

The background of the slide is a deep space image featuring a large, vibrant nebula with swirling patterns of purple, pink, and blue. Scattered throughout the dark cosmic background are numerous stars, some appearing as bright white points and others as smaller, dimmer blue or red specks. The overall effect is one of vastness and celestial beauty.

Hubble vs. James Webb

Battle of the Space Giants

Dr Maggie Aderin-Pocock MBE

Overview

- Why have space telescopes
- Why Hubble and Webb
- The Telescopes
- The Locations
- The Challenges
- The Costs
- The Science
- The Future
- The Winner



Why Have Space Telescopes?

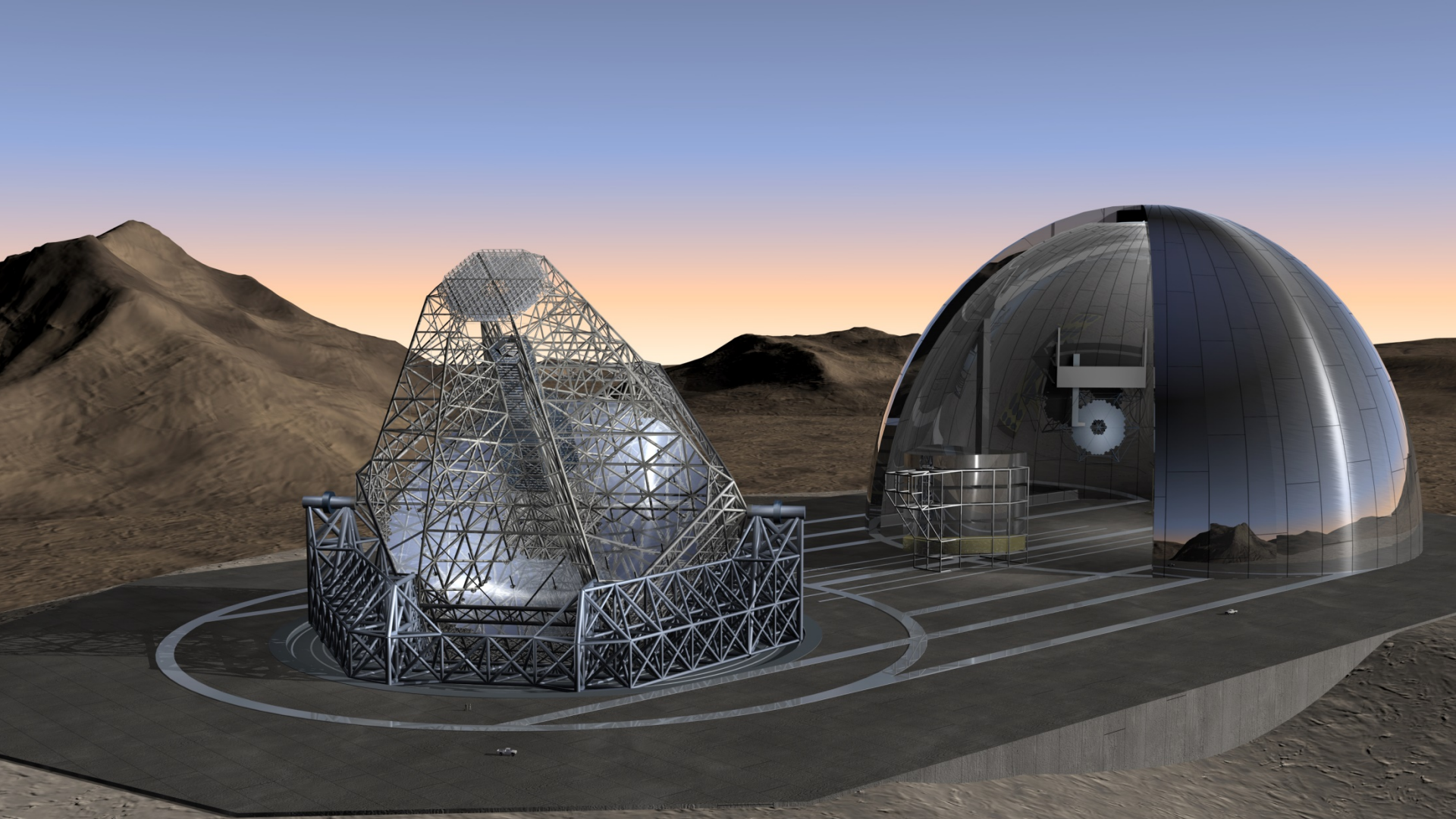


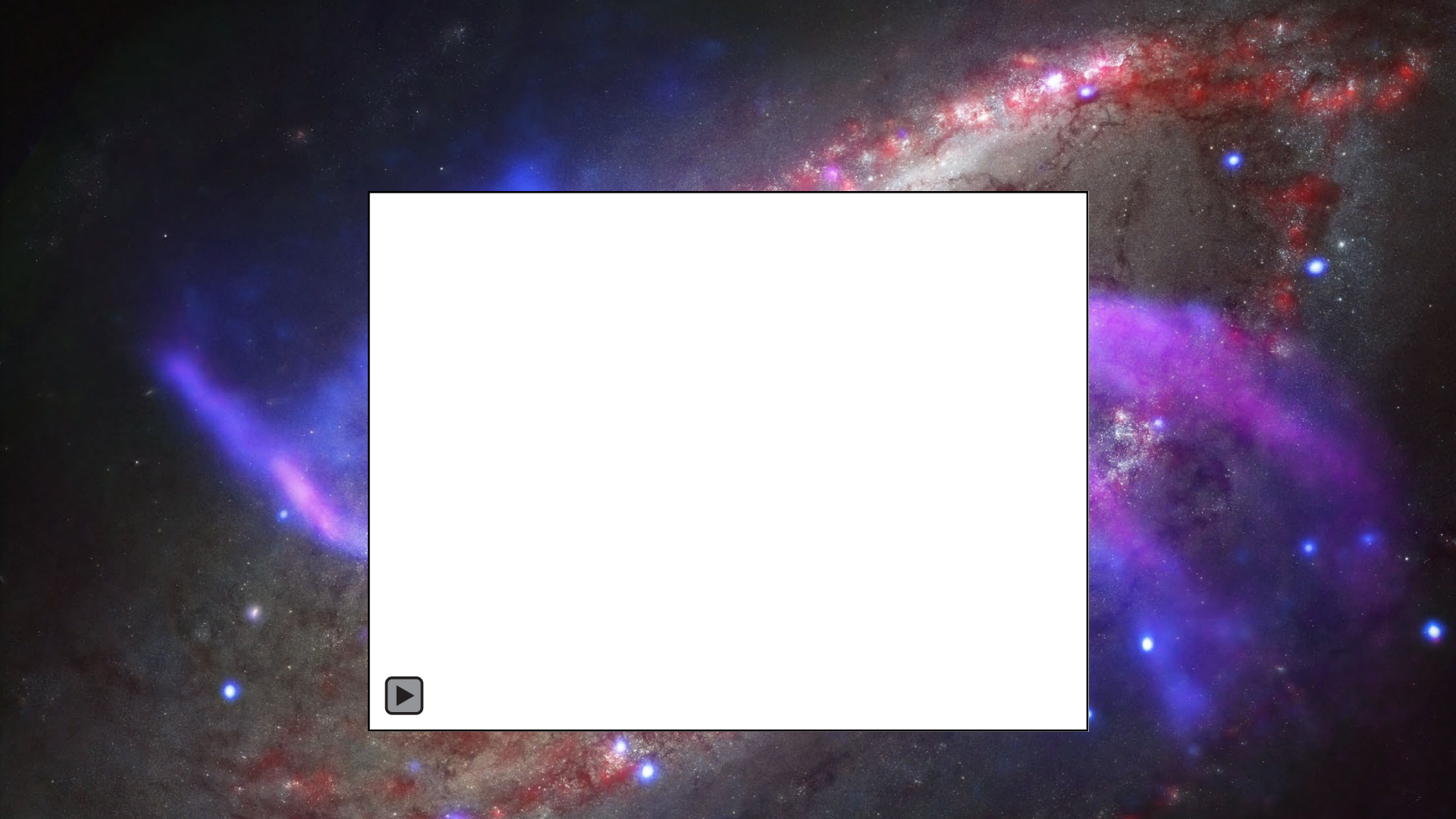




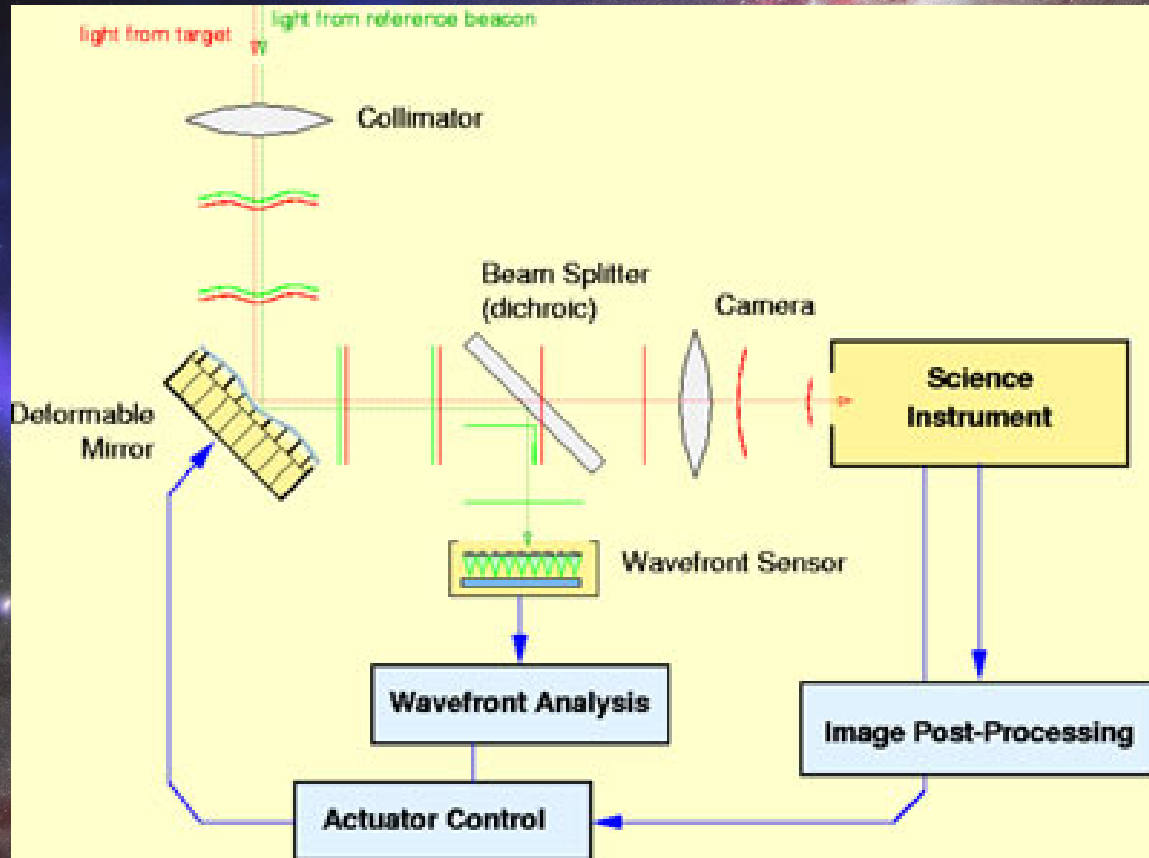


The European Extremely Large Telescope (E-ELT)





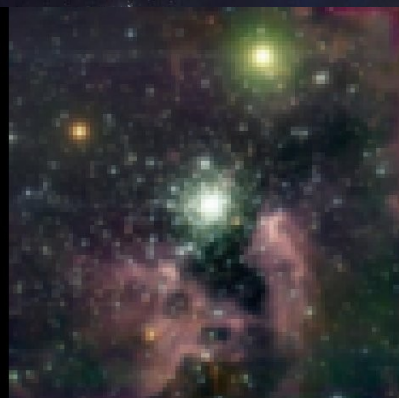
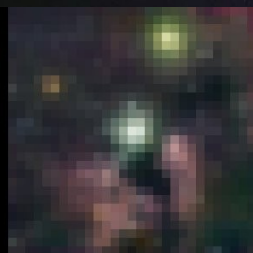
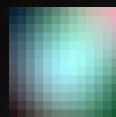
How is Adaptive Optics Done



