



# ***"JWST", the James Webb Space Telescope***

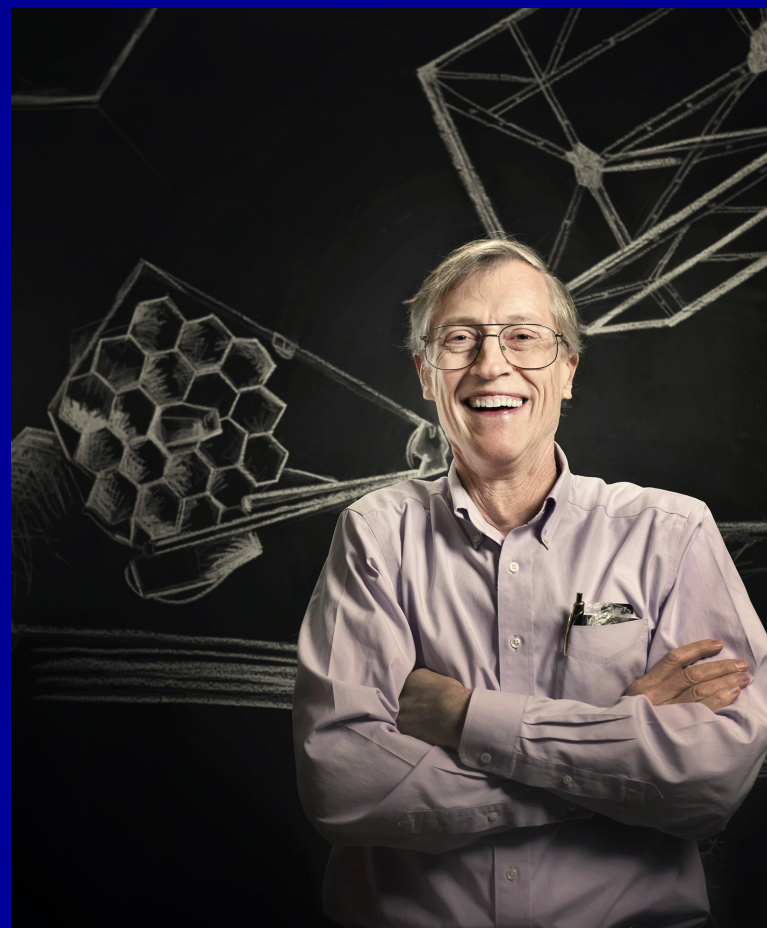
Ollie Open House  
August 24, 2022

**Jonathan F. Ormes**

[JFOrmes@gmail.com](mailto:JFOrmes@gmail.com)

University of Denver

Department of Physics and Astronomy





*"Sometimes I wonder if there's more to life than  
unlocking the mysteries of the universe."*

