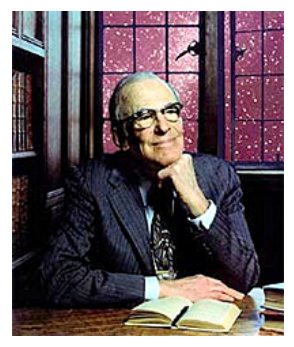


Hubble Space Telescope

25 years on April 24, 2015



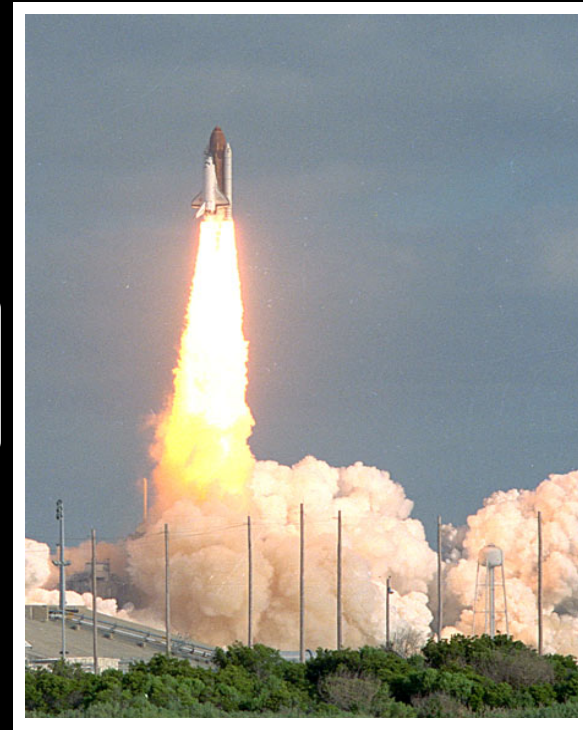
Hubble: from idea to launch



1946
Spitzer's famous paper



1977
US Congress funds
the "Large Space
Telescope Project"



1950

1960

1970

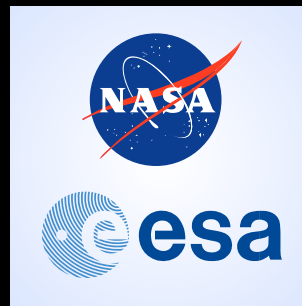
1980

1990

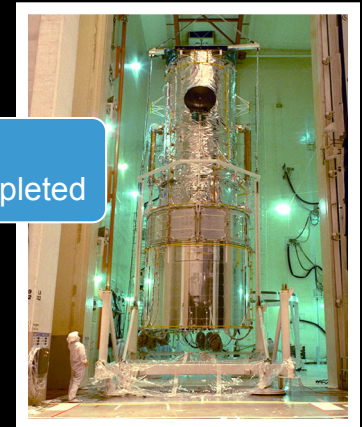
1958
NASA is established

1962
National Academy of Sciences
recommends a large space
telescope be a US national priority

1976
Combined proposal



1985
Hubble is completed



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)