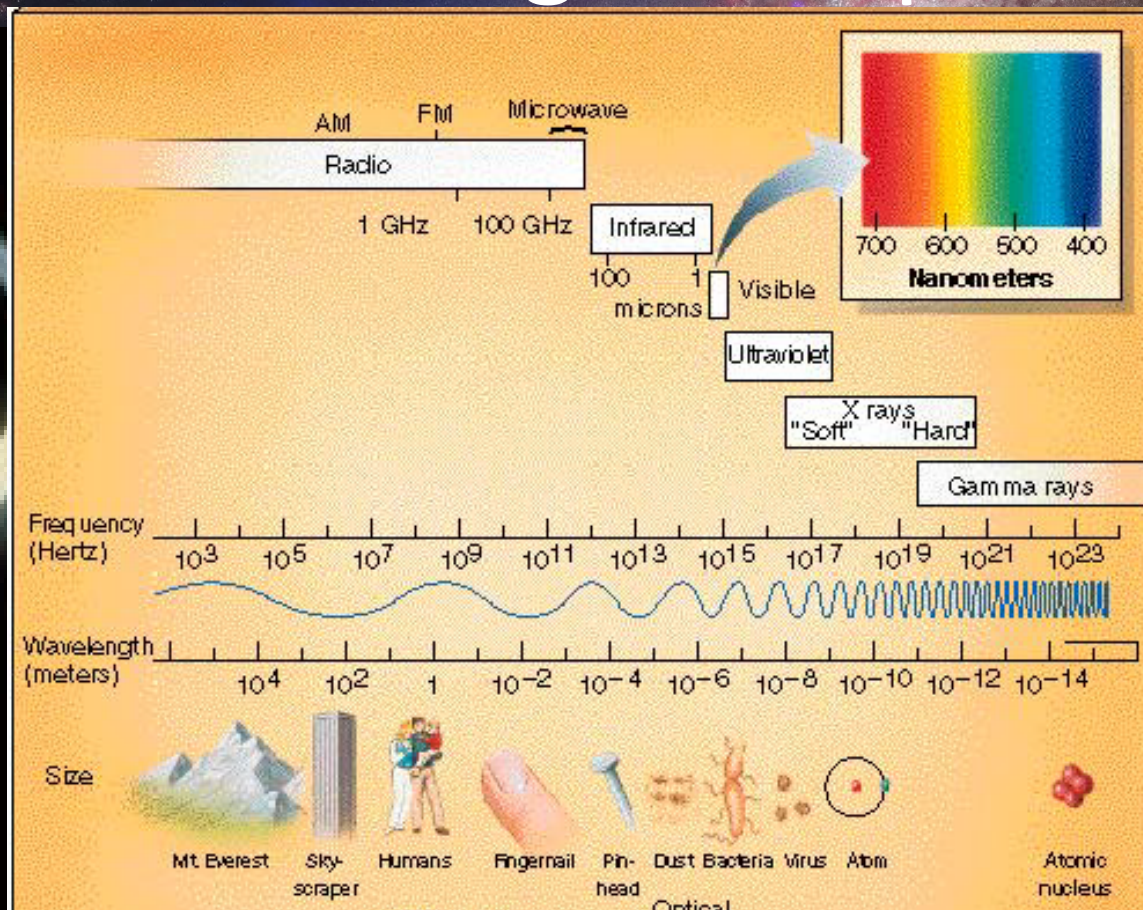
Adaptive Optics

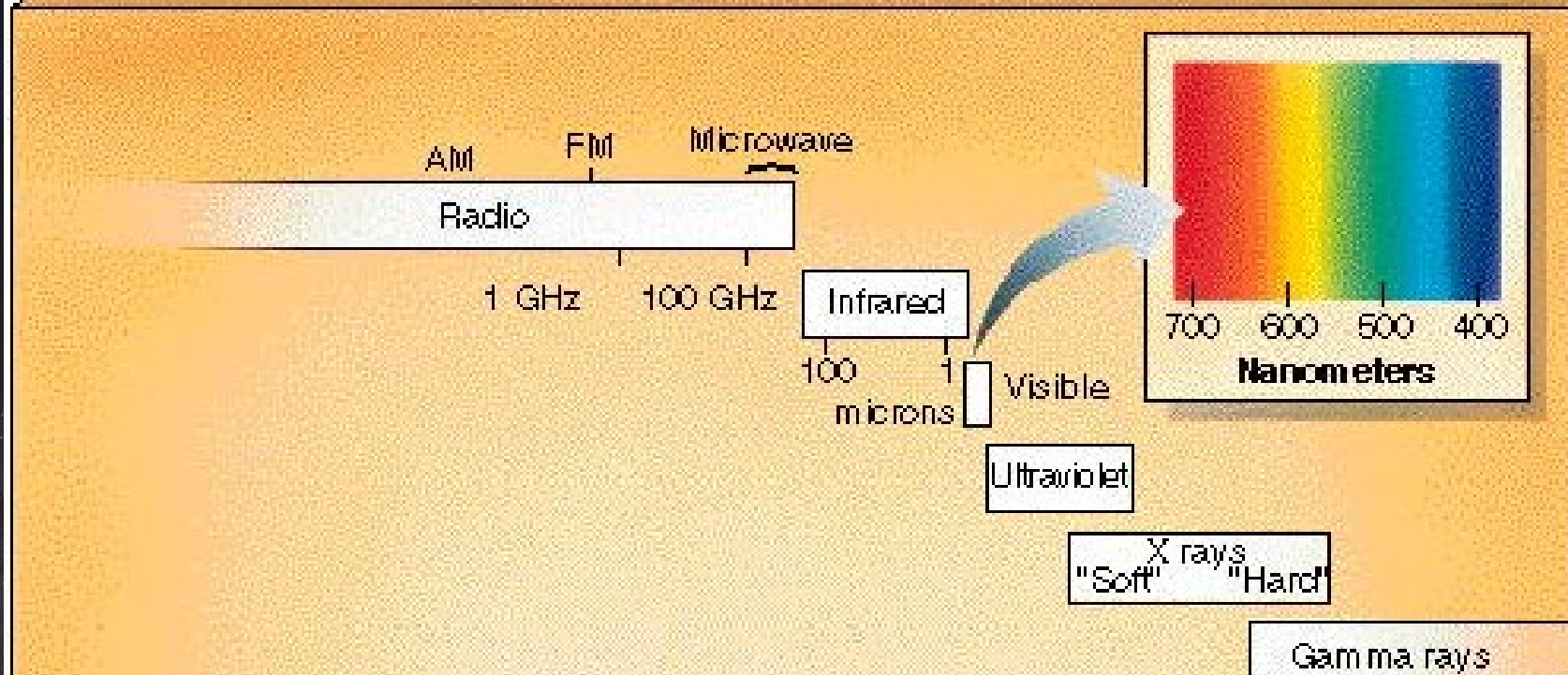
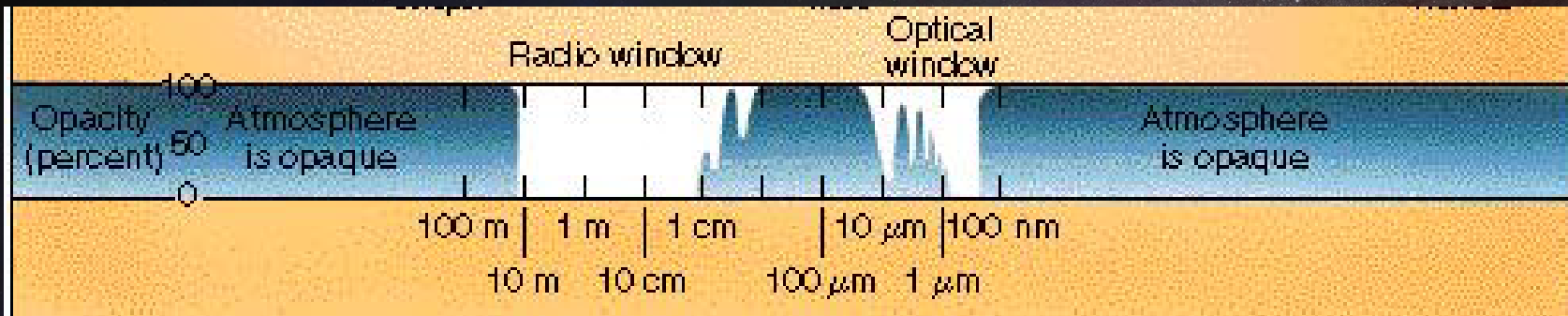


www.eso.org



The Electromagnetic Spectrum



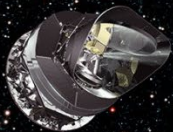


ESA'S FLEET ACROSS THE SPECTRUM



planck

Looking back
at the dawn of time



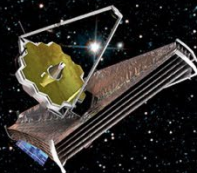
herschel

Unveiling the cool
and dusty Universe



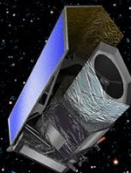
jwst

Observing the first light



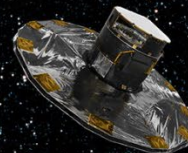
euclid

Probing dark matter, dark energy
and the expanding Universe



gaia

Surveying a billion stars



hst

Expanding the frontiers
of the visible Universe



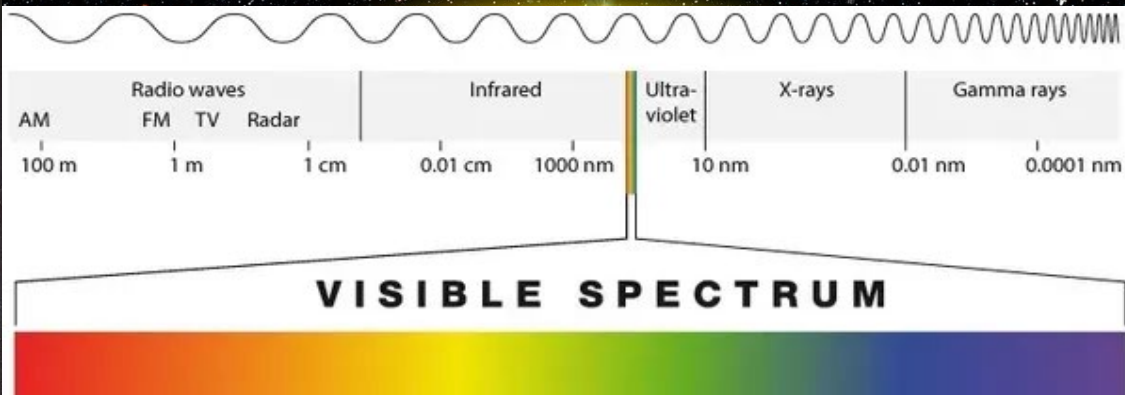
xmm-newton

Seeing deeply into the hot
and violent Universe



integral

Seeking out the extremes
of the Universe



Why Hubble and Webb



The Men

Edwin Hubble



James Webb

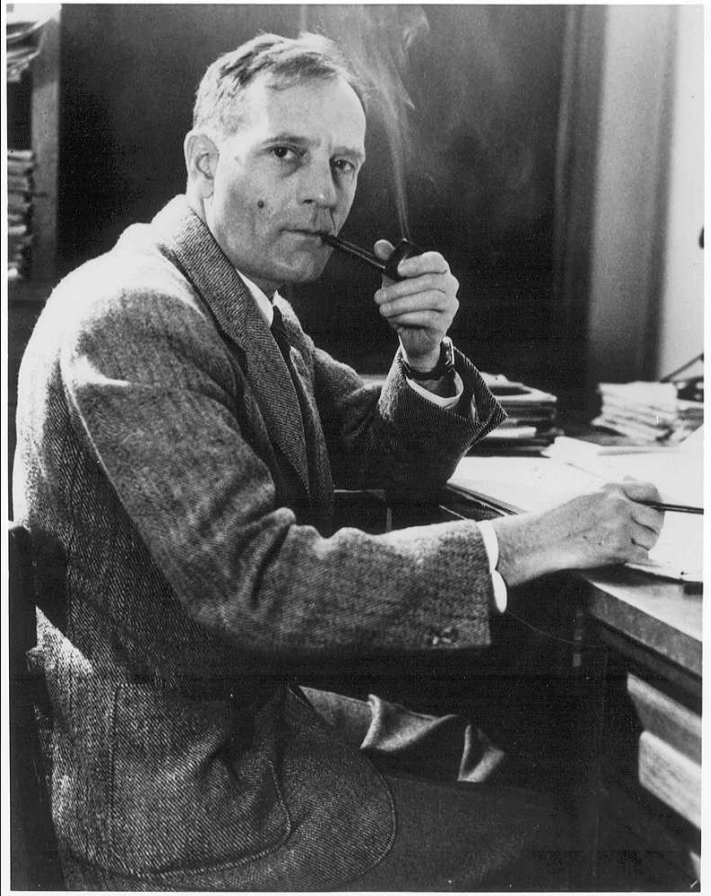


Edwin Hubble The Man – 5 Facts



- Hubble's father wanted him to study Law, which he did till his father died
- Hubble thought that astronomy was a calling and should be done by people with a passion for it
- Hubble was described as an "Adonis" due to his height and good looks