# History of the Universe

PRESENT  
DAY

MODERN  
GALAXIES  
FORM

FIRST  
GALAXIES  
FORM

FIRST  
STARS  
FORM

THE  
BIG BANG



HUBBLE



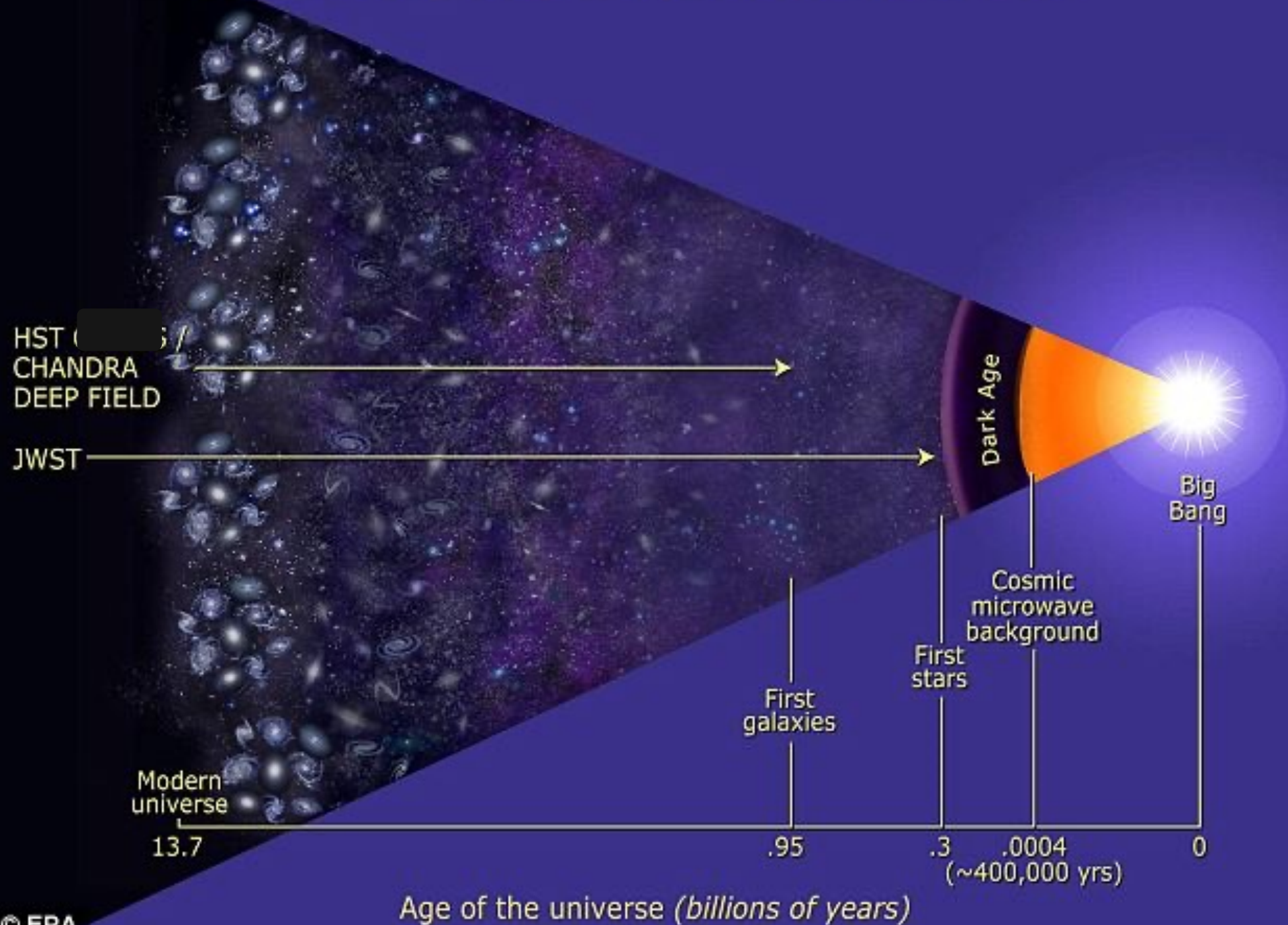
JWST

RANGE

the first stars came into life.