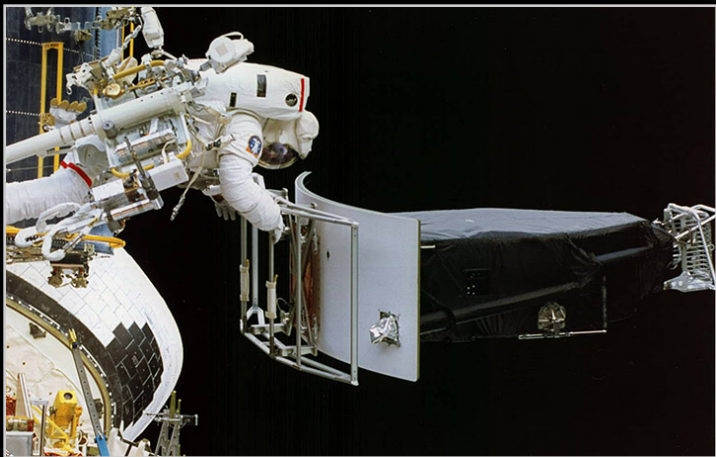




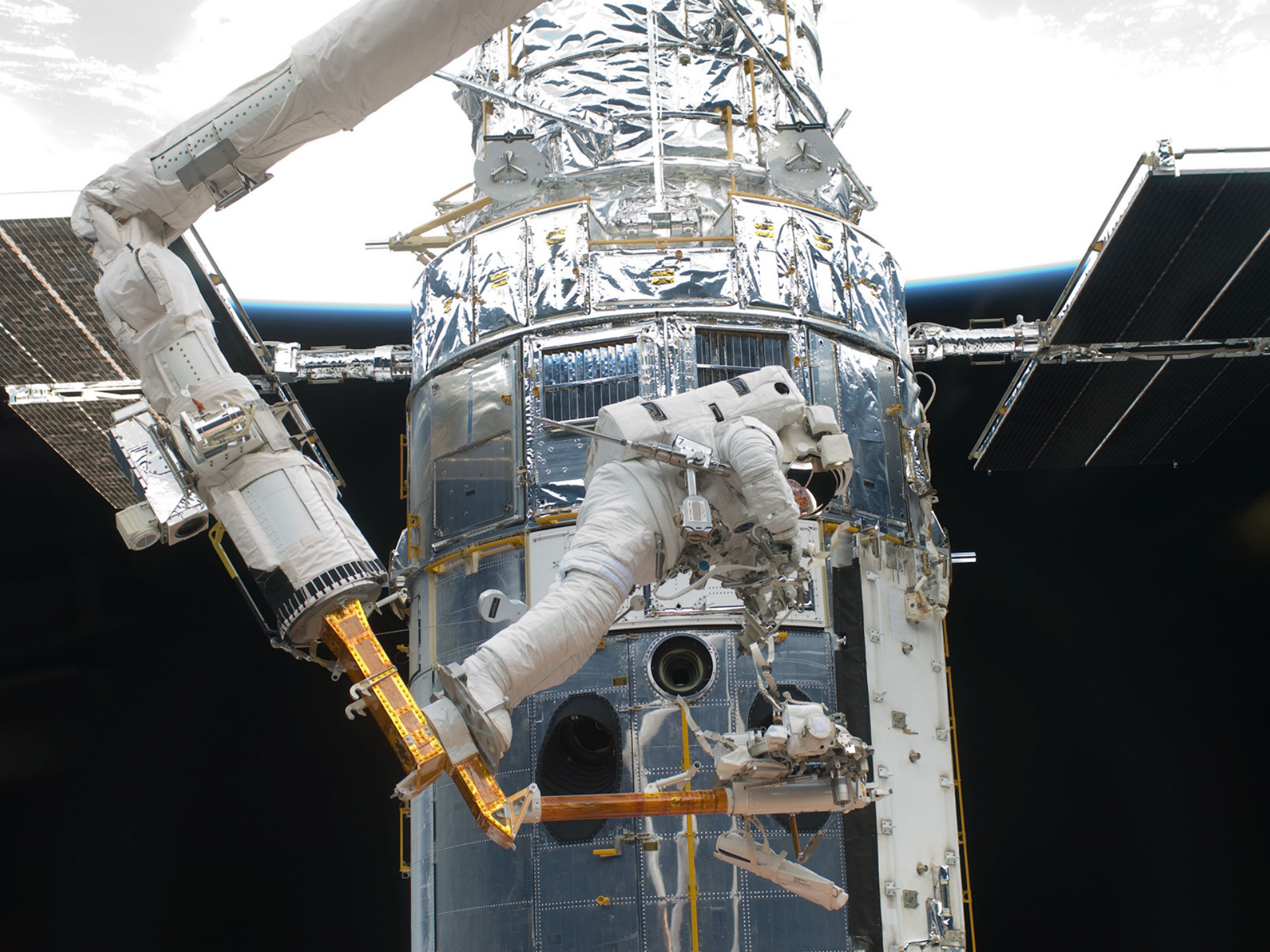
In orbit after launch



After in-orbit repair



Galaxy M100





Time/Space Location

Time it takes light to reach Earth

Planets

Minutes to hours

Stars

Years to thousands of years

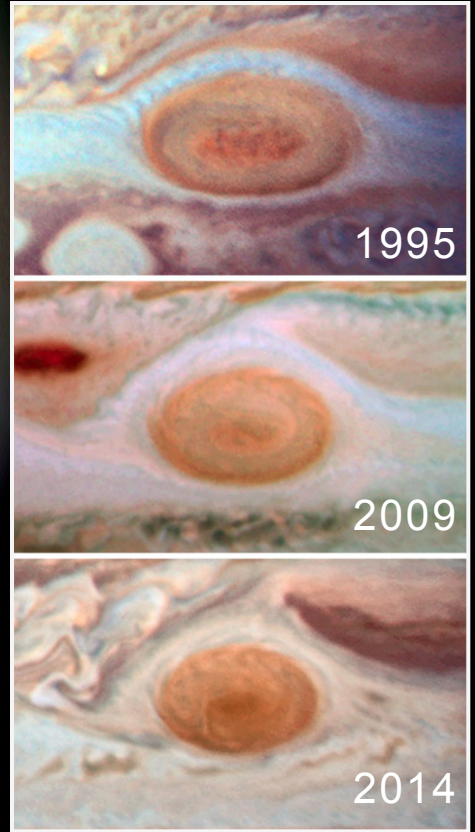
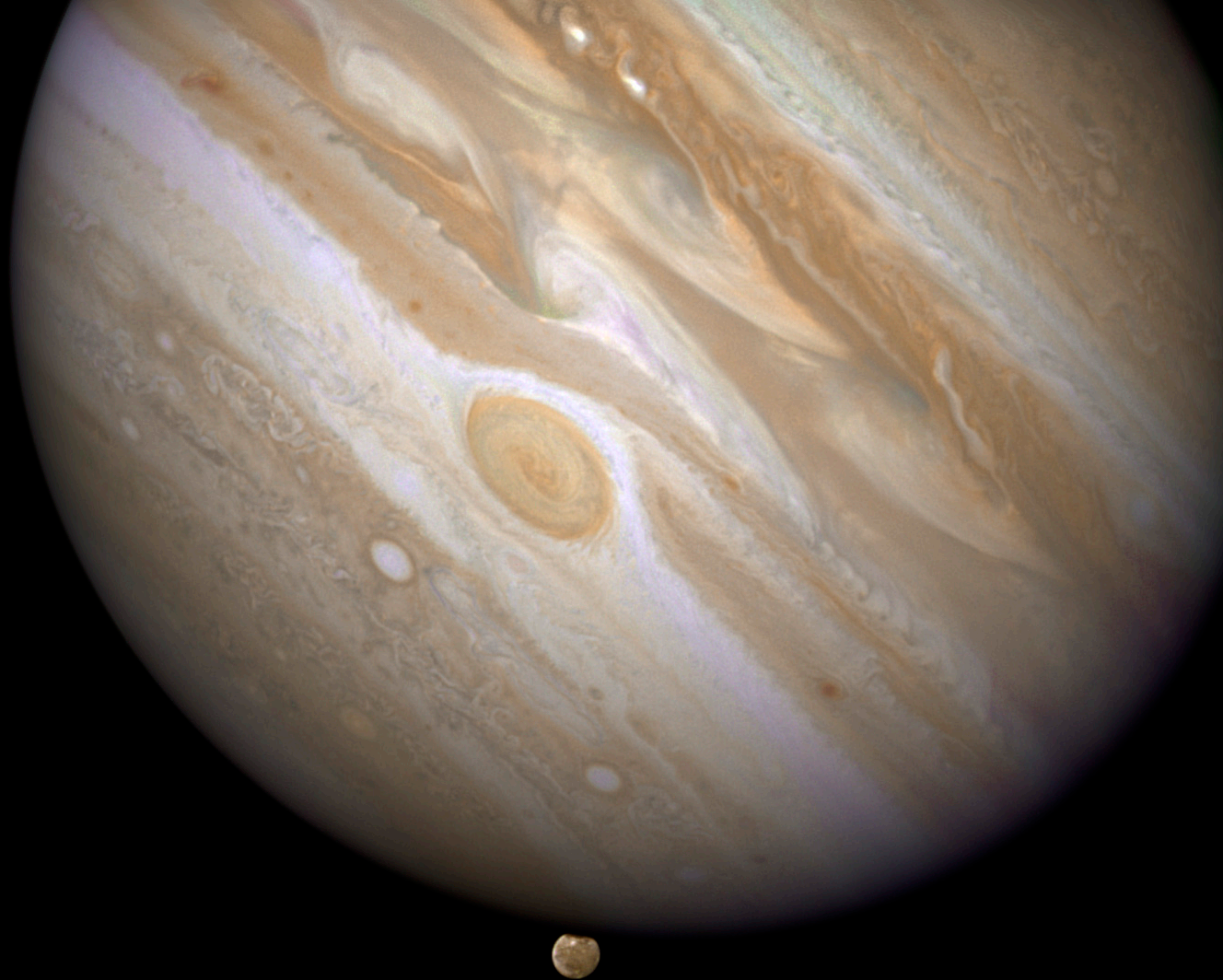
Galaxies

Millions to billions of years

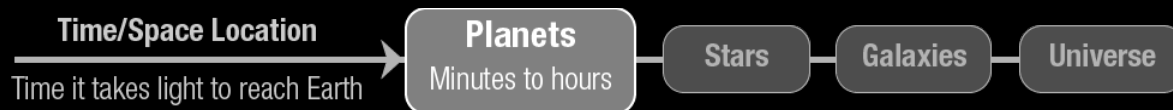
Universe

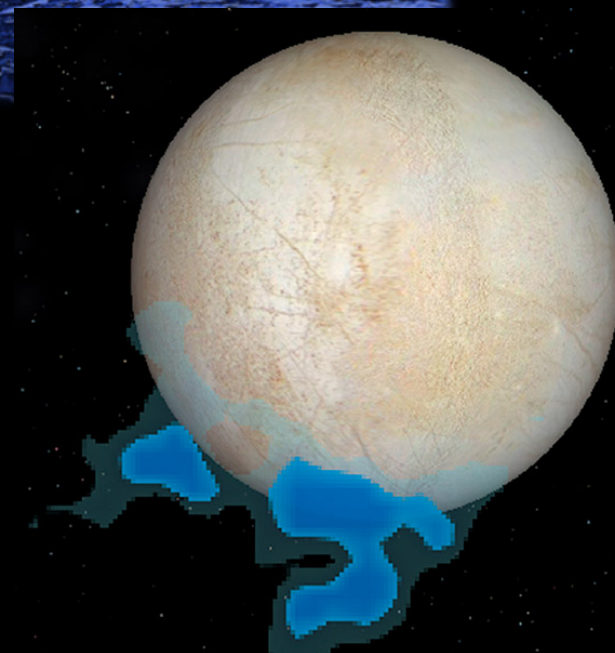
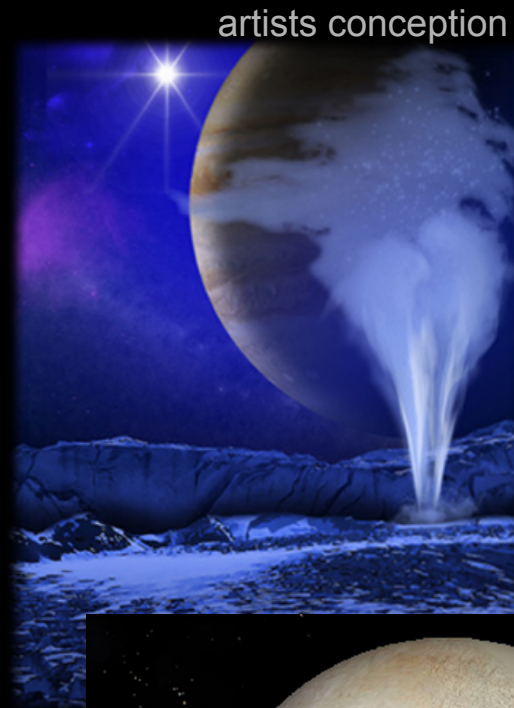
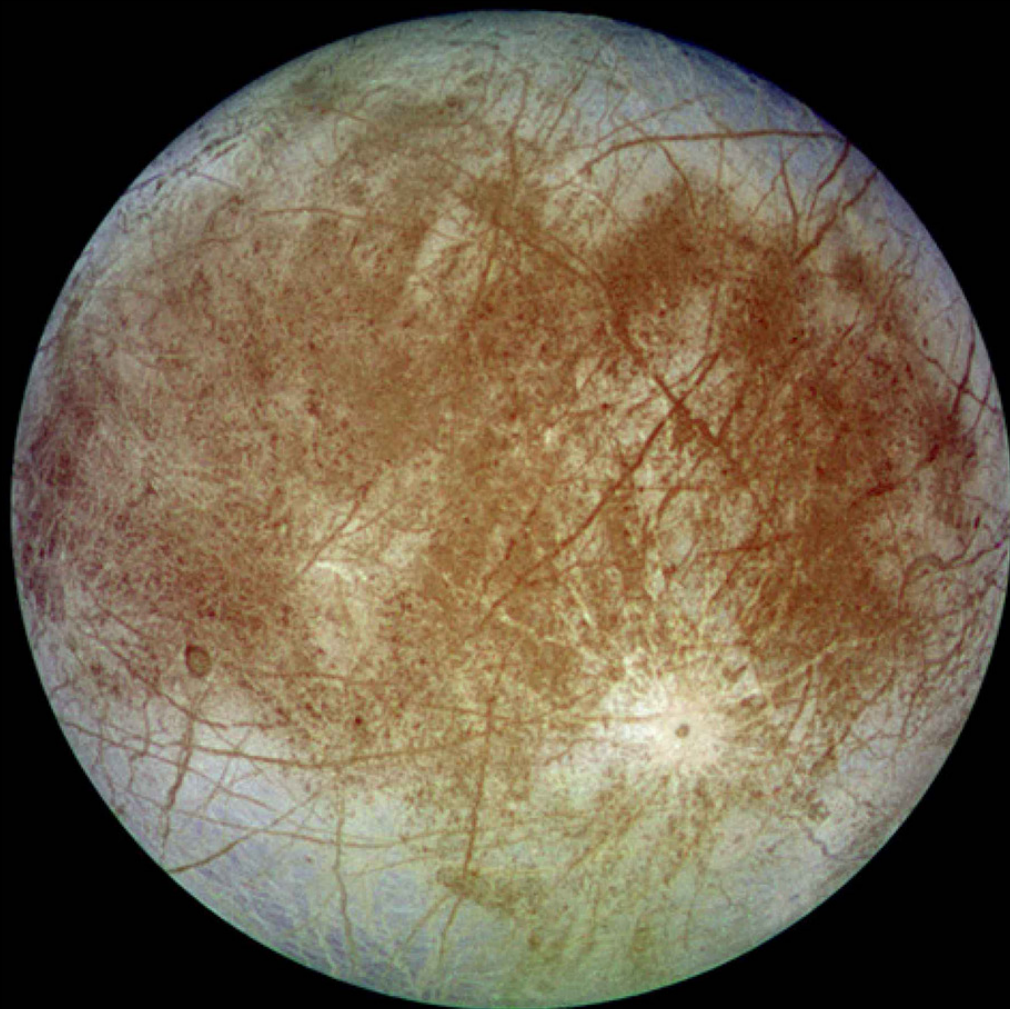
Billions of years



