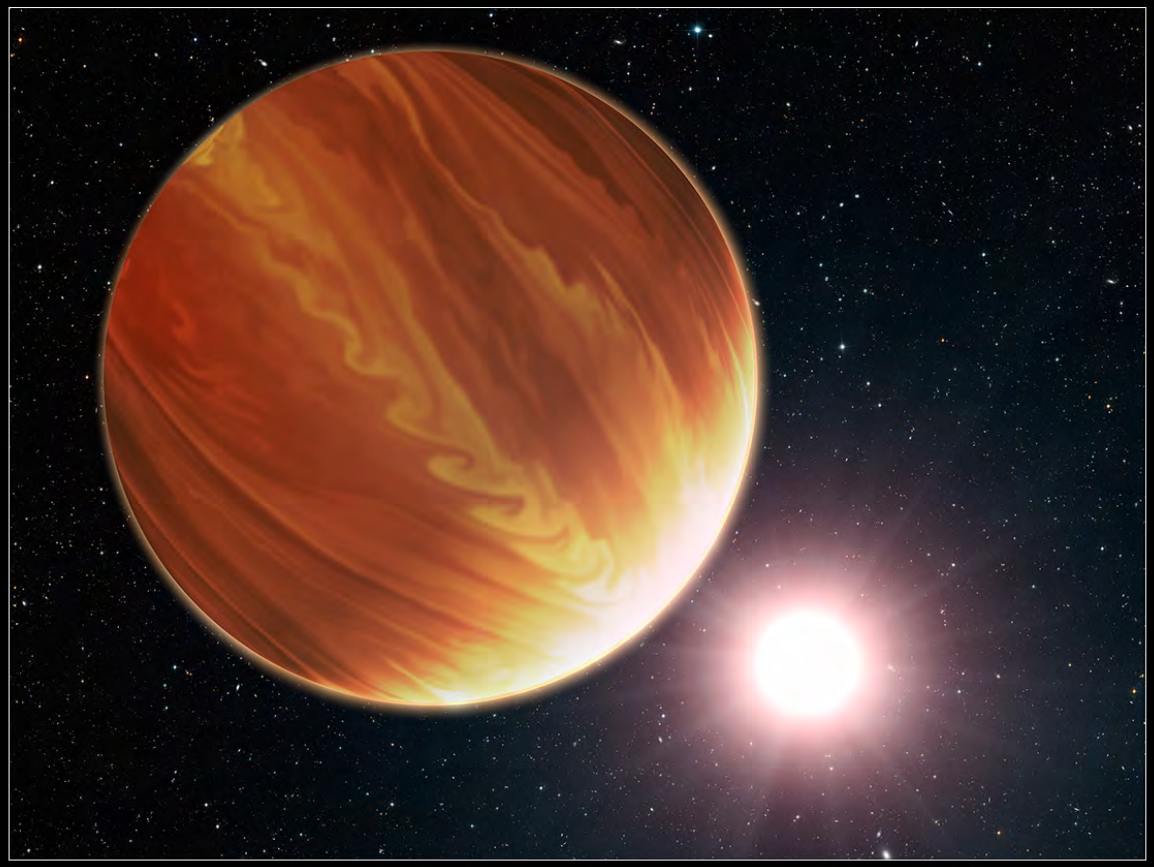


the Universe is being pushed apart, and we don't know by what..

Gravitational Lensing: Dark Matter in clusters of galaxies magnifies background galaxies and distorts their appearance