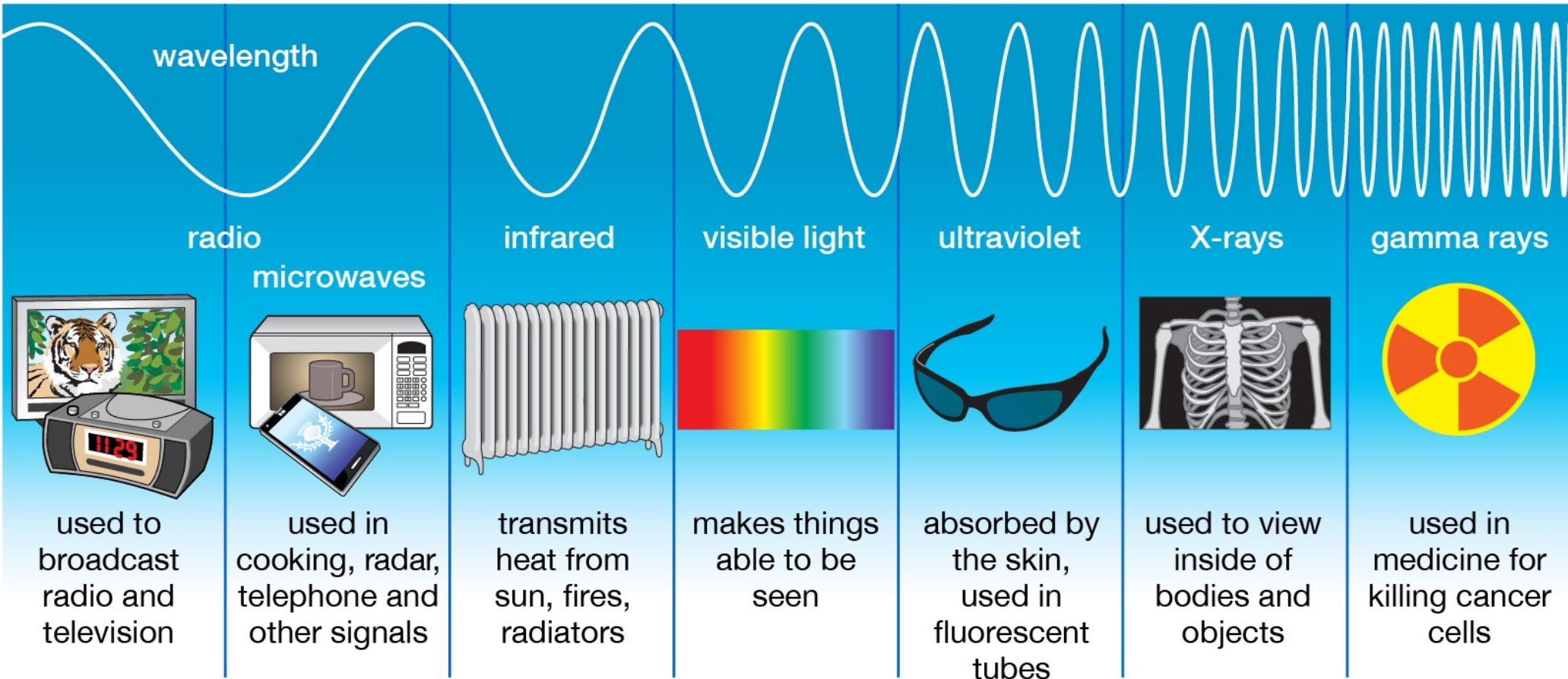
# Seeing back into the cosmos





# Electromagnetic spectrum

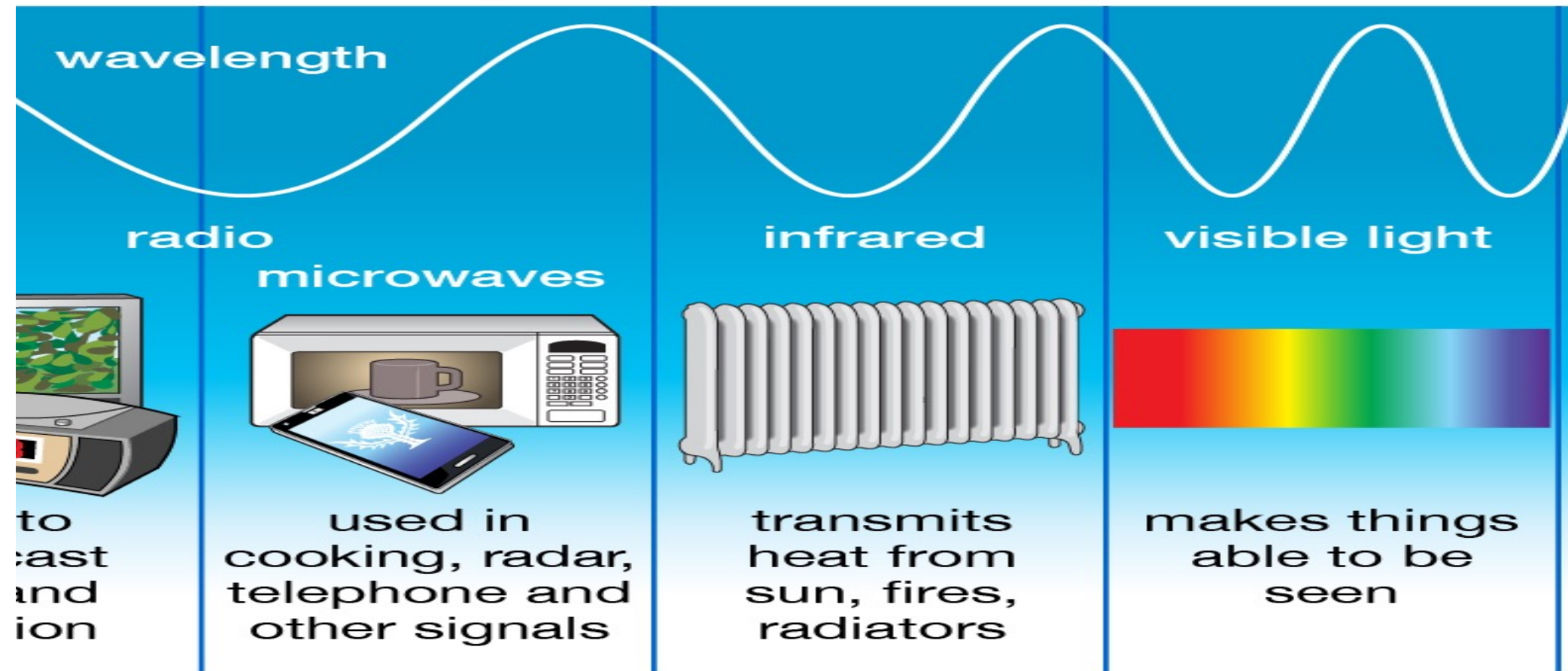
## Types of Electromagnetic Radiation



When the Universe expands, so does the radiation, making its wavelength larger. The further it travels, the larger the expansion. Visible light becomes infrared light.