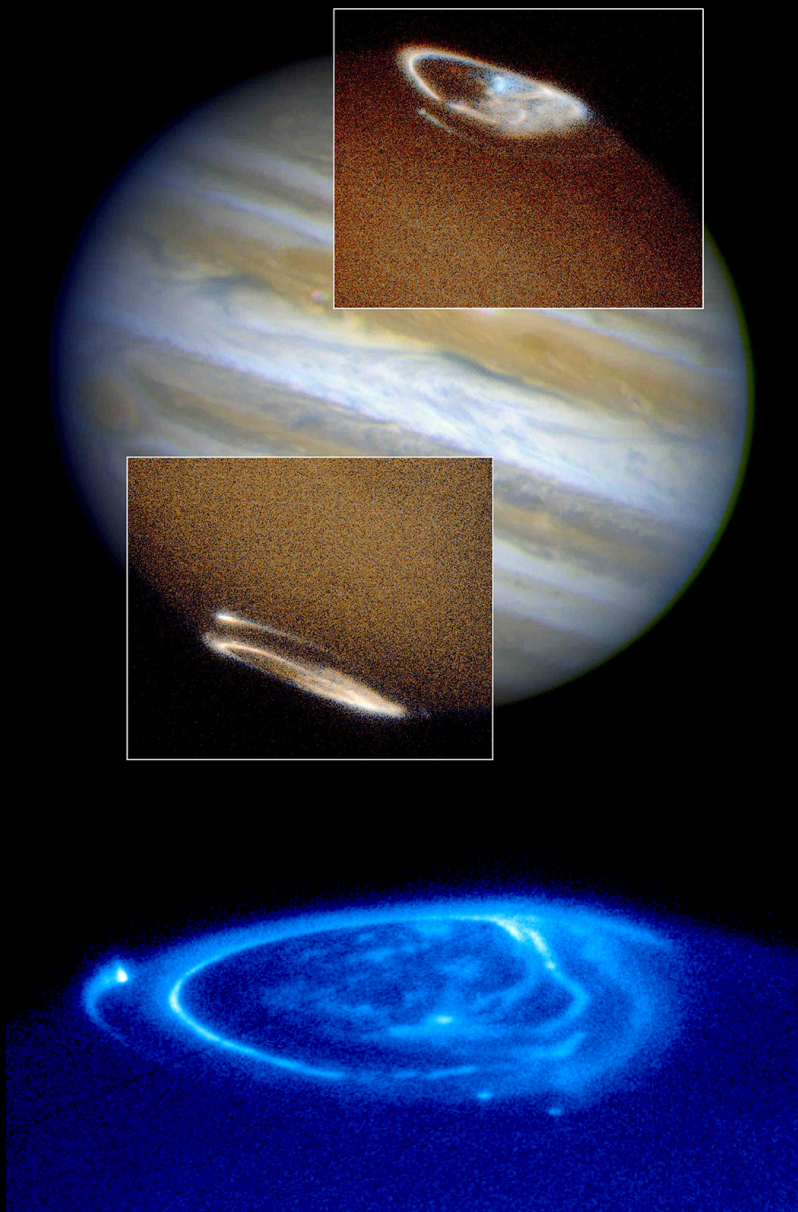


Jupiter: the shrinking red spot

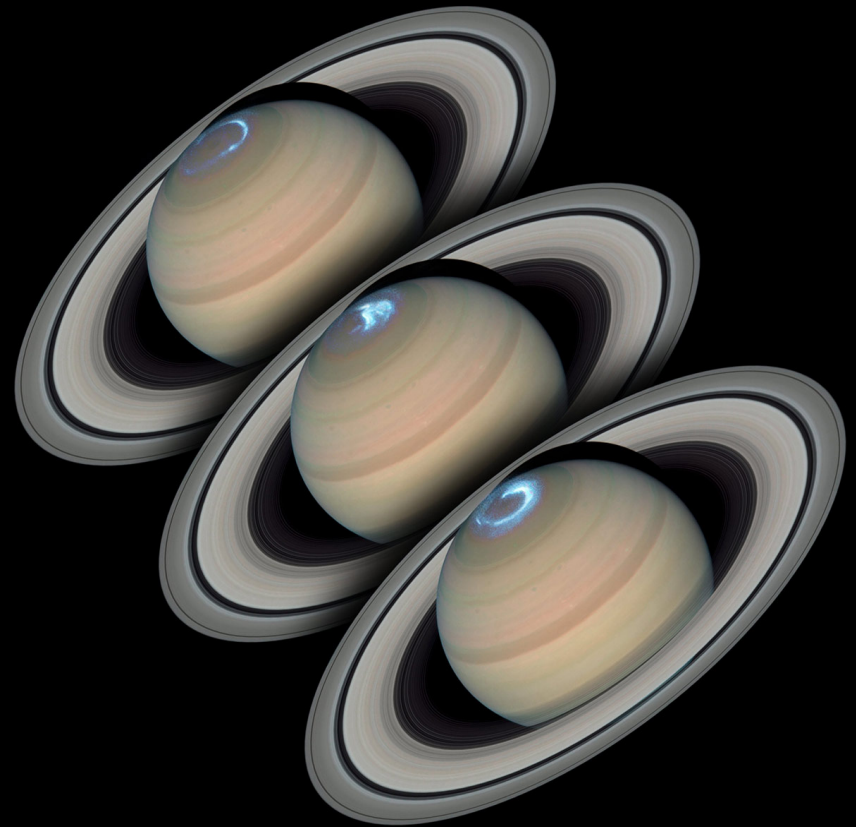




Europa: water?