Edwin Hubble The Man – 5 Facts



- Hubble liked to wear a cape, smoke a pipe and had a fake English accent
- Hubble made major discoveries in astronomy that changes our knowledge of the Universe

James E Webb The Man – 5 Facts



- Webb served as a government official for most of his career
- The E in Webb's name stands for Edwin
- Webb also worked in the law in his early career
- Both men served in the military during WWI
- Webb was the second administrator of NASA

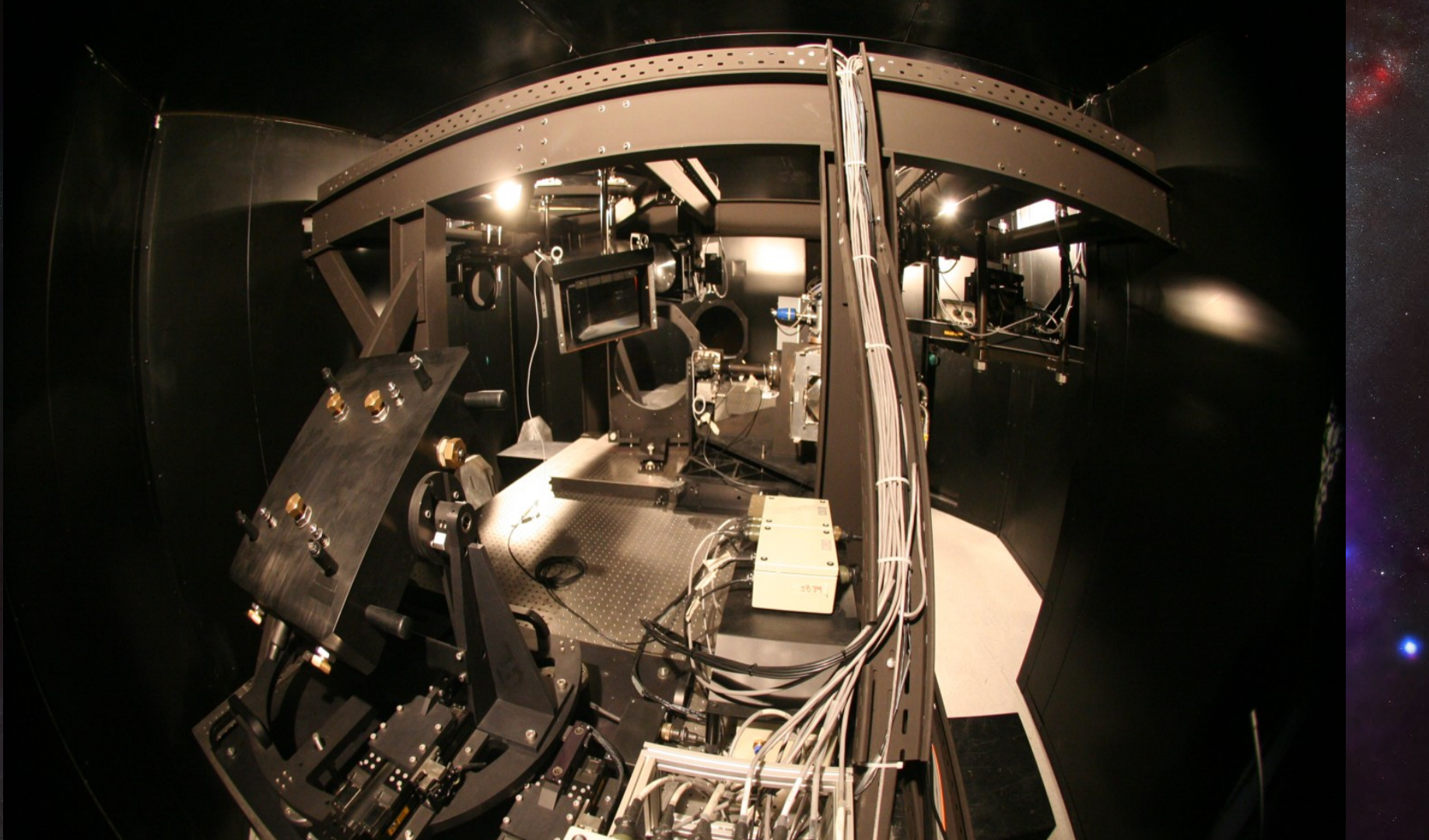
Next Generation Space Telescope

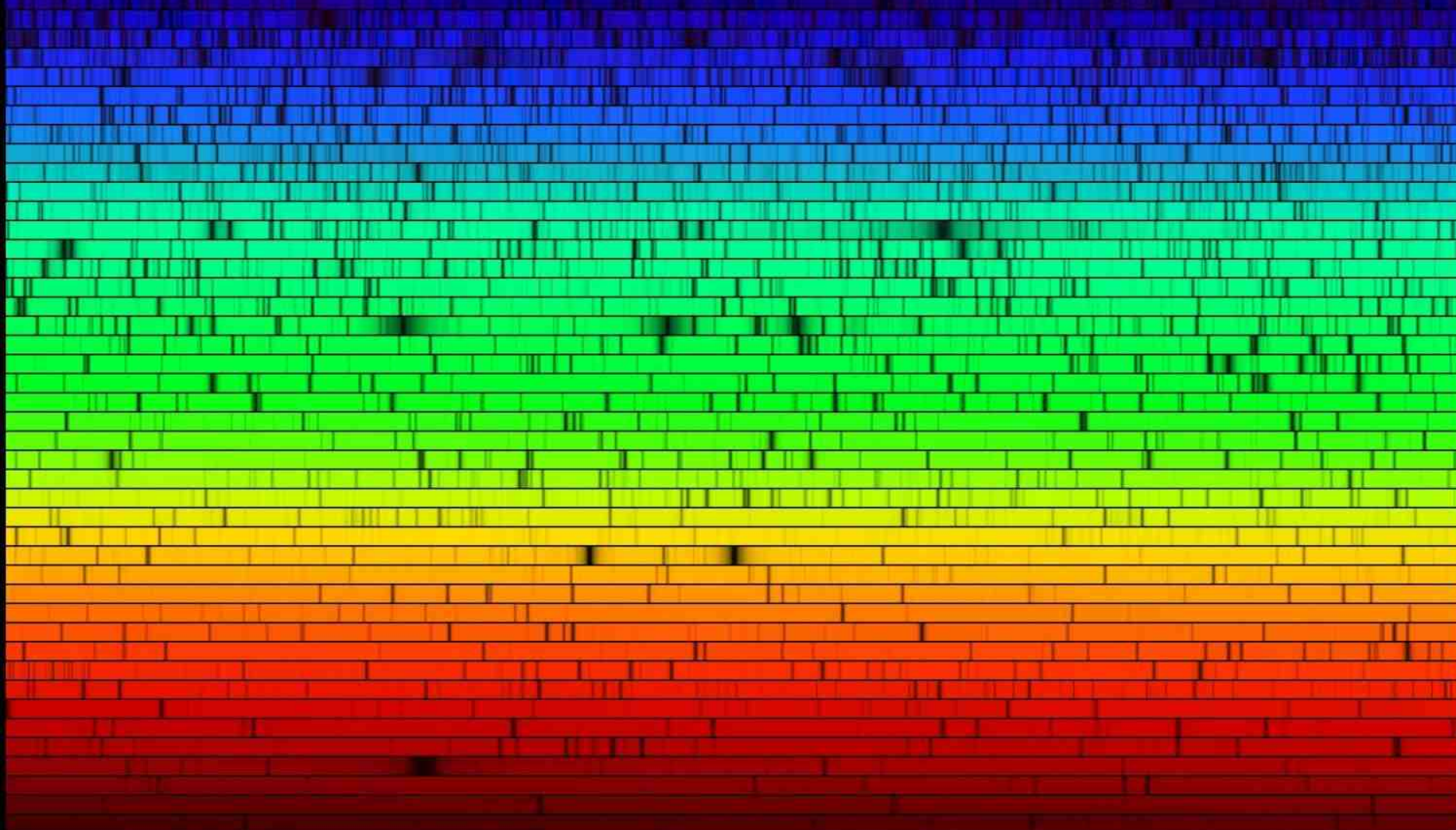


Edwin Hubble Achievements



- Hubble worked at Mount Wilson using a the largest telescopes in the world
- Hubble was able to measure distances in the universe by using cepheid variables





James Webb

He took our nation on its first voyages of exploration, turning our imagination into reality. Indeed, he laid the foundations at NASA for one of the most successful periods of astronomical discovery.



Men to the Moon - 12th Sept 1962



The Crazy Dream

Orbital vs Suborbital Trajectories

International Space Station Orbit

↑ To Space

400 Km

1961

May 5

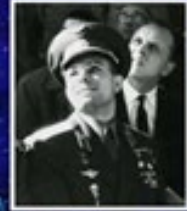
Astronaut Alan Shepard becomes the first American in space.



1961

April 12

Russian cosmonaut Yuri Gagarin becomes the first human in space.



Suborbital Flight (Sounding Rocket)