# Visible light becomes infrared.

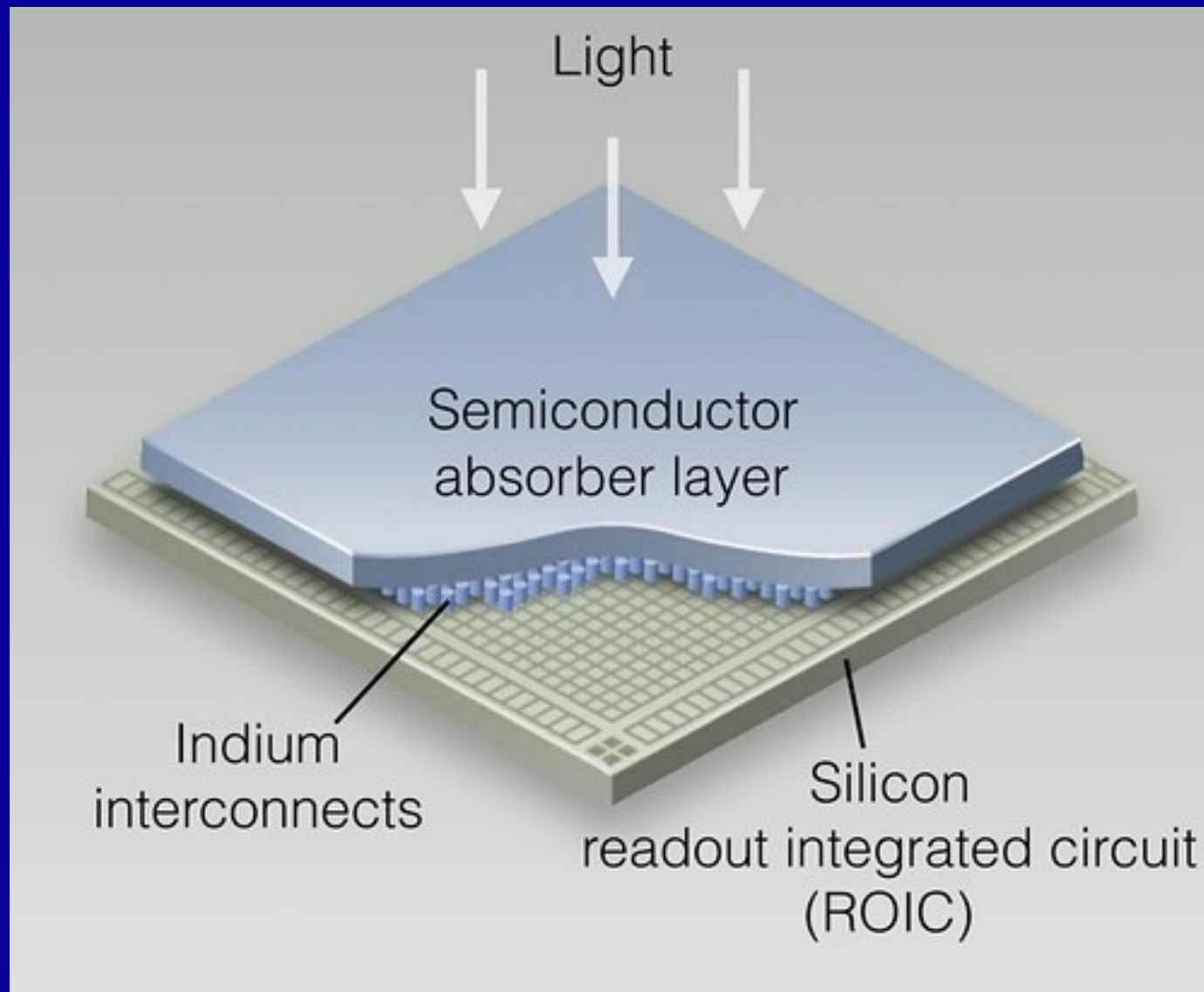
## of Electromagnetic Radiation



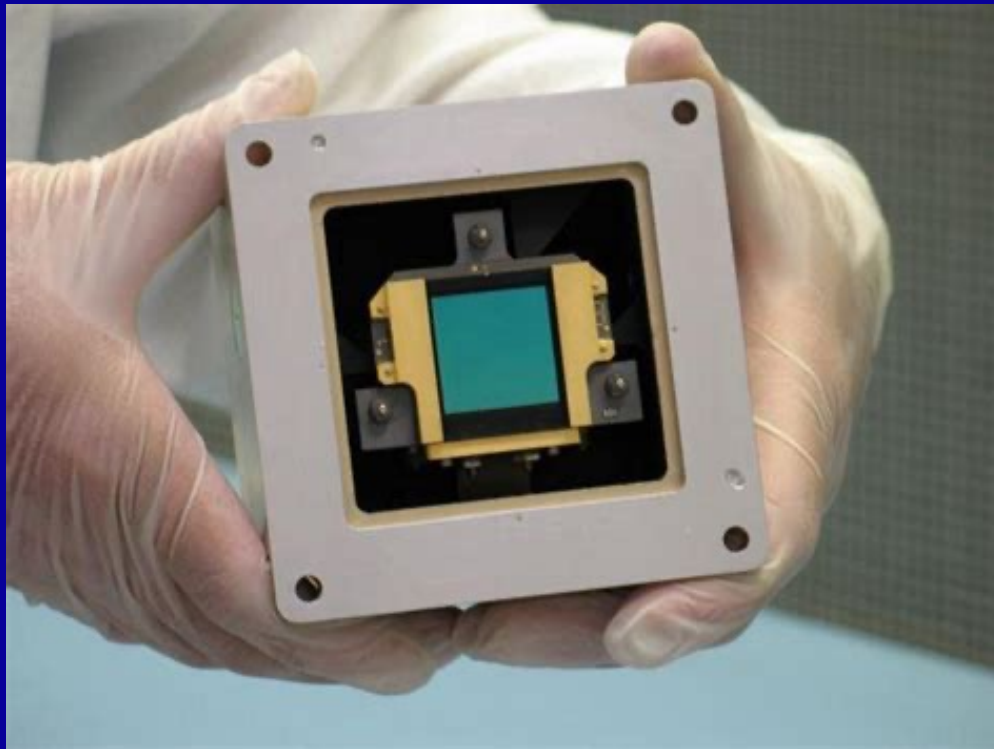