Jupiter aurora

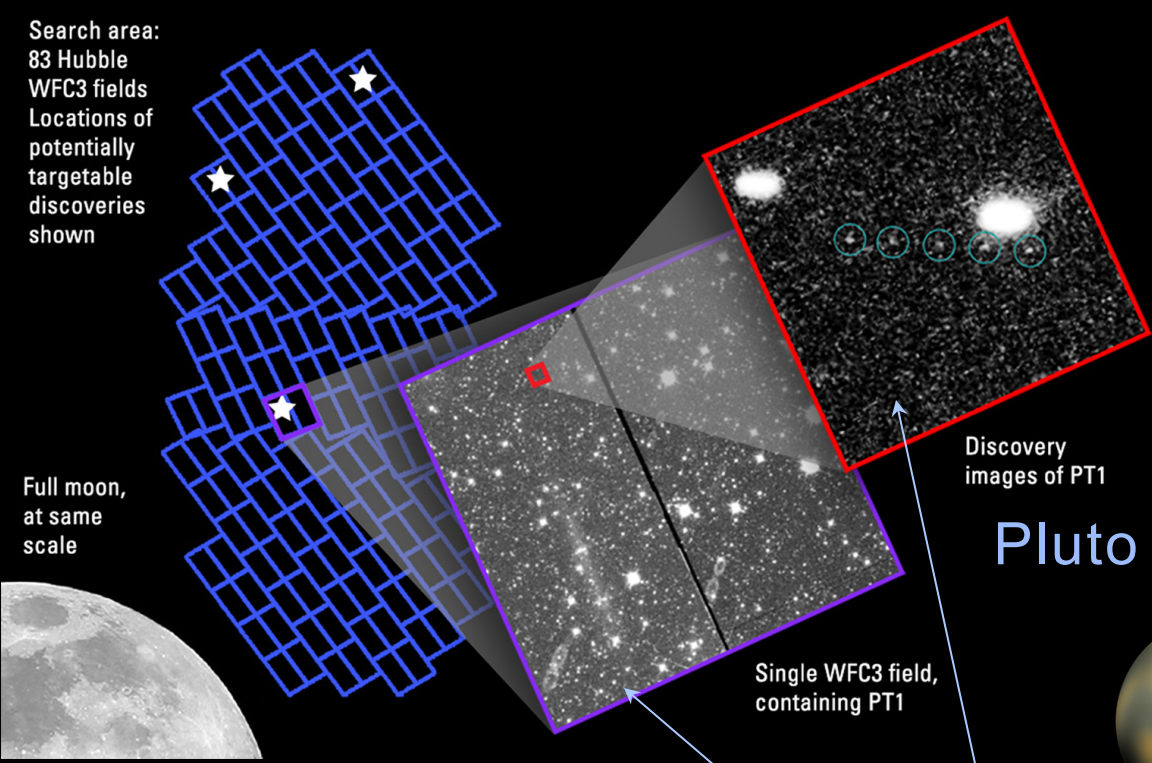


Saturn rings and aurora



Search area:
83 Hubble
WFC3 fields
Locations of
potentially
targetable
discoveries
shown

Full moon,
at same
scale

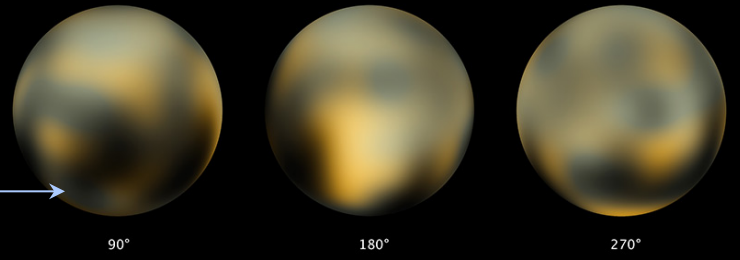


Discovery
images of PT1

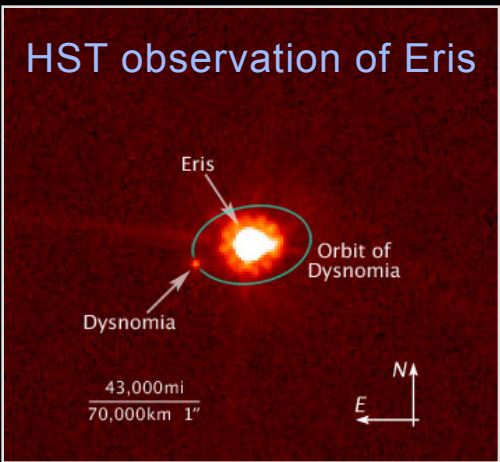
Pluto & New Horizons Mission

Single WFC3 field,
containing PT1

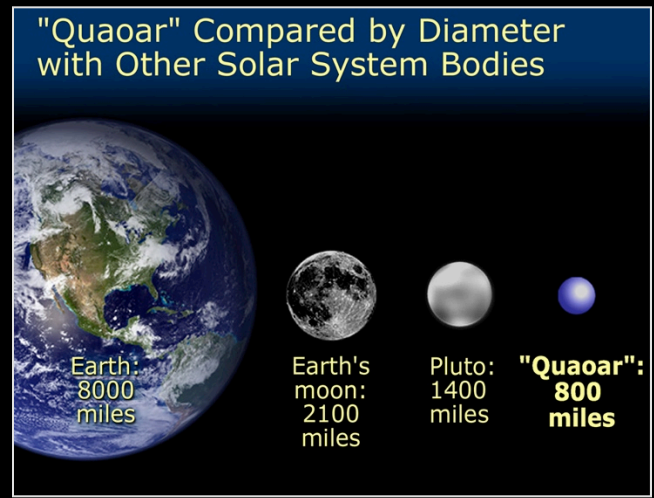
HST observations



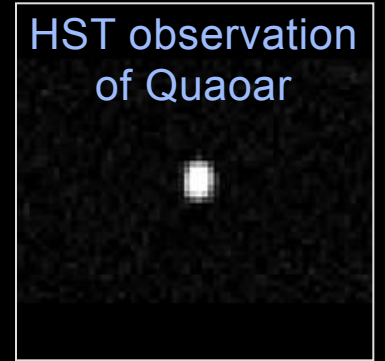
HST observation of Eris

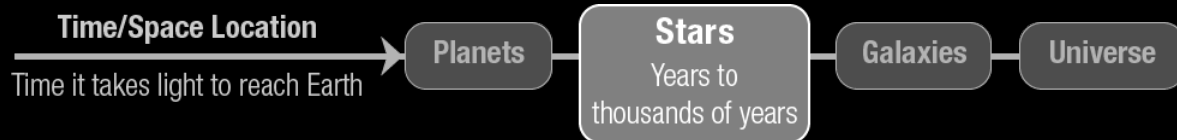


"Quaoar" Compared by Diameter with Other Solar System Bodies



HST observation of Quaoar





Carina Nebula

Time/
Space
Location



Planets



Stars



Galaxies



Universe



M16 Pillars of Creation (1995)

Time/
Space
Location



Planets

Stars

Galaxies

Universe



M16 Pillars of Creation: Optical (2015)

Time/
Space
Location



Planets



Stars



Galaxies



Universe



M16 Pillars of Creation: Infrared (2015)