Lowest Possible Orbit

Orbital Flight

100 Km

Commercial Airlines

12 Km

0 Km

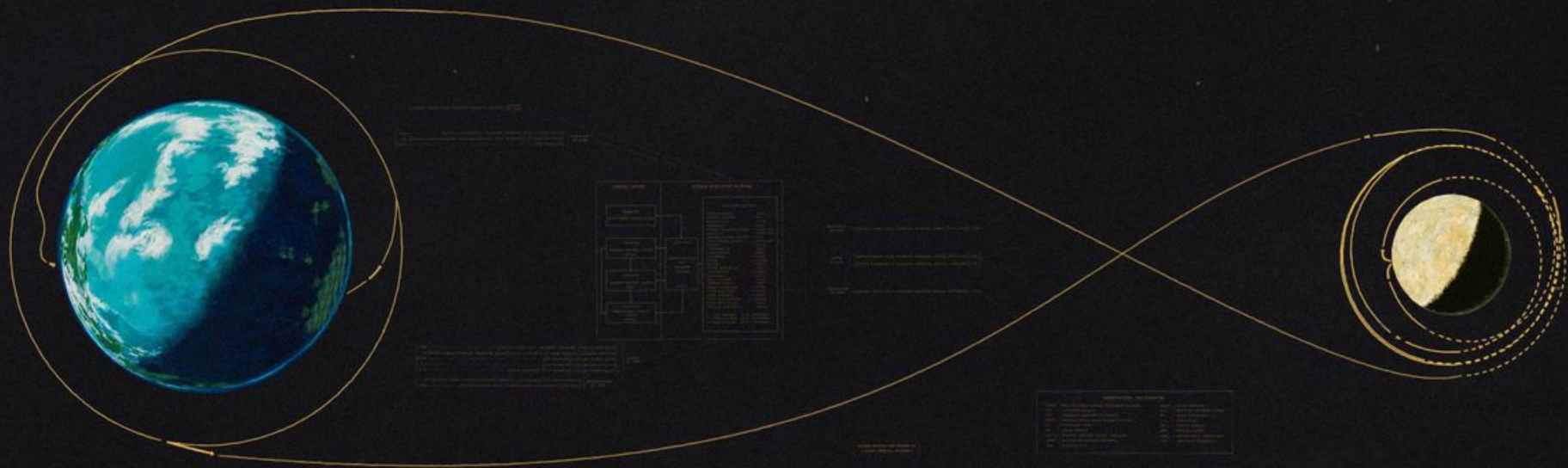
1962

February 20

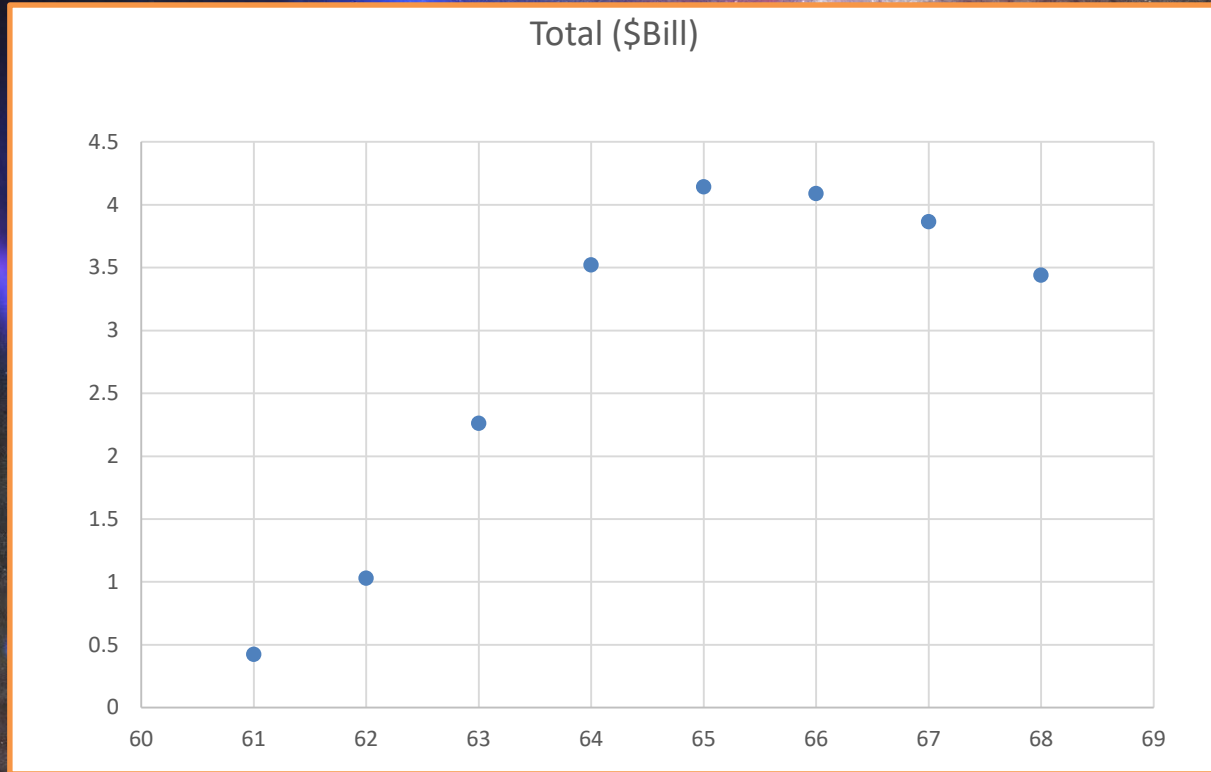
Astronaut John Glenn becomes the first American in orbit.