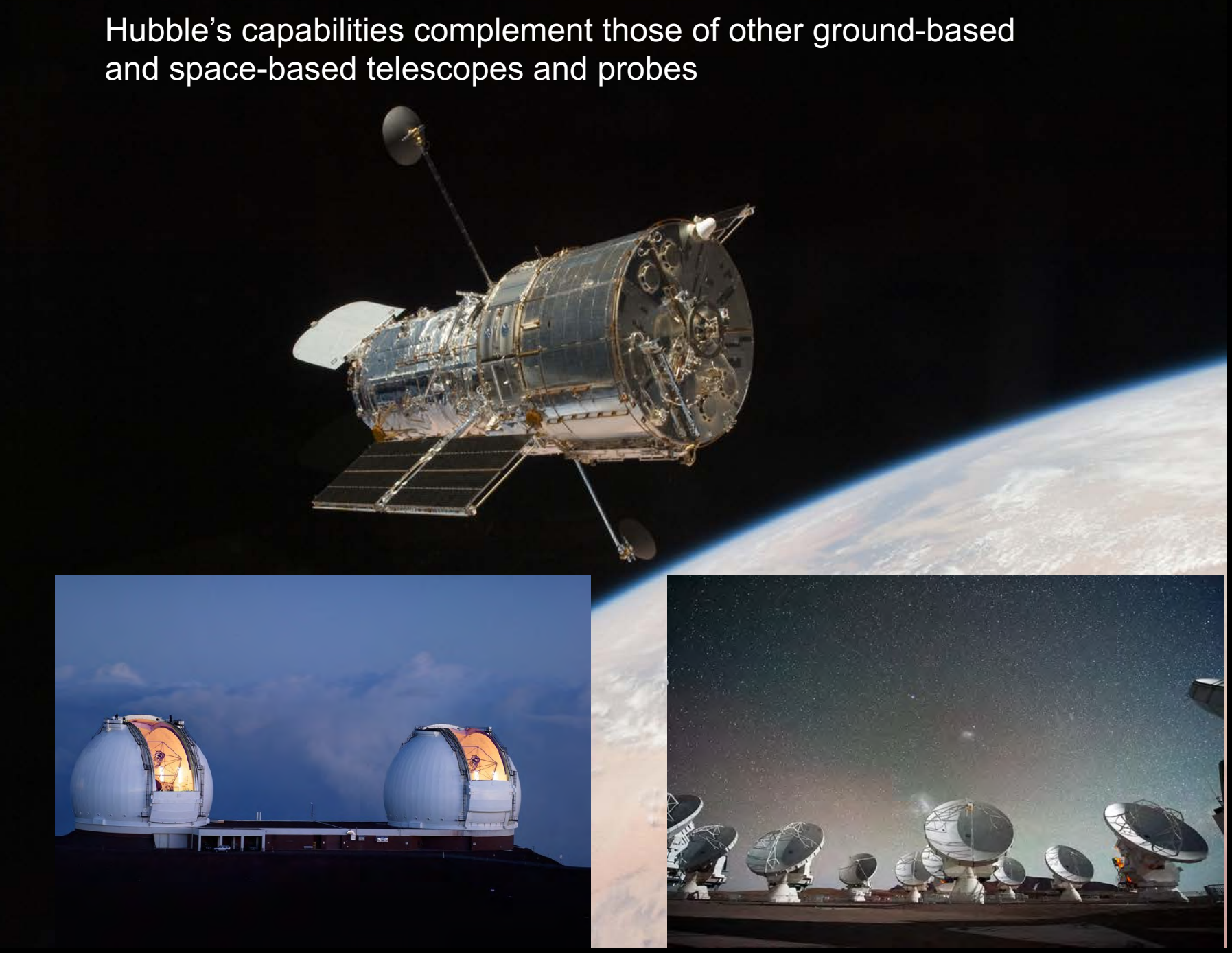
Hubble is analyzing exoplanet atmospheres



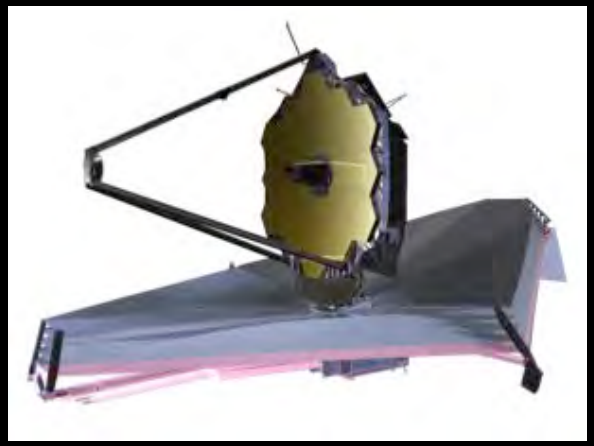
Artist's View of the Hot Extrasolar Planet Osiris (HD 209458b)