Time/
Space
Location



Planets

Stars

Galaxies

Universe



Horsehead Nebula: Optical

Time/
Space
Location



Planets

Stars

Galaxies

Universe



Horsehead Nebula: Infrared

Time/
Space
Location



Planets



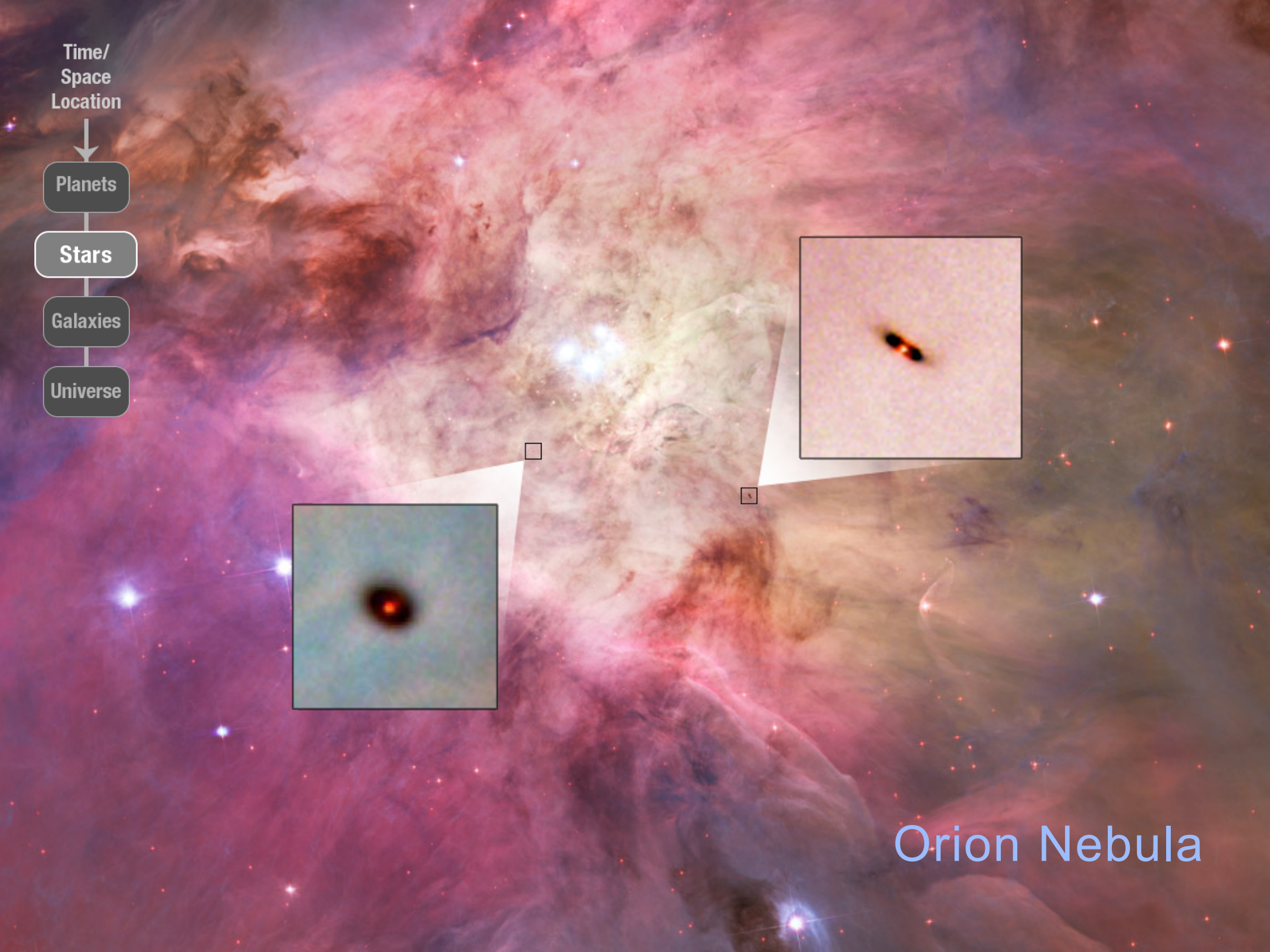
Stars



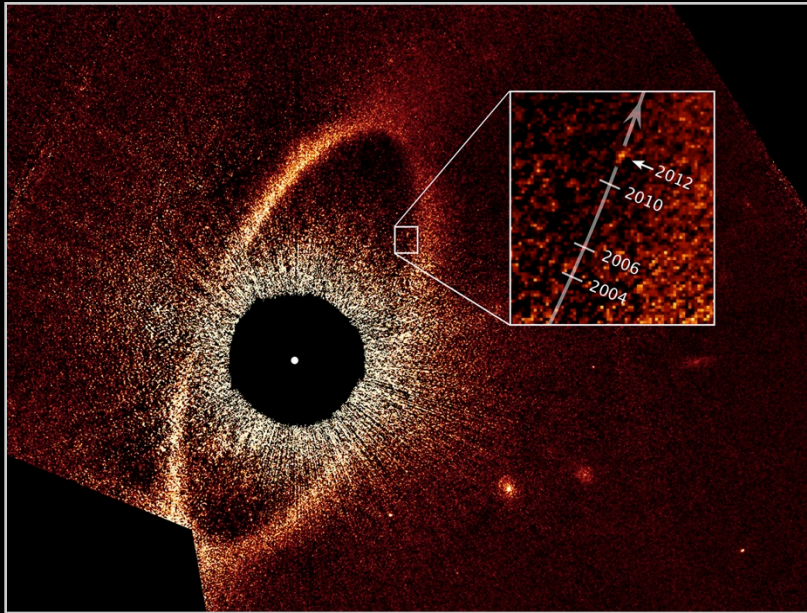
Galaxies



Universe



Orion Nebula



Fomalhaut b – image of a planet in a debris disk around a nearby star

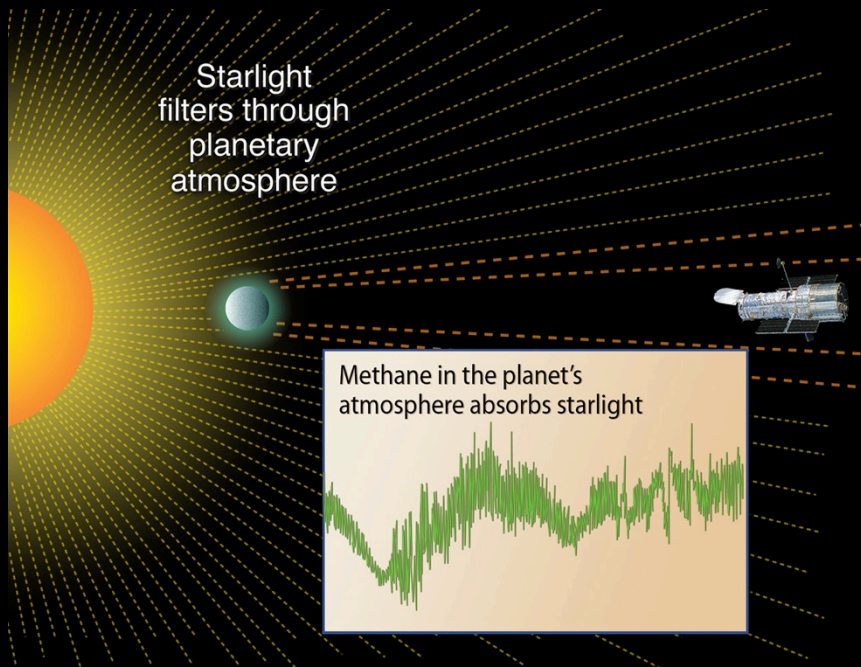
Time/
Space
Location

Planets

Stars

Galaxies

Universe



HD 18733b – observation of methane in an exoplanet atmosphere

Exoplanets

Time/
Space
Location



Planets



Stars



Galaxies



Universe



NGC 602

Time/
Space
Location



Planets

Stars

Galaxies

Universe



Cat's Eye Nebula

death of a star like the sun



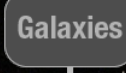
Time/
Space
Location



Planets



Stars

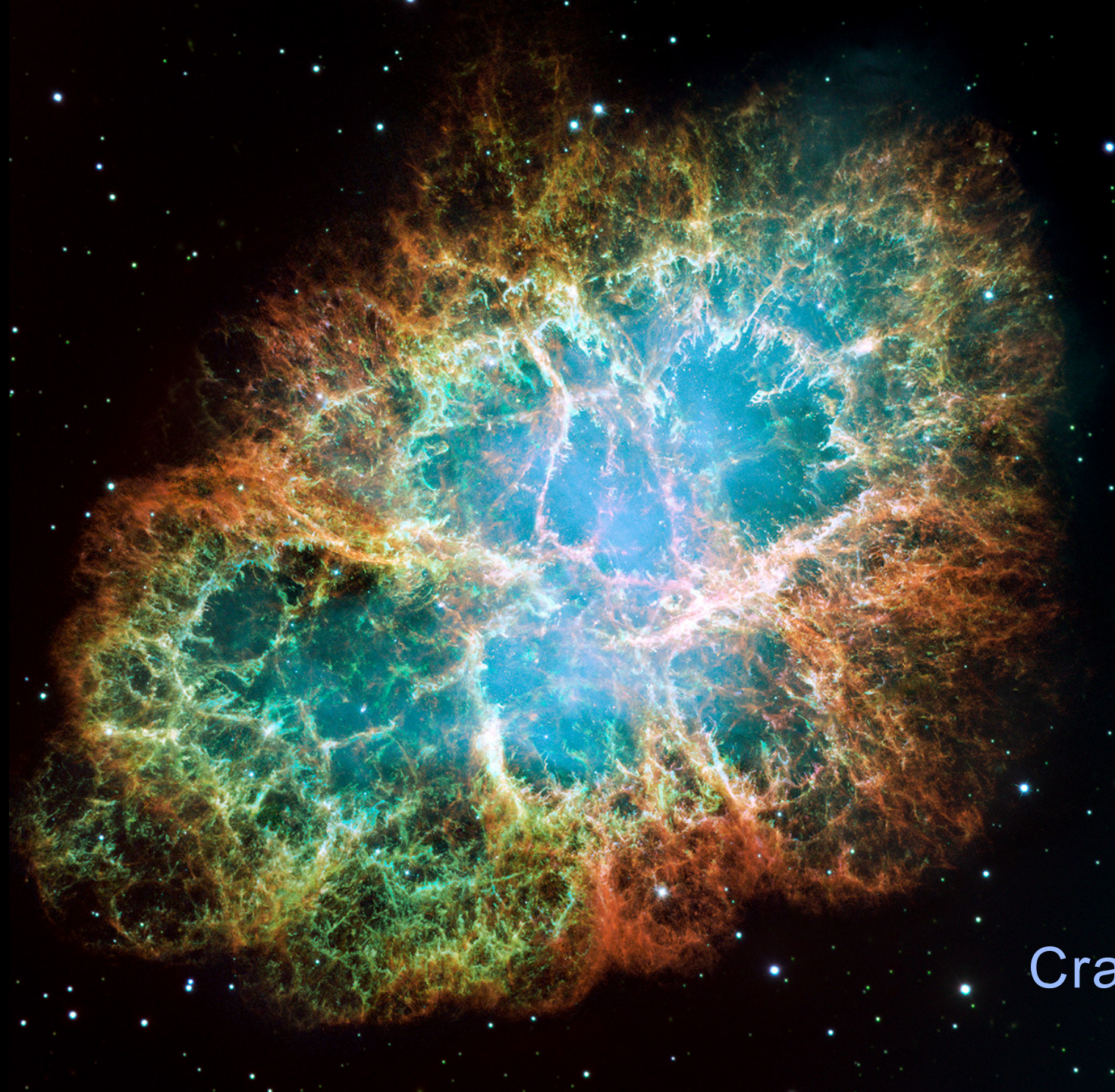


Galaxies



Universe

Bug/Butterfly Nebula



Time/
Space
Location



Planets



Stars



Galaxies



Universe

Crab Nebula

Time/
Space
Location



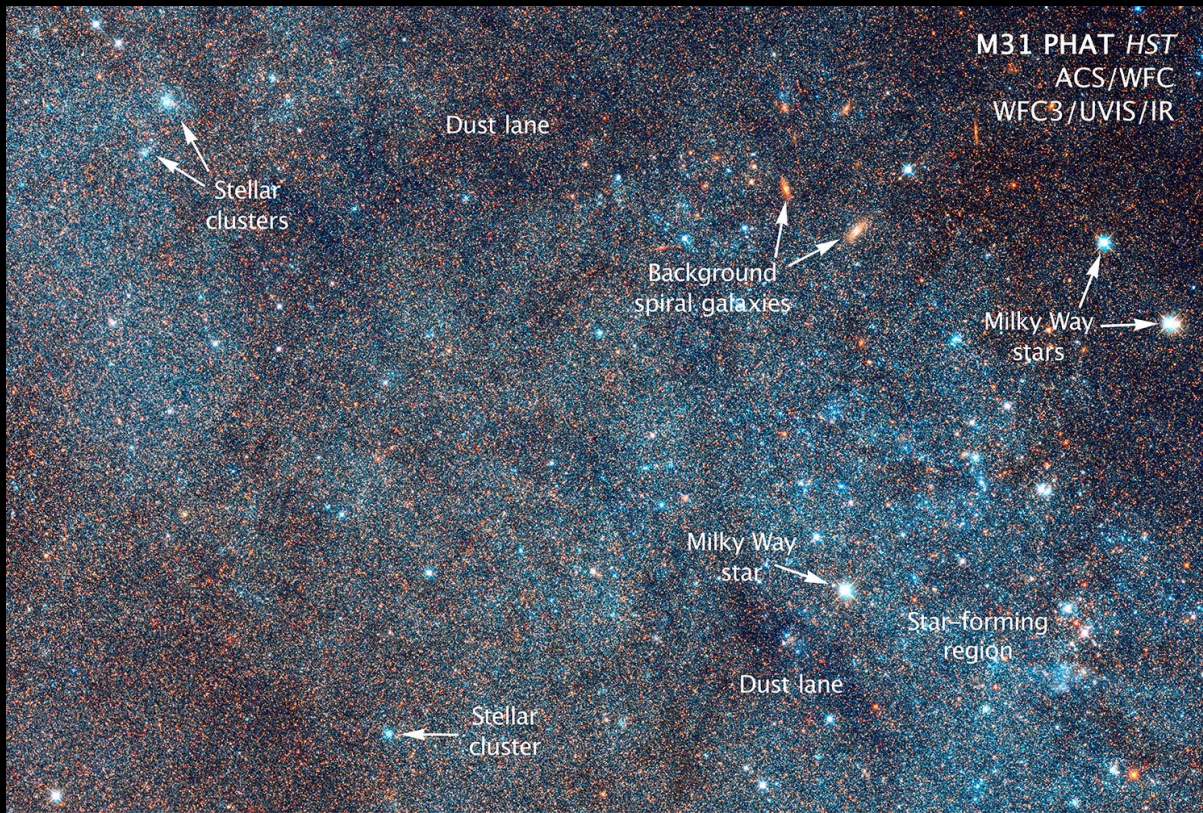
Planets

Stars

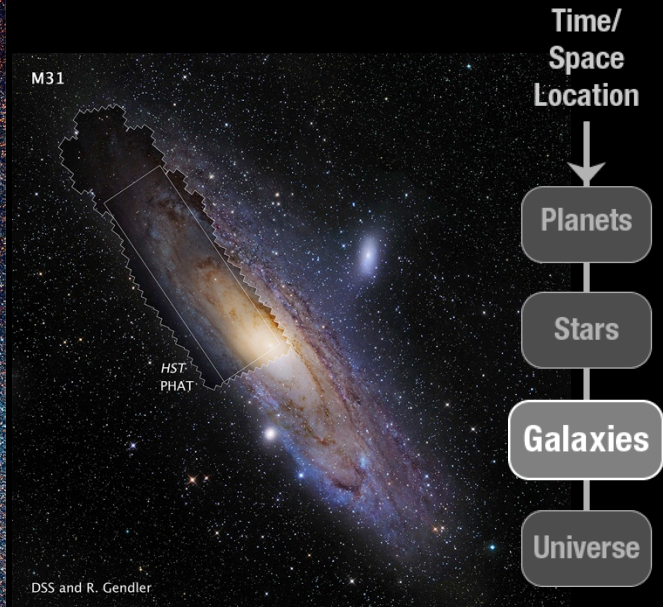
Galaxies

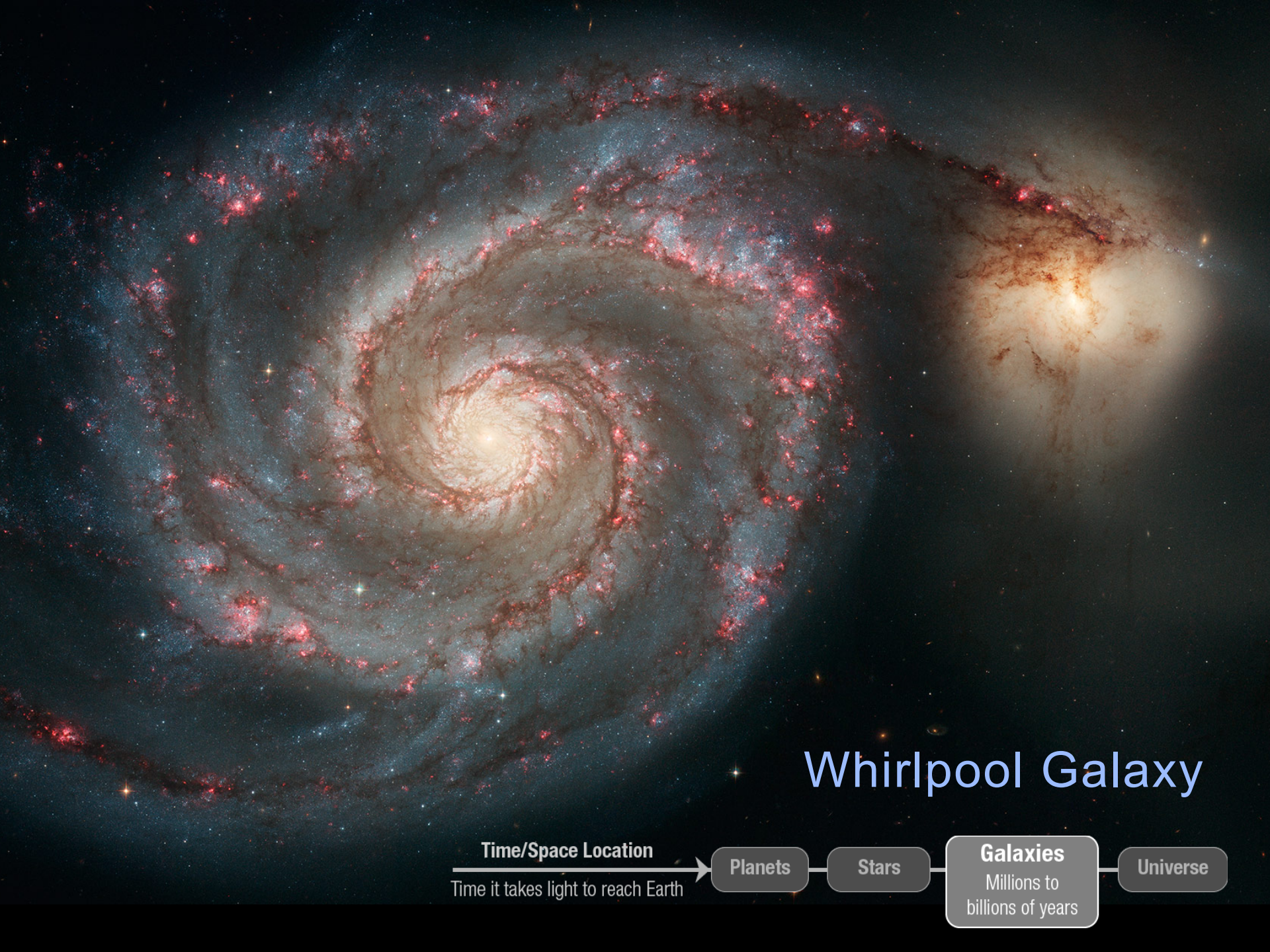
Universe

Supernova Remnant

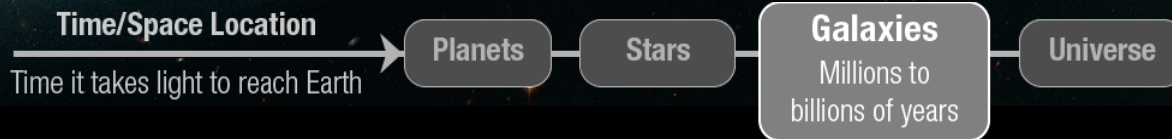