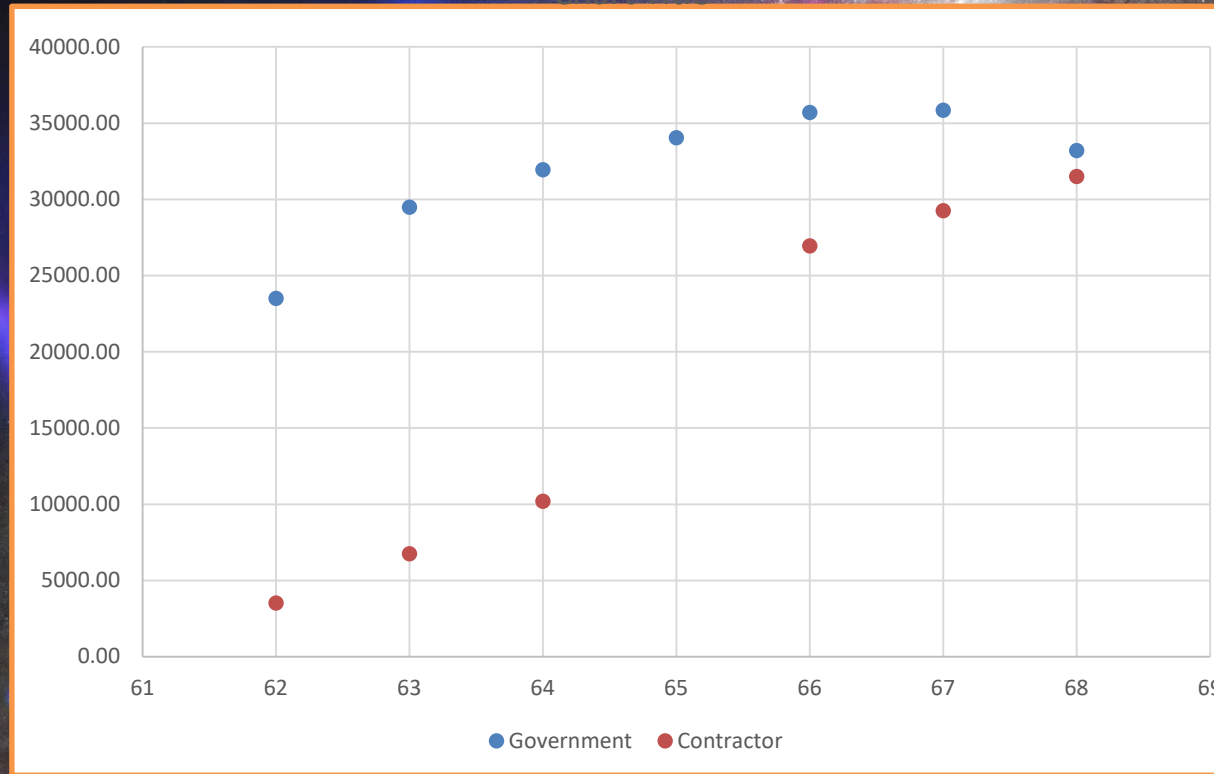
*Curvature of Earth Not to Scale

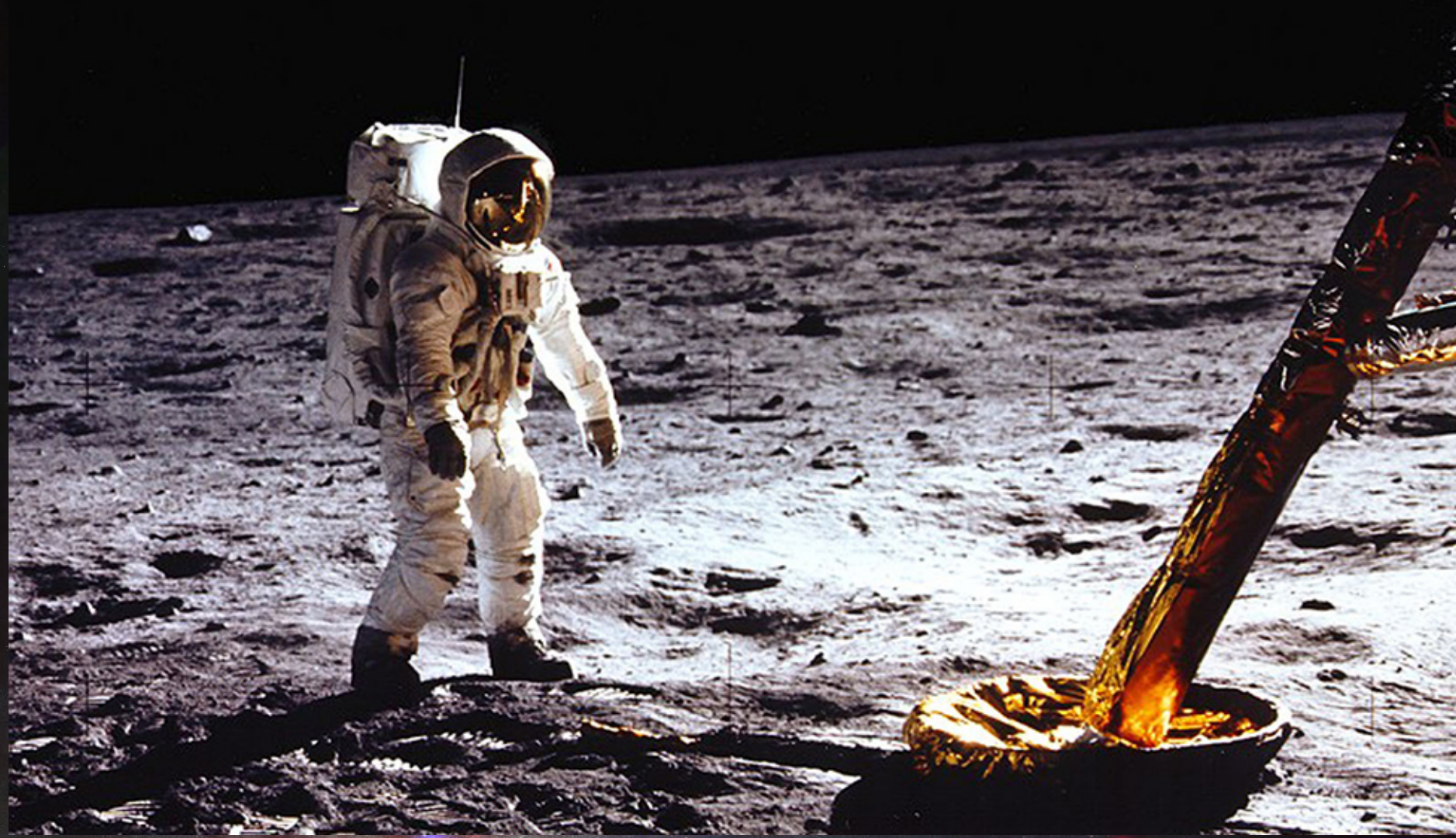


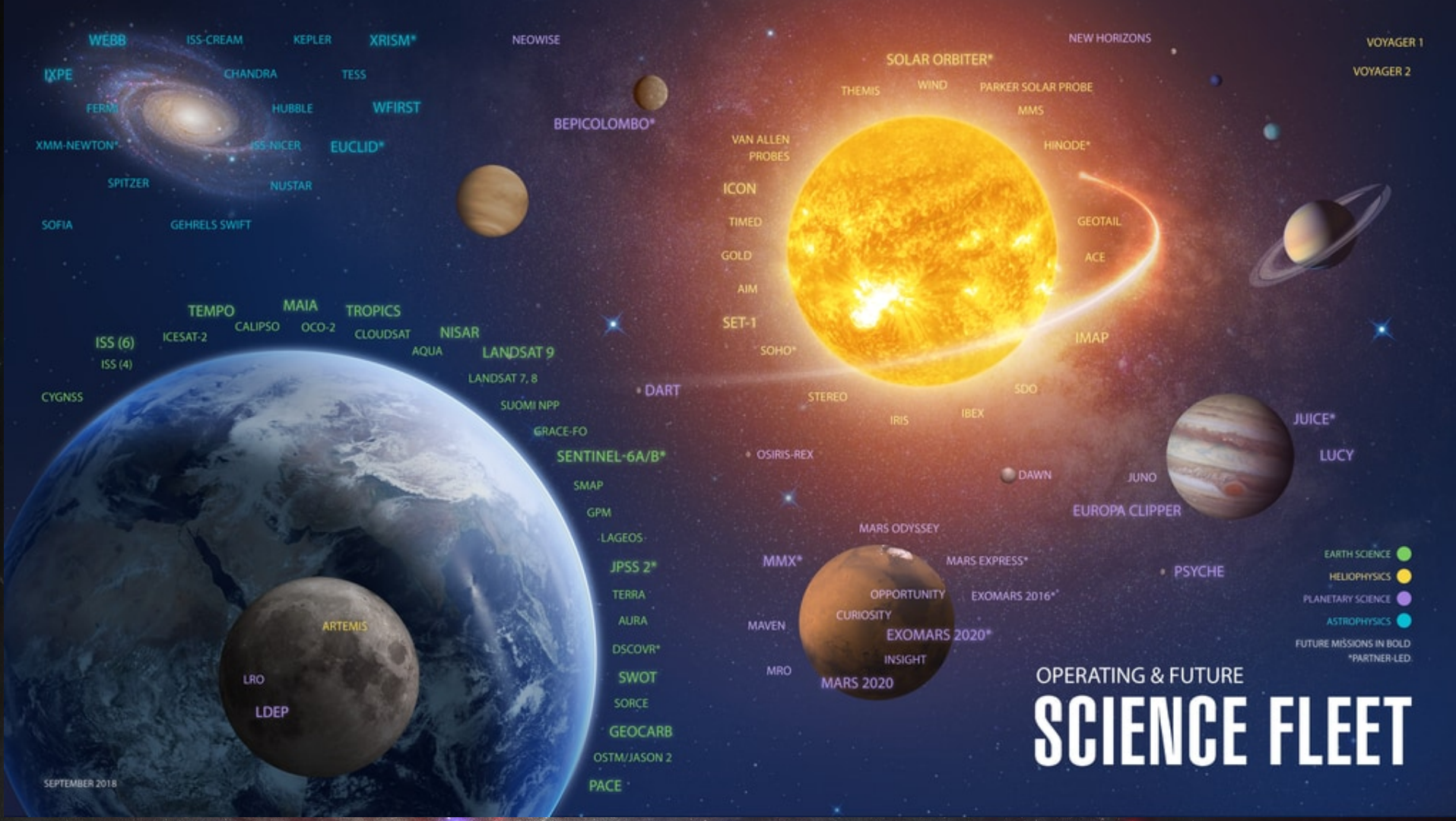
Awards Made in \$Billions



Number of Government /Contract personnel





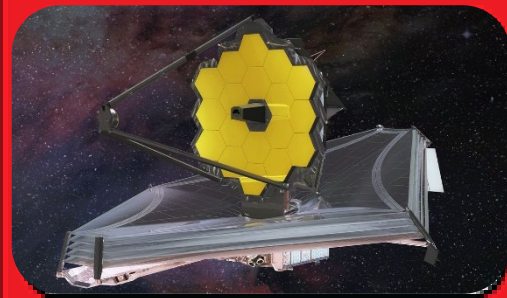


The Machines

Hubble



JWST



The Hubble Space Telescope

Size: 13.2 m long,
4.3 m in diameter

Weight: Almost 11 tons

Mirror Size: Main mirror about
2.4 meters

Launched By: Discovery 24/04/90

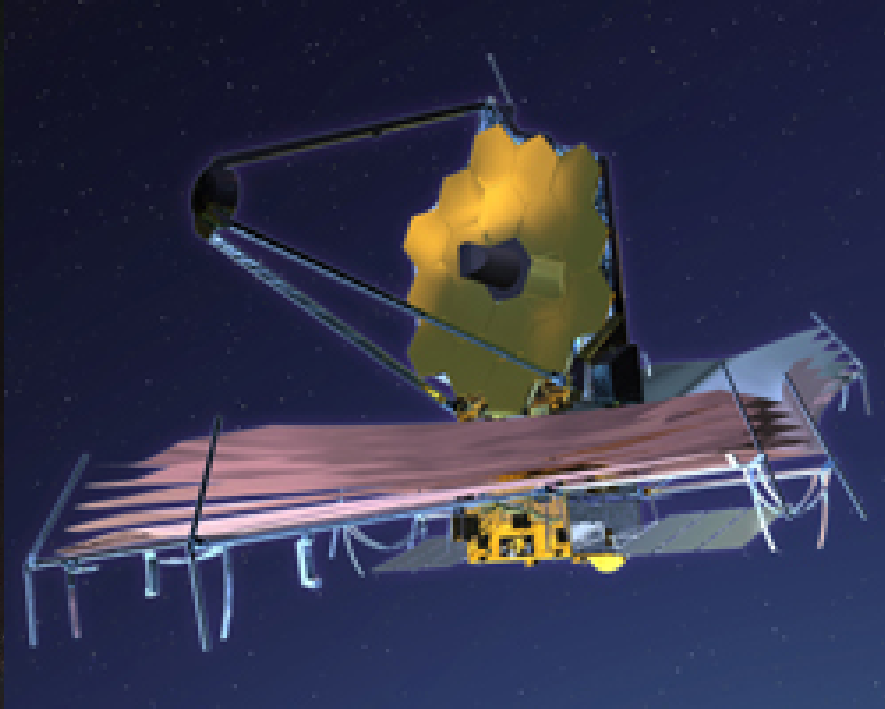
Orbit: 550 km above our heads



3D Hubble Model



James Webb Space Telescope



Size: sunshade as large as a tennis court

Weight: 6 tons

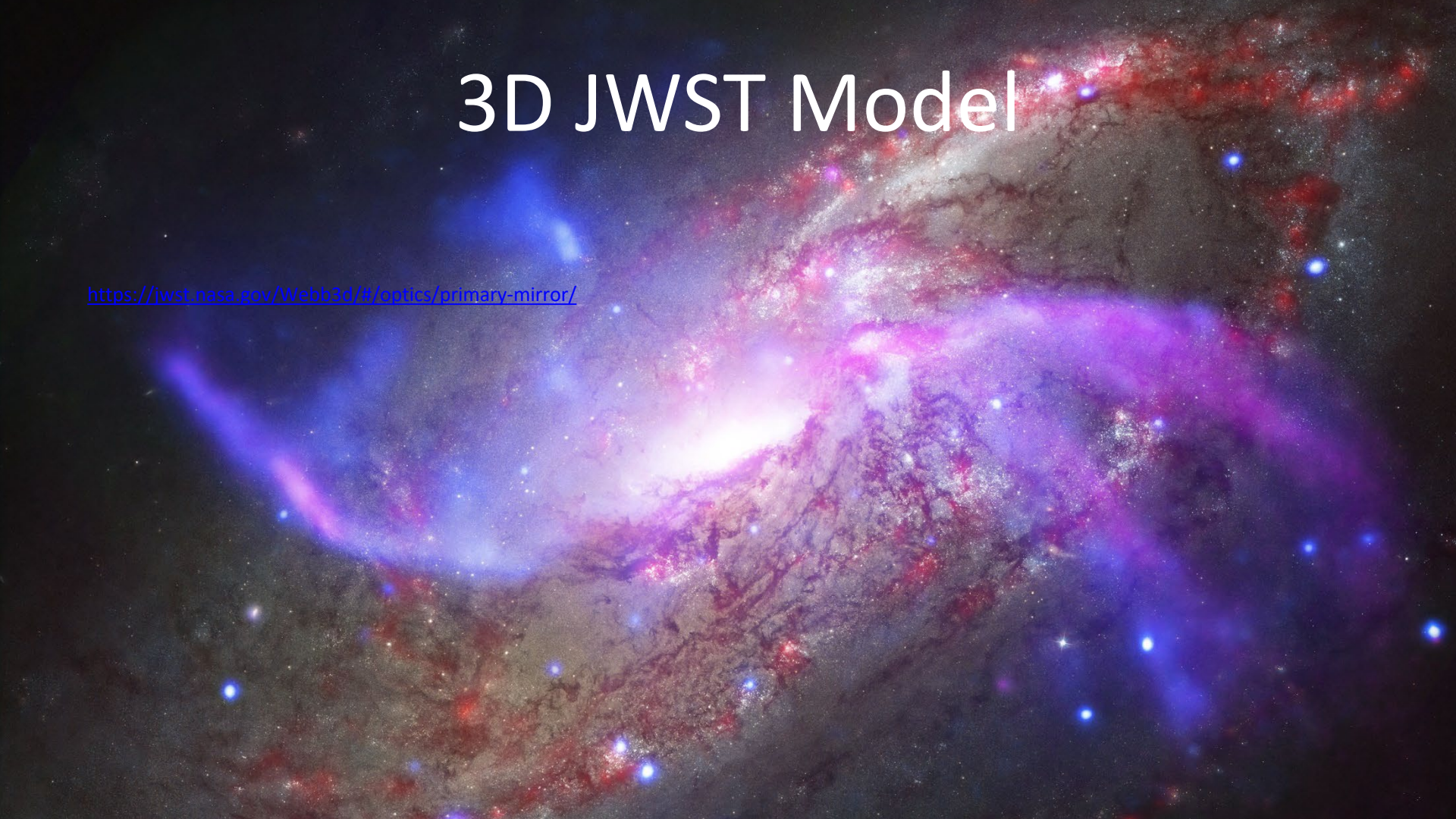
Mirror Size: primary mirror is a 6.5 meters

To Be Launched By: Ariane

Orbit: 1.5 million km away from Earth

3D JWST Model

<https://jwst.nasa.gov/Webb3d/#/optics/primary-mirror/>

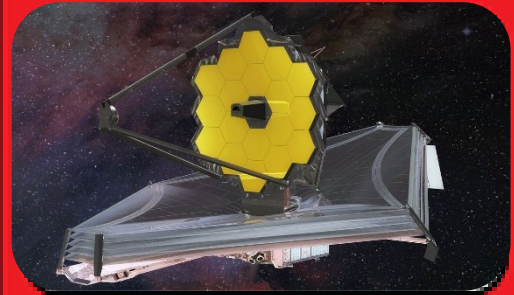


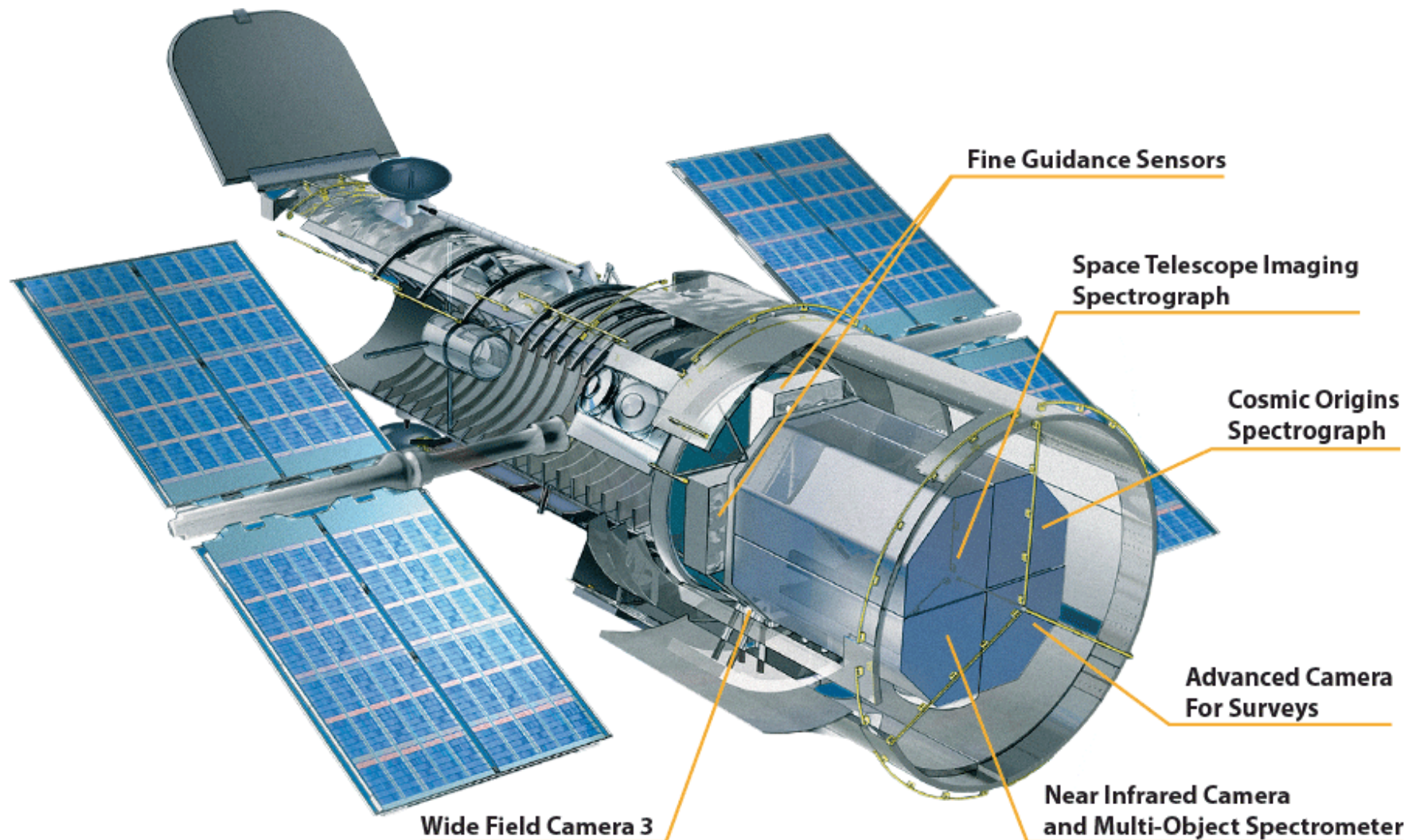
Instrumentation

Hubble Instruments



JWST Instruments





THE JAMES WEBB SPACE TELESCOPE

Science Instrument Module (SIM)