cyclopædia Britannica, Inc.



# An infrared detector



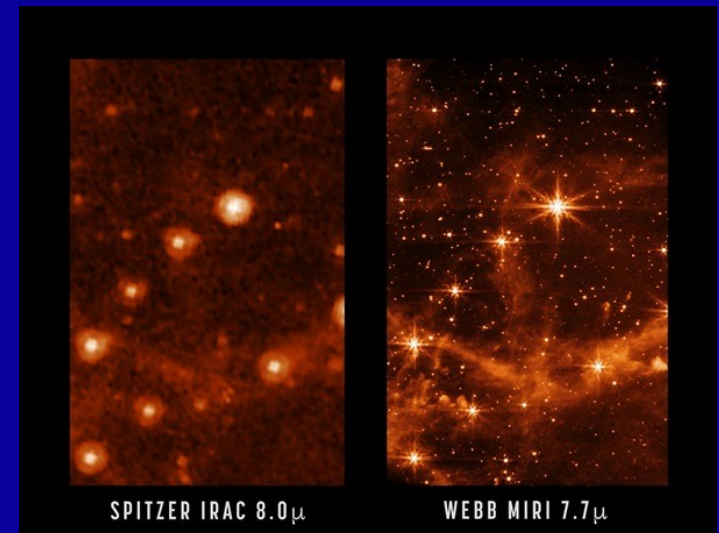
# JWST has infrared detectors to see deeper into the universe.