Andromeda: M31

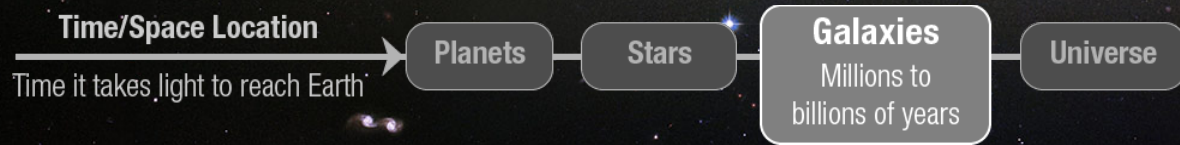




Whirlpool Galaxy



Sombrero Galaxy



Time/
Space
Location

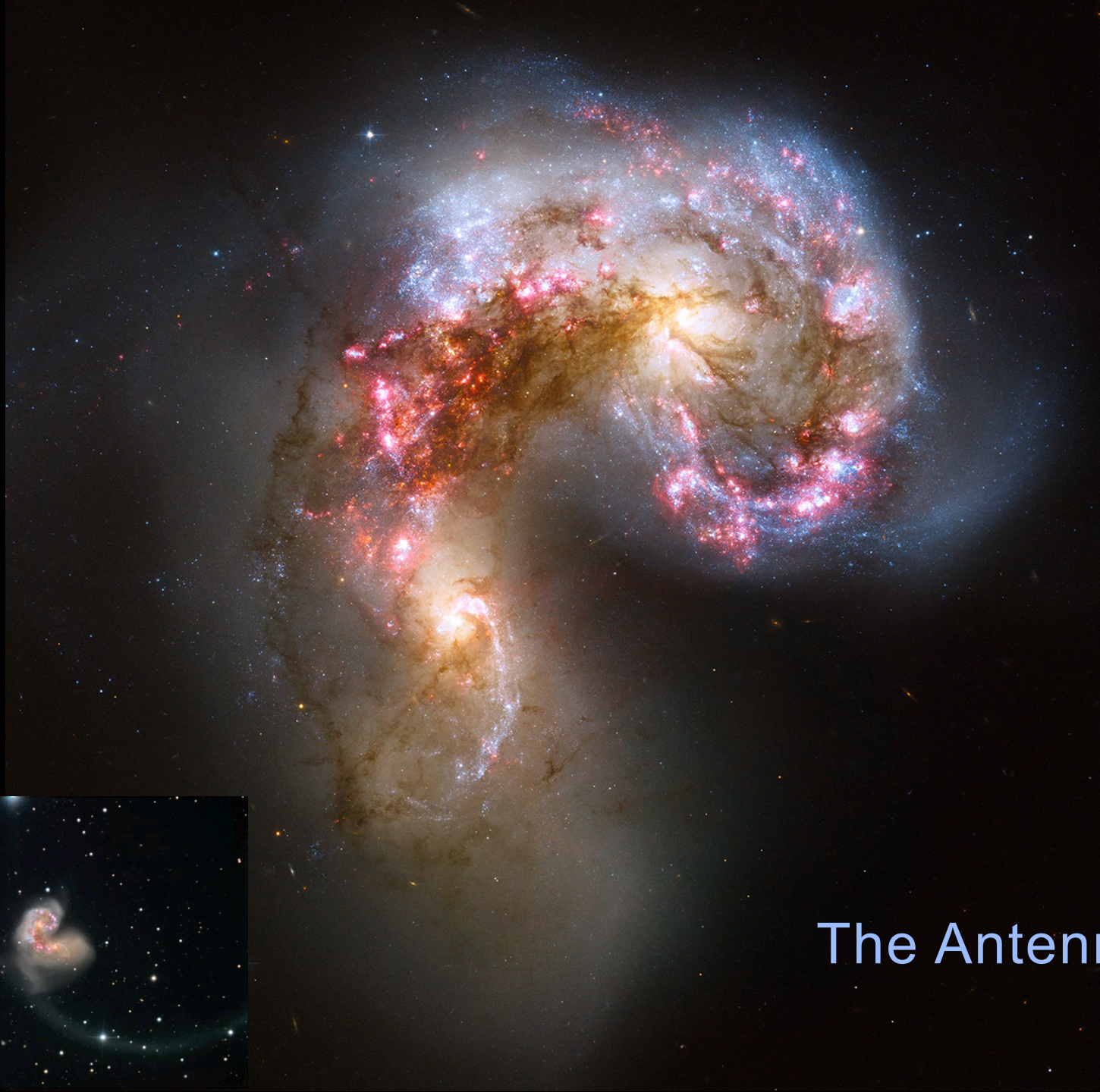


Planets

Stars

Galaxies

Universe



The Antennae

Time/
Space
Location



Planets

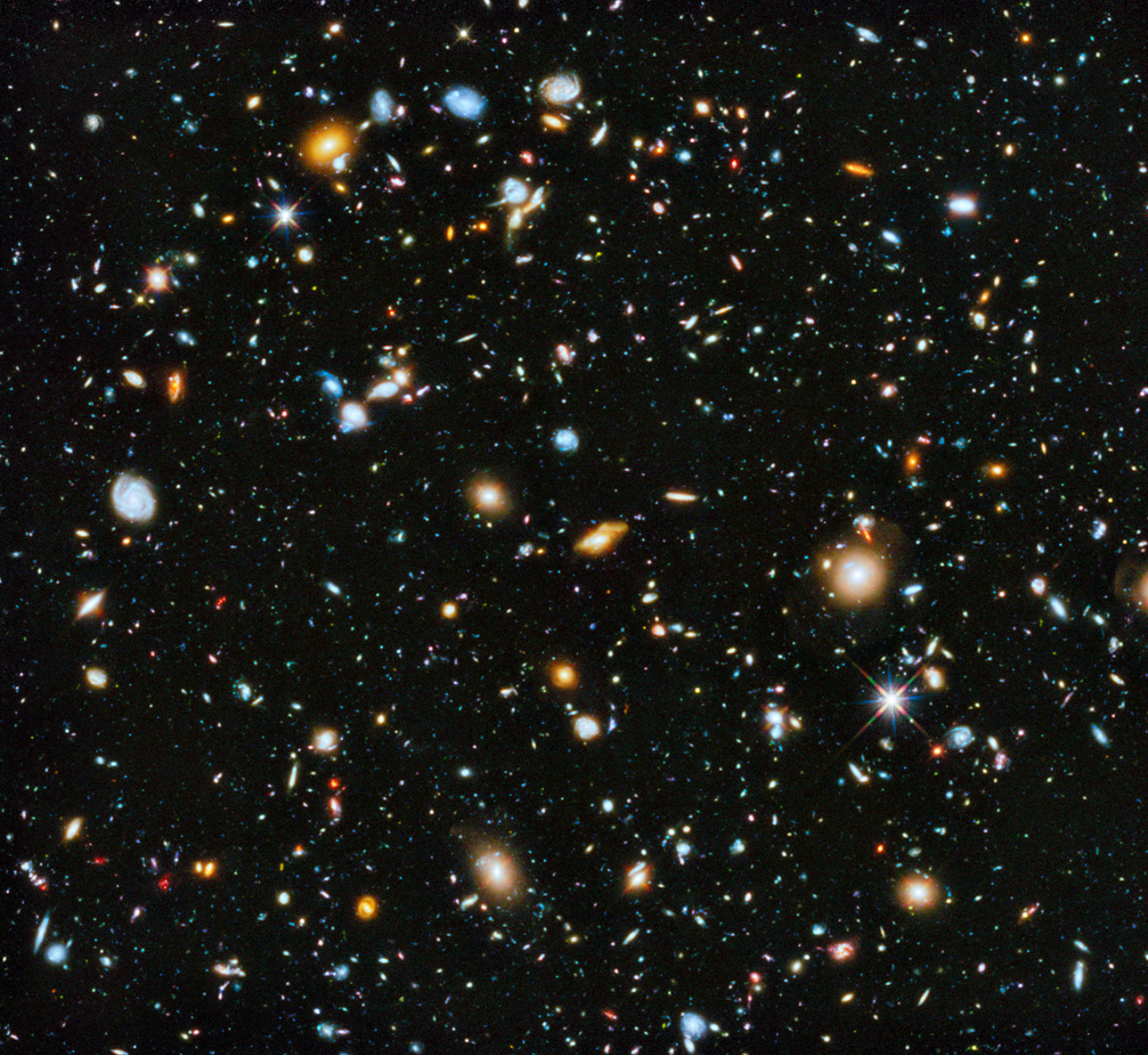
Stars

Galaxies

Universe



Rose Galaxy



Time/
Space
Location



Planets

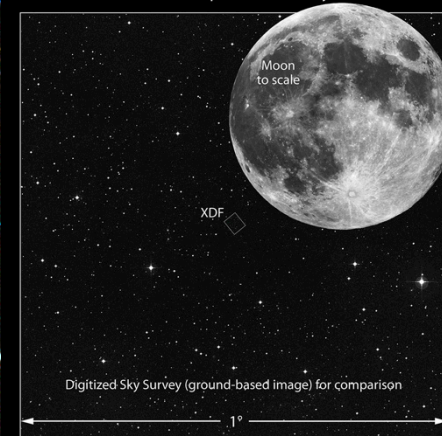
Stars

Galaxies

Universe

Light reaches
earth in
billions
of years

Size of Hubble eXtreme Deep Field on the Sky



Hubble Ultra Deep Field 2014 - UV, Visible, and IR



Time/
Space
Location



Planets



Stars



Galaxies



Universe

Light reaches
earth in
billions
of years

Frontier Field
Abell 2744

Hubble Discoveries

Original Science Goals

The Cosmic Distance Scale
and Hubble Constant

Gas Inside and
Outside Galaxies

Brightness of
Supernovae

Origin and Evolution of
the Solar System

Supermassive
Black Holes

Additional Science Examples

Source of Gamma
Ray Bursts

Dark Energy and the
Universe's Expansion

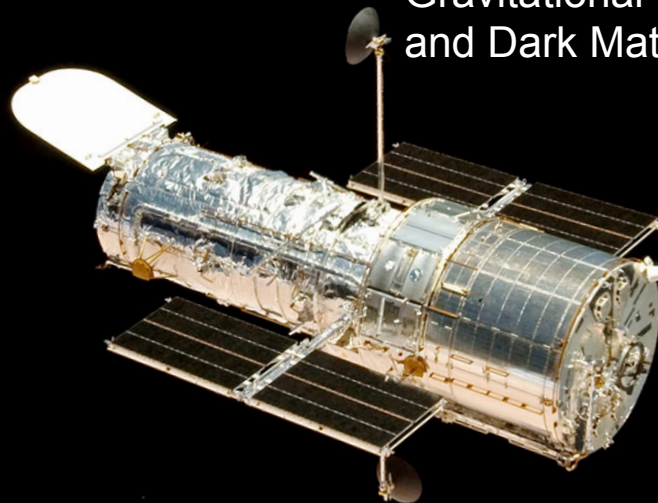
Ages of Stars Beyond
the Milky Way

Gravitational Lensing
and Dark Matter

Star Formation
History of the
Early Universe

Imaging and
Atmospheric
Analysis of