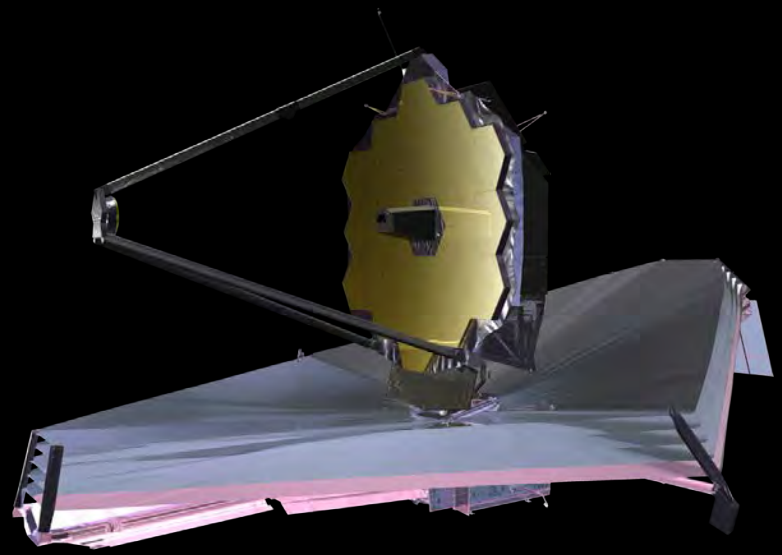
NASA, ESA, and G. Bacon (STScI) ▪ STScI-PRC14-36a

Hubble's capabilities complement those of other ground-based and space-based telescopes and probes



The Hubble Space Telescope mission continues with strong scientific capability, likely through the 2020's and hopefully beyond, and its scientific capabilities complement future missions like the James Webb Space Telescope (JWST, launch 2021)





HST
2.4 m

JWST
6.5 m

1 µm

10 µm

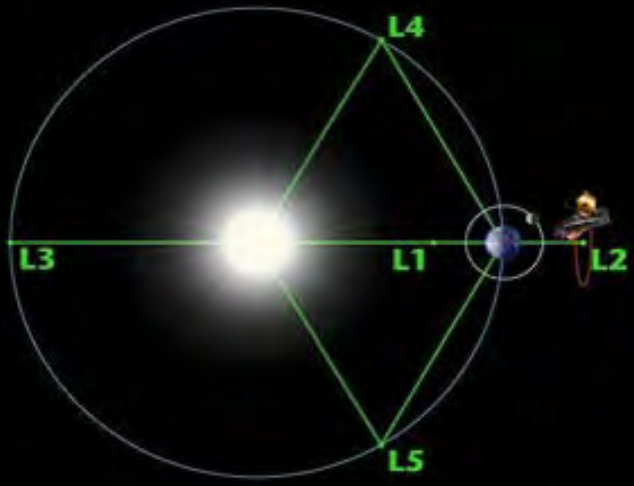
100 µm

Hubble

JWST

Infrared

Webb's Place in Space



Great sites for Hubble Space Telescope Images and Information!