Houses all of Webb's cameras and science instruments

Trim flap

Helps stabilize the satellite

Solar power array

Always facing the Sun, panels convert sunlight into electricity to power the observatory

Earth-pointing antenna

Sends science data back to Earth and receives commands from NASA's Deep Space Network

Spacecraft bus

Contains most of the spacecraft steering and control machinery, including the computer and the reaction wheels

Primary Mirror

18 hexagonal segments made of the metal beryllium and coated with gold to capture faint infrared light

Secondary Mirror

Reflects gathered light from the primary mirror into the science instruments

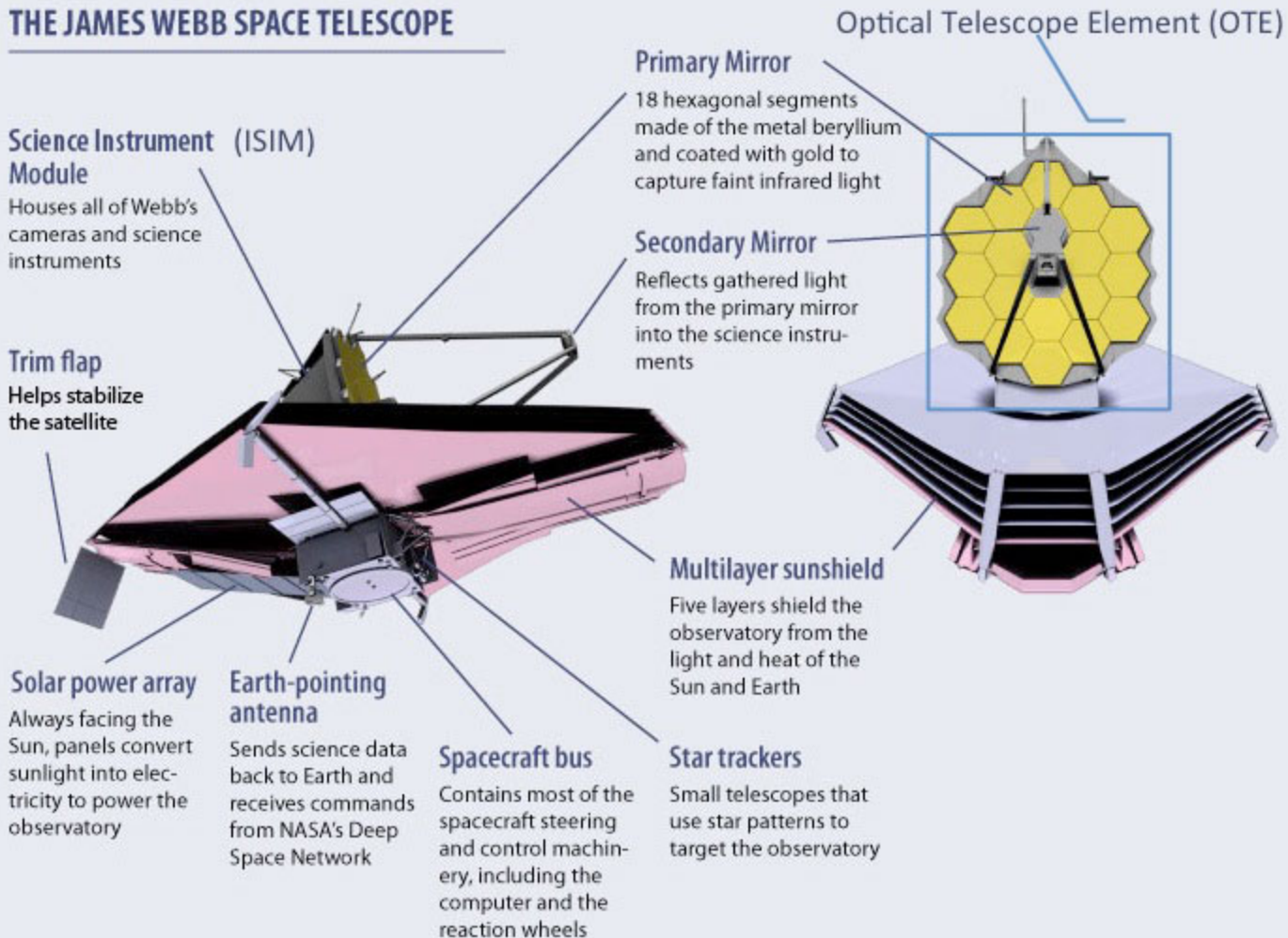
Multilayer sunshield

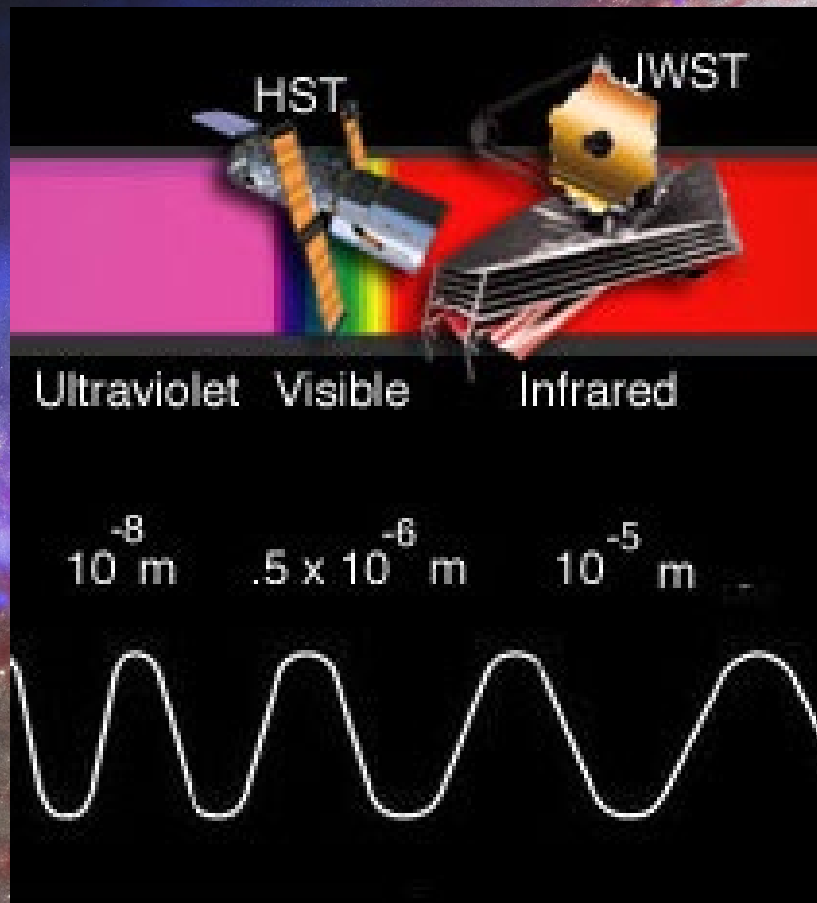
Five layers shield the observatory from the light and heat of the Sun and Earth

Star trackers

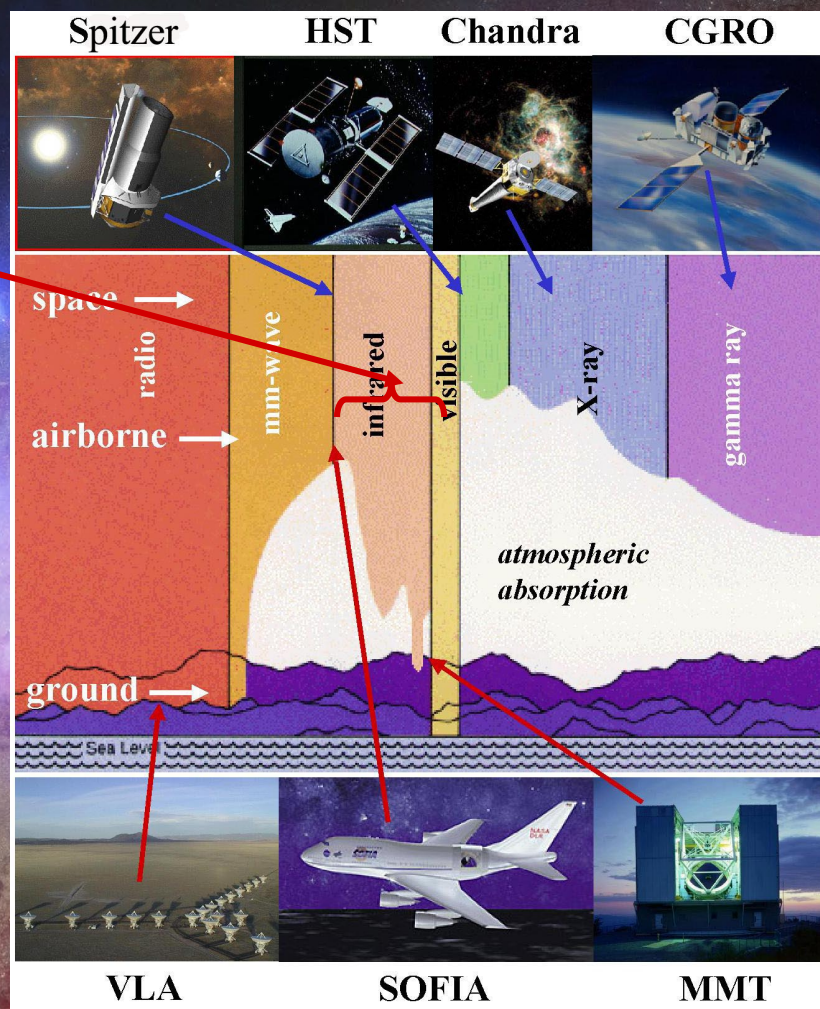
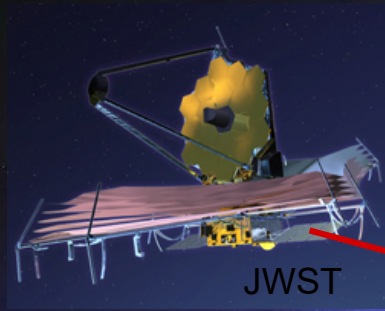
Small telescopes that use star patterns to target the observatory

Optical Telescope Element (OTE)