Exoplanets

Star and Planetary
System Formation





Hubble is Part of Our Children's Education



A national sample of *Amazing Space* users provides data on selection criteria and use of materials in a variety of settings.



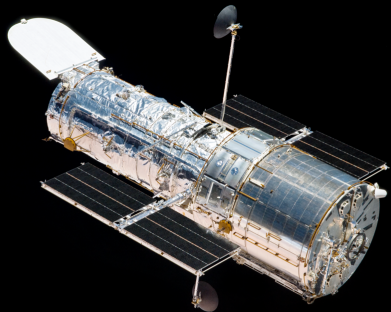
Reach:

500,000 pre- and in-service teachers

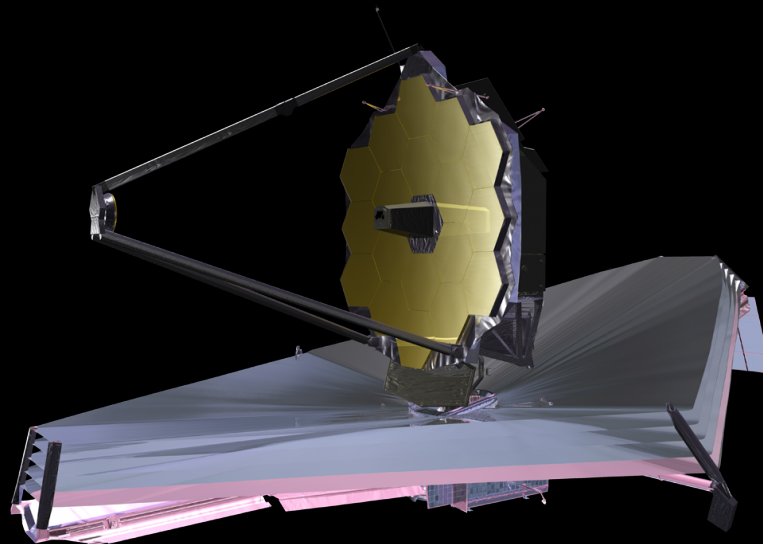
6.3 million students per year

Hubble education materials are used in all 50 states





HST
2.4 m



JWST
6.5 m

1 μm

10 μm

100 μm

Hubble

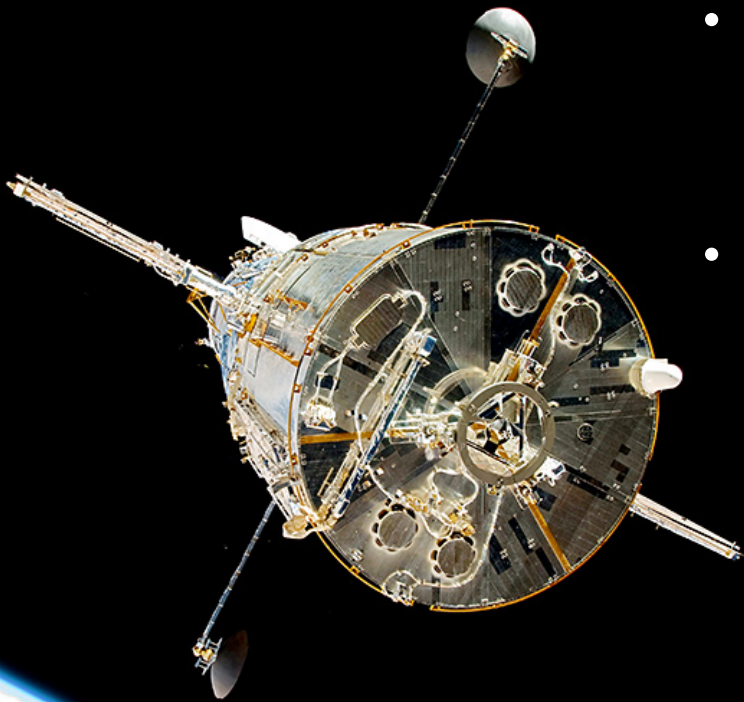
JWST

Infrared



Hubble 2020 Vision

- HST continues operation through 2020
 - Most productive observatory
 - Strong science synergy with James Webb Space Telescope in 2019-2020 timeframe
- HST Status
 - Healthy instruments, more powerful than ever
 - Healthy spacecraft (gyros, reaction wheels)
- Examples of trending science topics
 - Properties of planetary systems
 - Stellar evolution throughout time
 - Nature of dark matter and dark energy
 - Black hole properties on all scales (stellar to supermassive)
 - Origin and evolution of galaxies
 - Cycles of matter and energy in galaxies





More anniversary info: www.nasa.gov/hubble

HUBBLE 25

H25

Science

Images

Videos

Explore

News/Events



THE
HUBBLE SPACE TELESCOPE