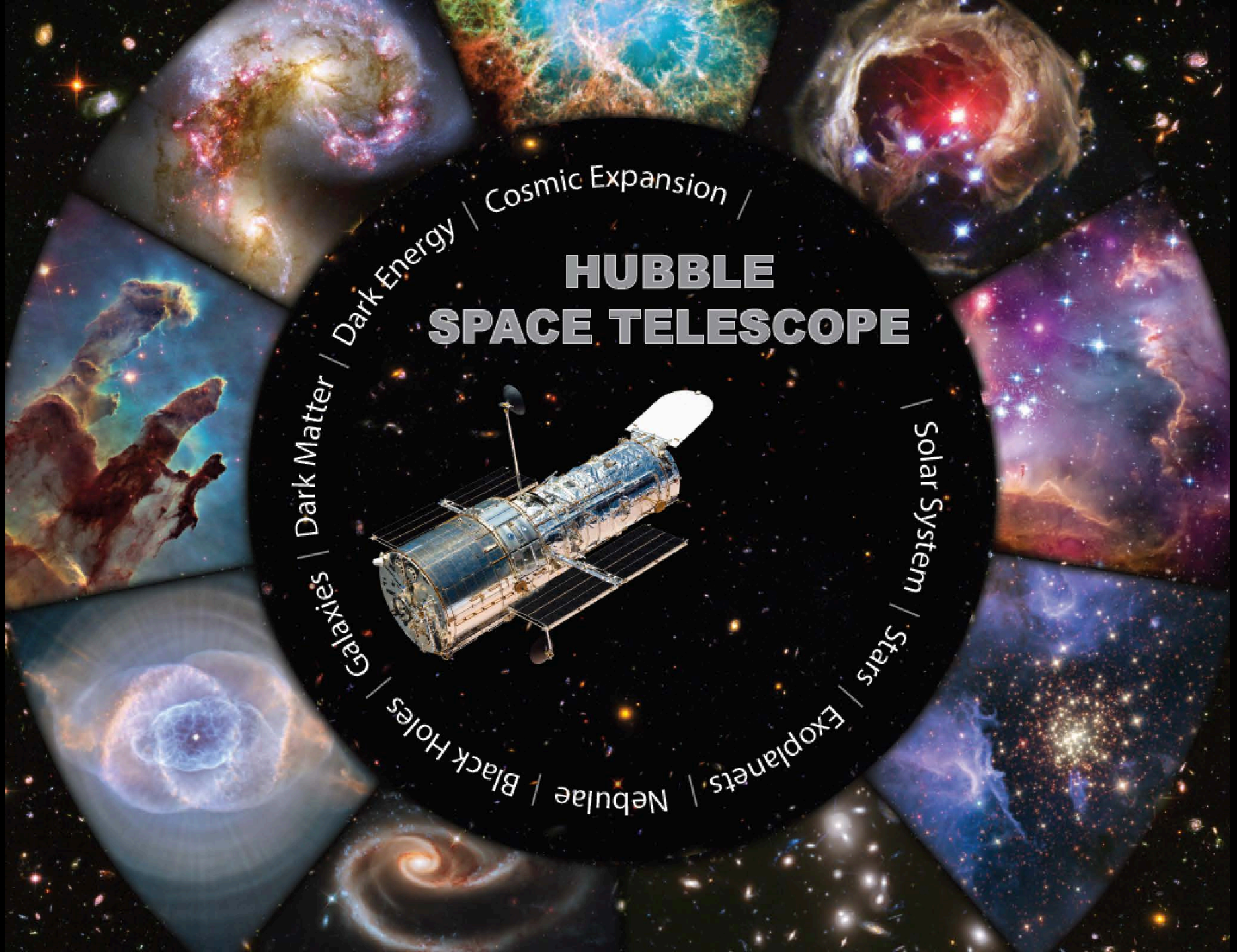
nasa.gov/Hubble

Hubblesite.org

www.spacetelescope.org
(European site)

Social media: @NASAHubble


HAPPY 30TH BIRTHDAY, HUBBLE !!