**Also an ir detector made with mercury-cadmium-telluride**

**It has a 1024x1024 pixel array of arsenic doped silicon pixels.**

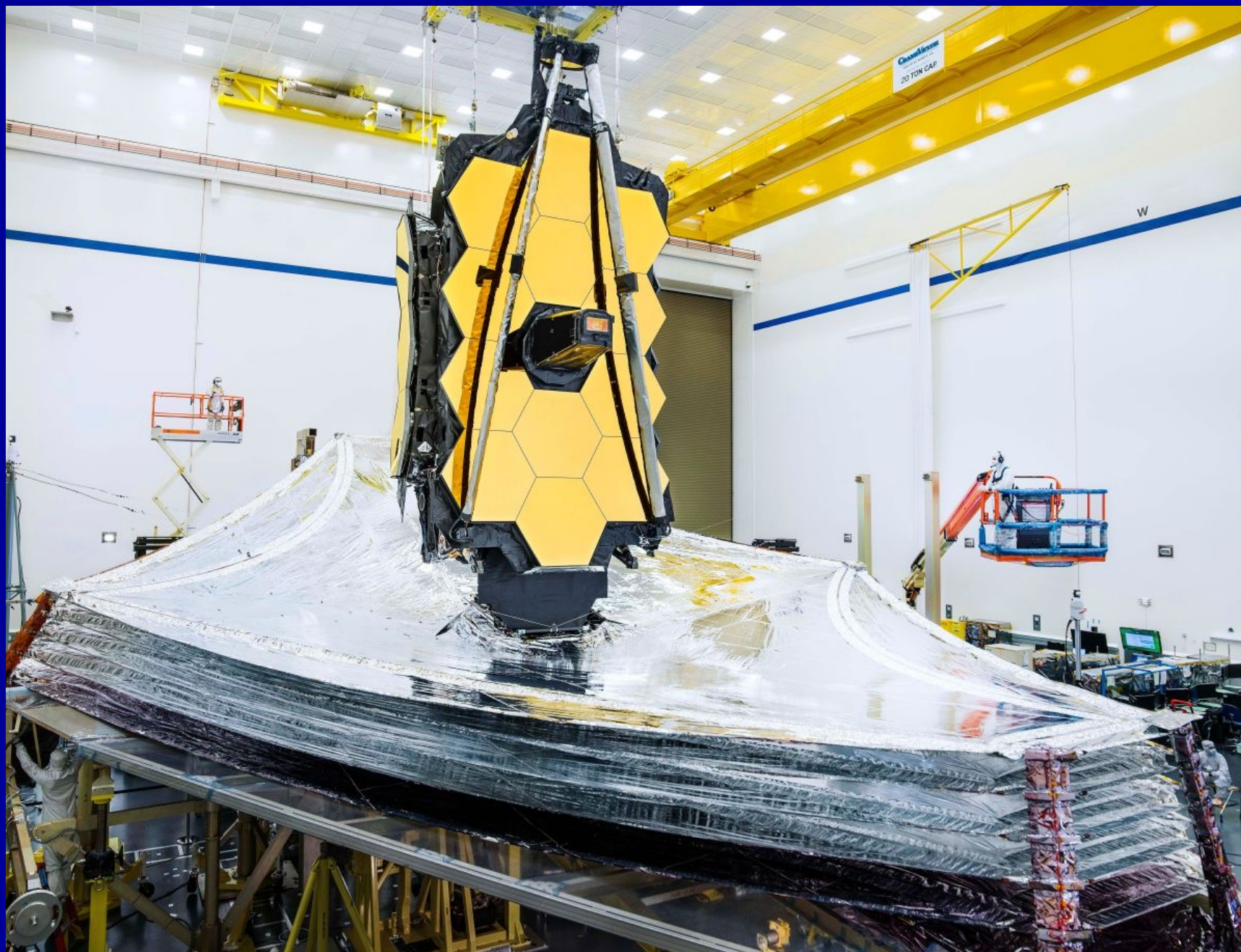
Three different detectors cover 0.6 to 28 microns