ANNIVERSARY

CELEBRATION

25 YEARS

Return to find new features and events throughout the year.

<http://hubble25th.org>

Supplemental Slides

Shuttle Missions for Hubble Launch, Repair, and Refurbishment

Launch

STS-31
Discovery



Servicing Mission 1

STS-61
Endeavour



Wide Field
Planetary Camera 2

Corrective Optics
Space Telescope
Axial Replacement

Gyros

Solar Arrays

Servicing Mission 2

STS-82
Discovery



Space Telescope
Imaging
Spectrograph

Near Infrared
Camera and
Multi-Object
Spectrometer

Fine Guidance
Sensor

Servicing Mission 3A

STS-103
Discovery



Advanced
Computer

Gyros

Fine Guidance
Sensor

Servicing Mission 3B

STS-109
Columbia



Advanced Camera
for Surveys

Near Infrared
Camera and
Multi-Object
Spectrometer
Cooling System

Power Control Unit
Solar Arrays

Servicing Mission 4

STS-125
Atlantis



Wide Field Camera 3

Cosmic Origins
Spectrograph

Space Telescope
Imaging
Spectrograph Repair

Advanced Camera
for Surveys Repair

Science Instrument
and Data
Handling Unit

Gyros

New Outer Blanket
Layer

Soft Capture
Mechanism

Batteries

Fine Guidance
Sensor



April
1990

December
1993

February
1997

December
1999

March
2002

May
2009



Hubble Space Telescope Refereed Science Publications per Year