Cosmic Expansion
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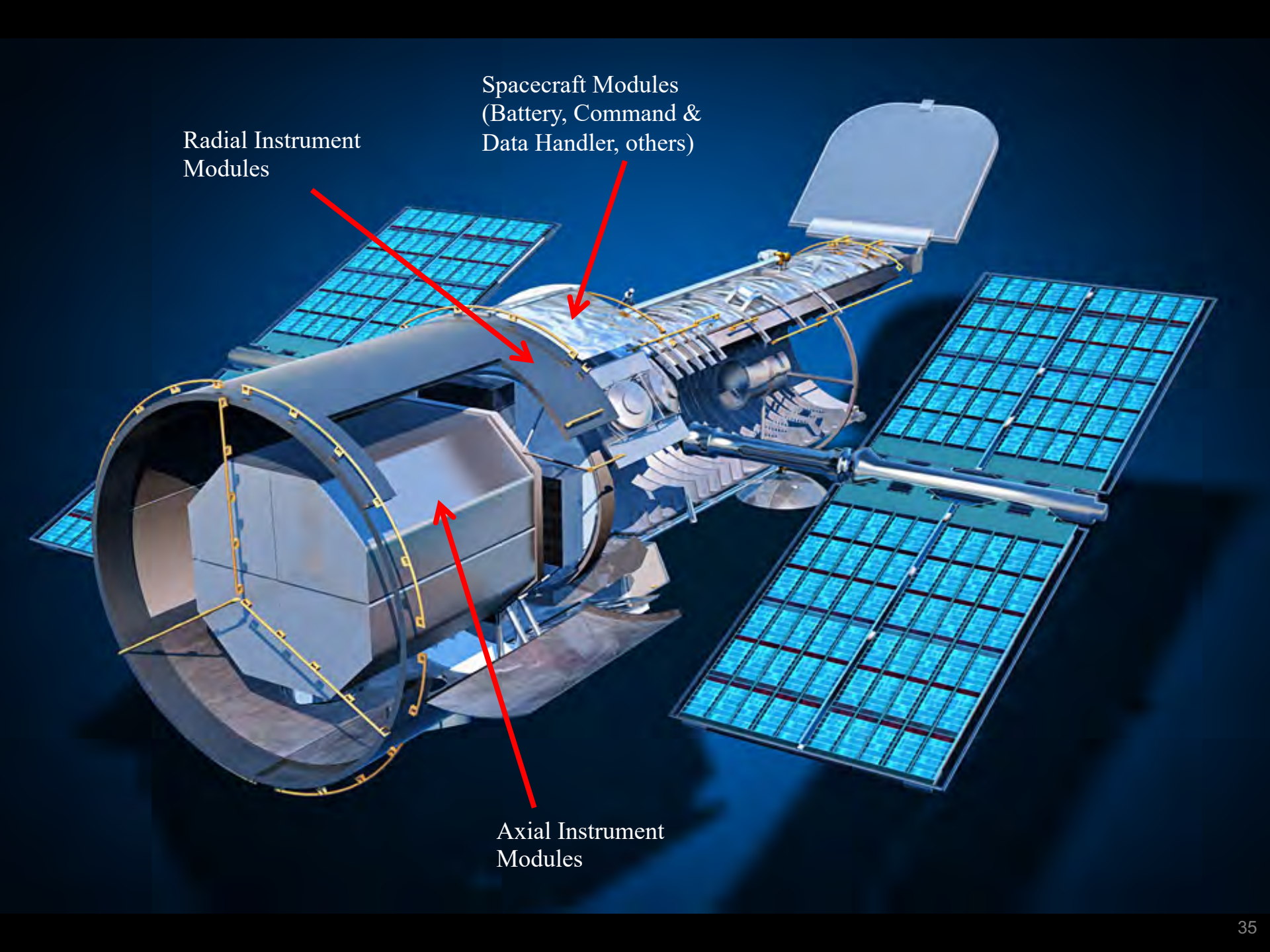
Solar System
HUBBLE
SPACE TELESCOPE

Additional information

(Some) Key Issues in Astronomy When Hubble Was Launched

- Distance scale, ***rate of expansion,*** and age of the universe
- Properties and distribution of ***gas around and between the galaxies***
- Supermassive ***black holes*** in the nuclei of galaxies; relation to Active Galactic Nuclei and Quasars
- Properties and evolution of ***star populations*** in our own and other galaxies
- Structure and properties of ***star-forming regions***
- Properties and long-term monitoring of planets, comets, and asteroids in our ***solar system***


Radial Instrument Modules
Spacecraft Modules (Battery, Command & Data Handler, others)
Axial Instrument Modules

Hubble Space Telescope Images are loved around the world