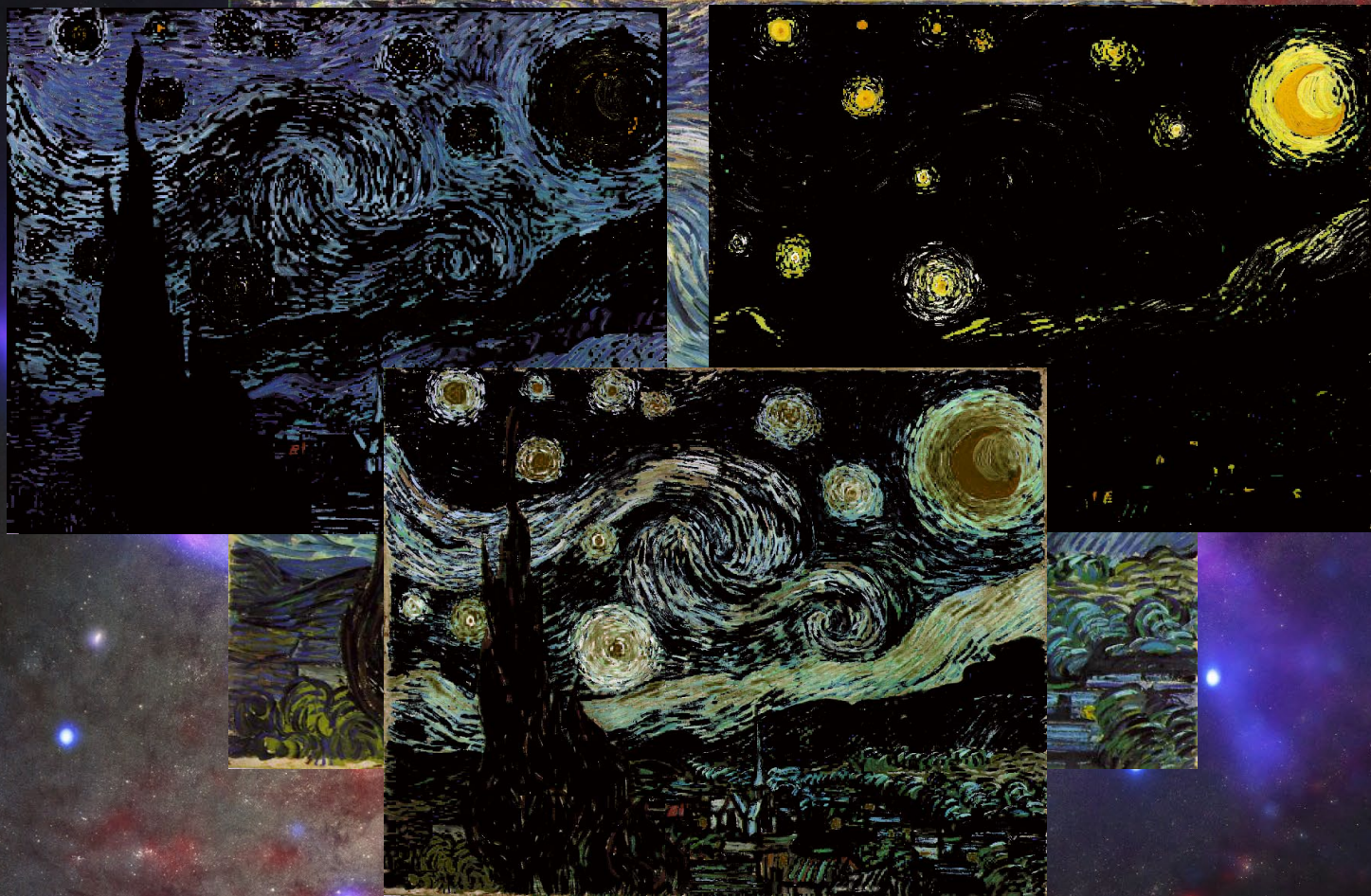


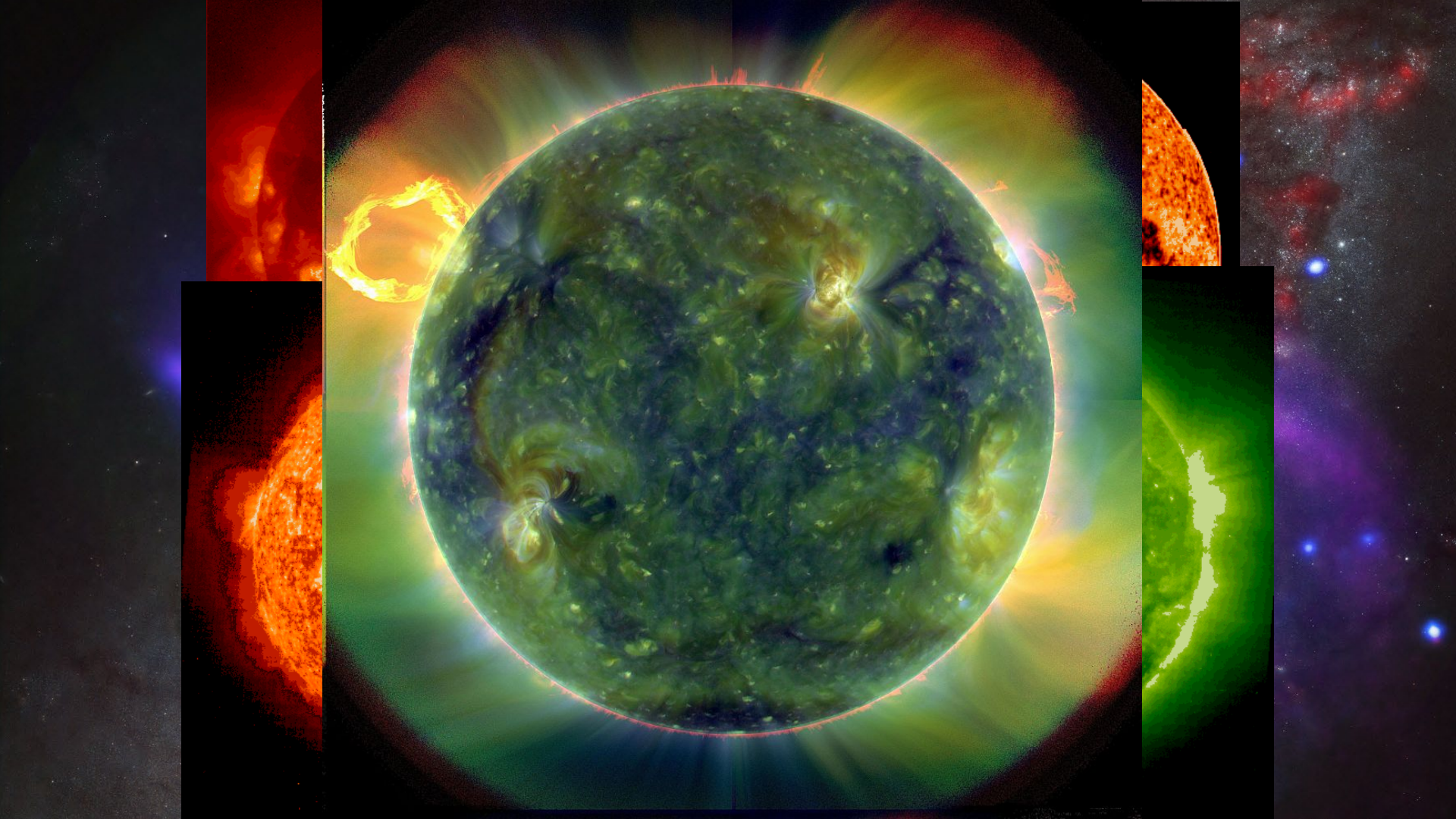






Van Gogh, Starry Night



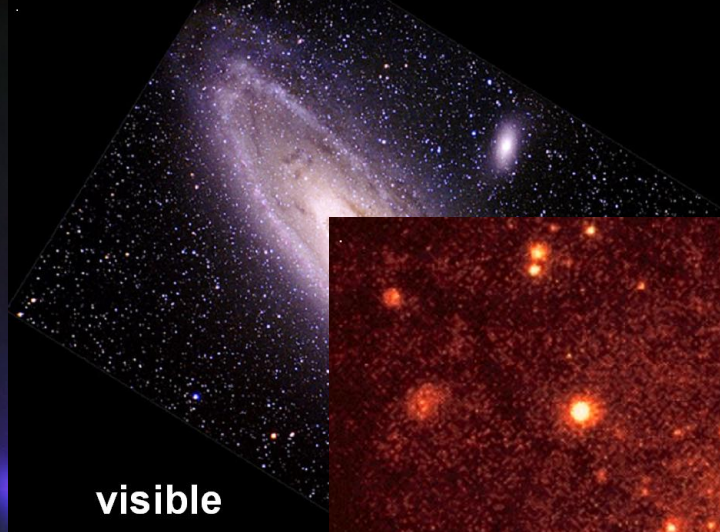


Our local galaxy the milky way
contains 300 billion stars

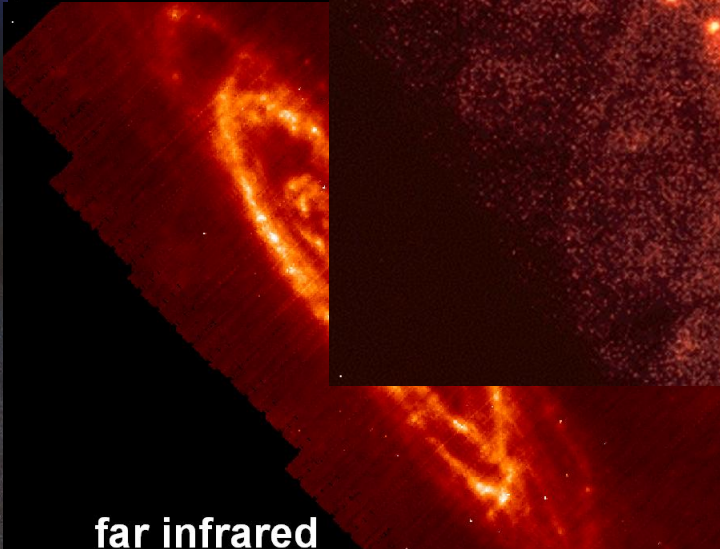
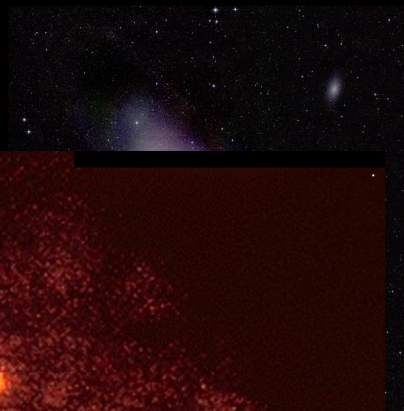


Science & Technology
Facilities Council

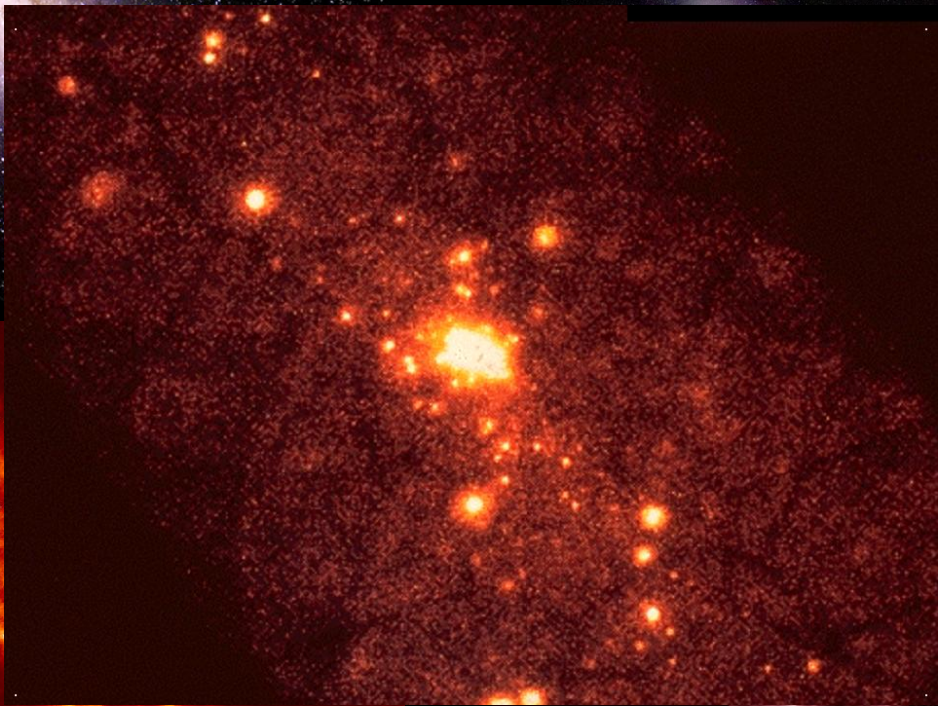
Science
Innovation



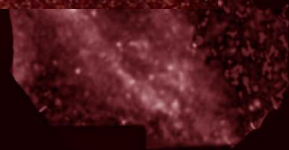
visible



far infrared



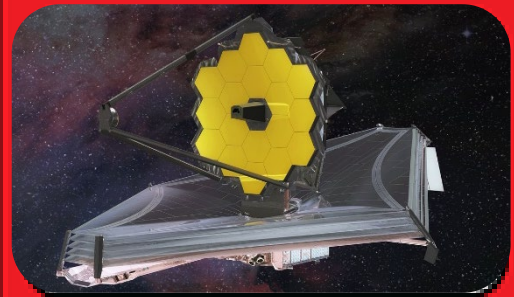
radio



Hubble Challenges



JWST Challenges



Hubble Trouble



These before and after images show the results of adjustments made to Hubble's primary mirror.

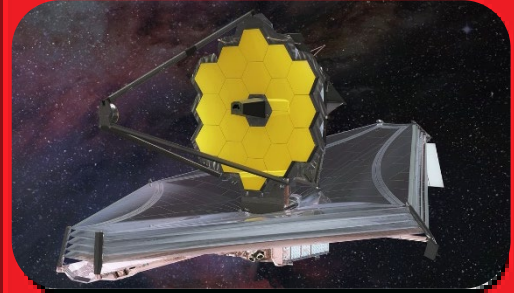
JWST Challenge

- *“Now estimated to cost \$9.7 billion, the project’s costs have increased by 95 percent and its launch date has been delayed by over 6.5 years since its cost and schedule baselines were established in 2009.”*
- **GAO Report: James Webb Space Telescope**

Hubble Science

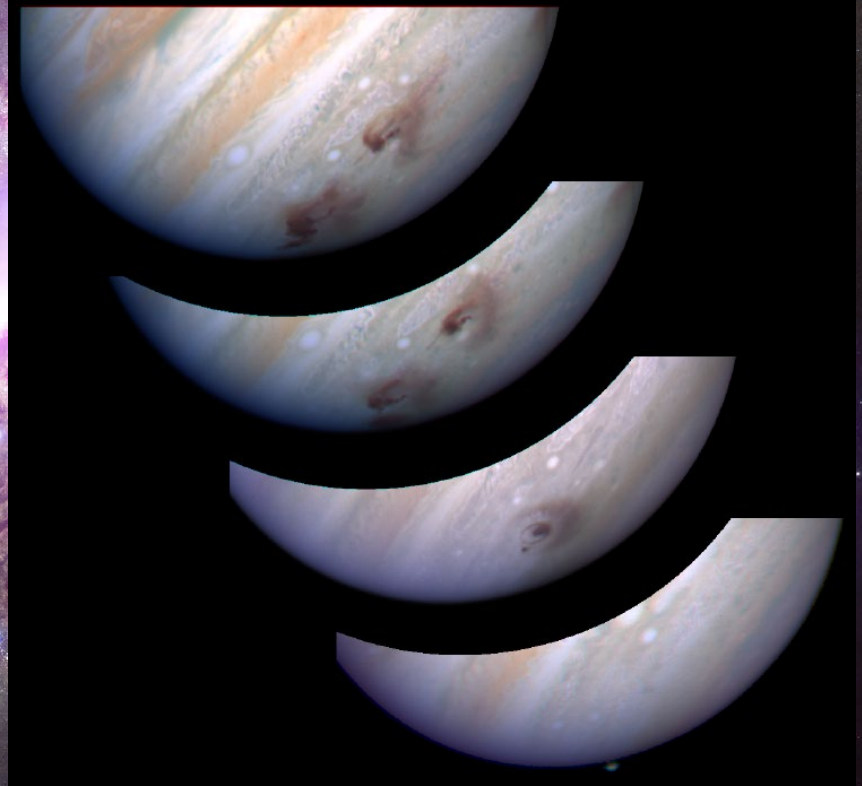
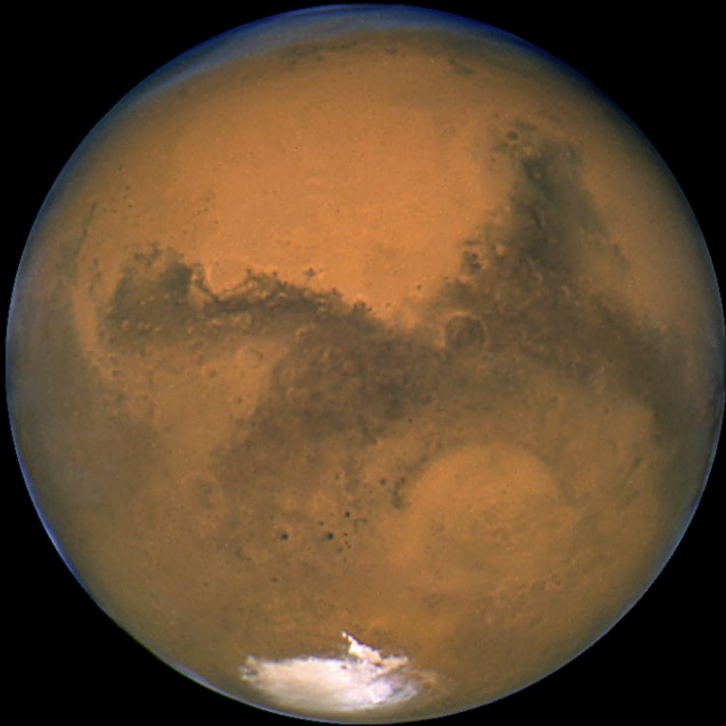


JWST Science



Hubble Images

- In Our Solar System



Hubble Images In the Universe Beyond

Sombrero Galaxy • M104



Hubble
Heritage

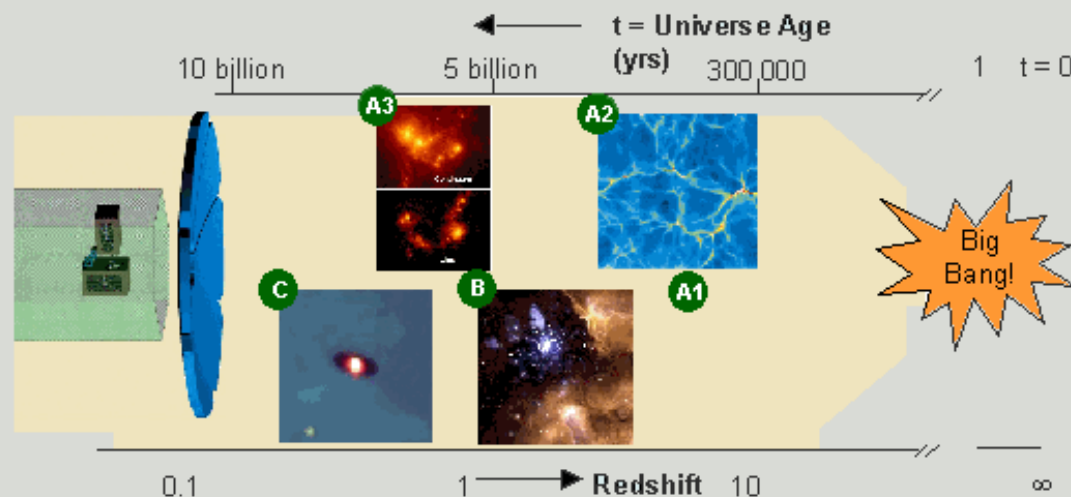
NASA and The Hubble Heritage Team (AURA/STScI) • Hubble Space Telescope ACS • STScI-PRC03-28

Cat's Eye Nebula • NGC 6543



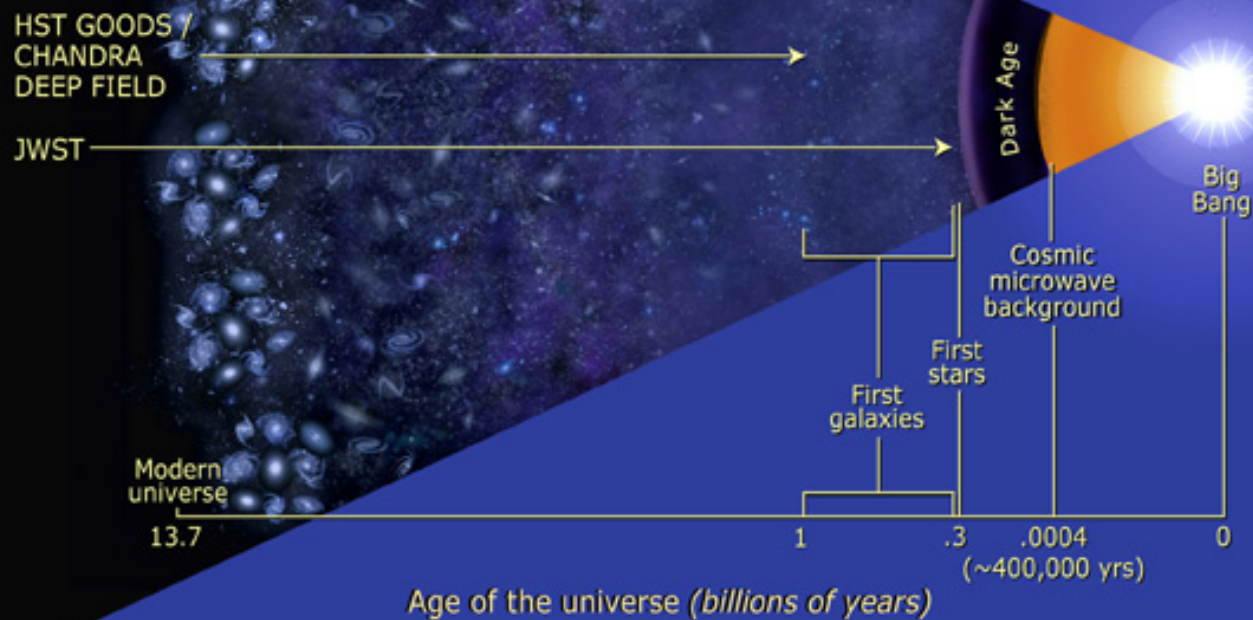
Hubble
Heritage

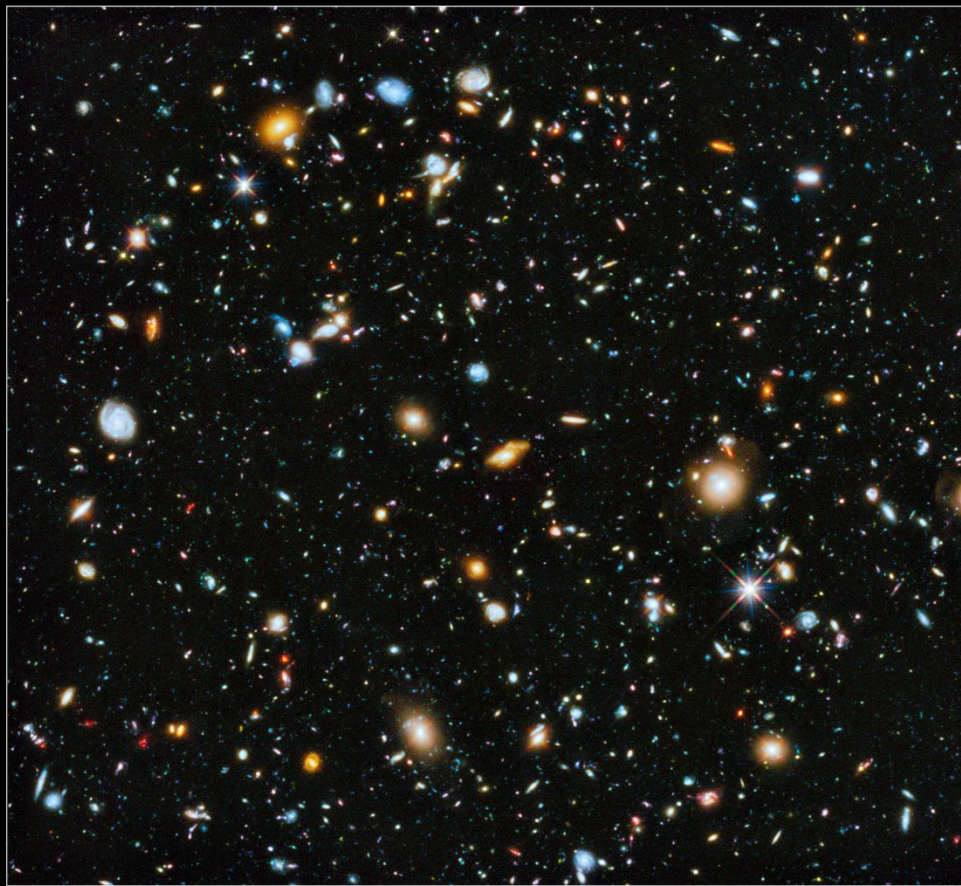
Science Objectives



- A Formation of galaxies**, from the first luminous massive condensations of material^(A1) through the reionization^(A2) of the Universe, to the assembly of galaxies and clusters and the development of morphological types ^(A3)
- B Formation of stars and brown dwarfs**, from twice the mass of Jupiter to the mass of the sun ($1000 M_J$) ^(B). We will probe the collapse of pre-stellar cores and test current ideas that the collapse is influenced by the local Jeans mass (near $1 M_\odot$) and by opacity-limited fragmentation (near $10 M_J$)
- C Planetary systems from birth to maturity**. We will use coronagraphy to image and obtain spectra of debris disks^(C) and compare their properties with those of our own counterpart, the Kuiper Belt. We will image and obtain spectra of massive giant planets around nearby stars, to determine their relation to debris disk structure and their atmospheric properties.

Seeing back into the cosmos





Hubble Ultra Deep Field 2014
Hubble Space Telescope • ACS • WFC3

Conclusion

- Hubble and Webb are designed to compliment each other rather than compete
- Sit in very different positions in space
- Work at different wavelengths
- JWST will look even further back in time and take us closer to the big bang
- Hubble has give us some amazing insights into the Universe around us
- Watch this space for news about JWST