# An origami telescope and sun shield: an engineering marvel

- Started 1995, estimated cost \$1.6B
- Original launch date 2013
- Mirror area: 5 x HST
- Final cost ~\$10B, launched Dec. 25, 2021
- 334 single-point failures
- Instruments at  $-220^{\circ}\text{C} = -364^{\circ}\text{F} = 53\text{Kelvin}$
- Gold-plated beryllium mirrors
  - 5 gm of gold total (0.17 oz)









1430 W/ m<sup>2</sup>

## Cross-Section of Webb's Five-Layer Sunshield

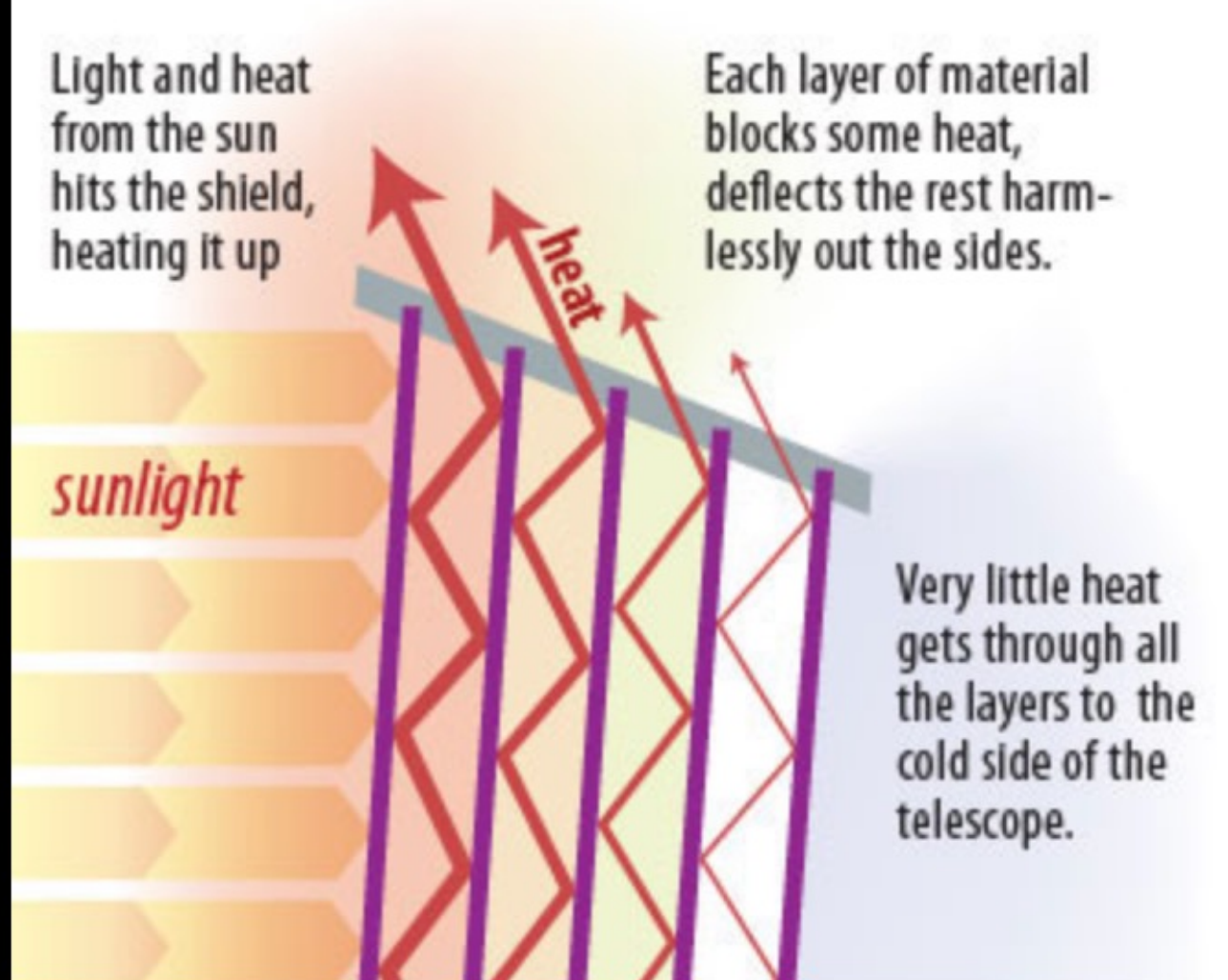
Light and heat from the sun hits the shield, heating it up

Each layer of material blocks some heat, deflects the rest harmlessly out the sides.

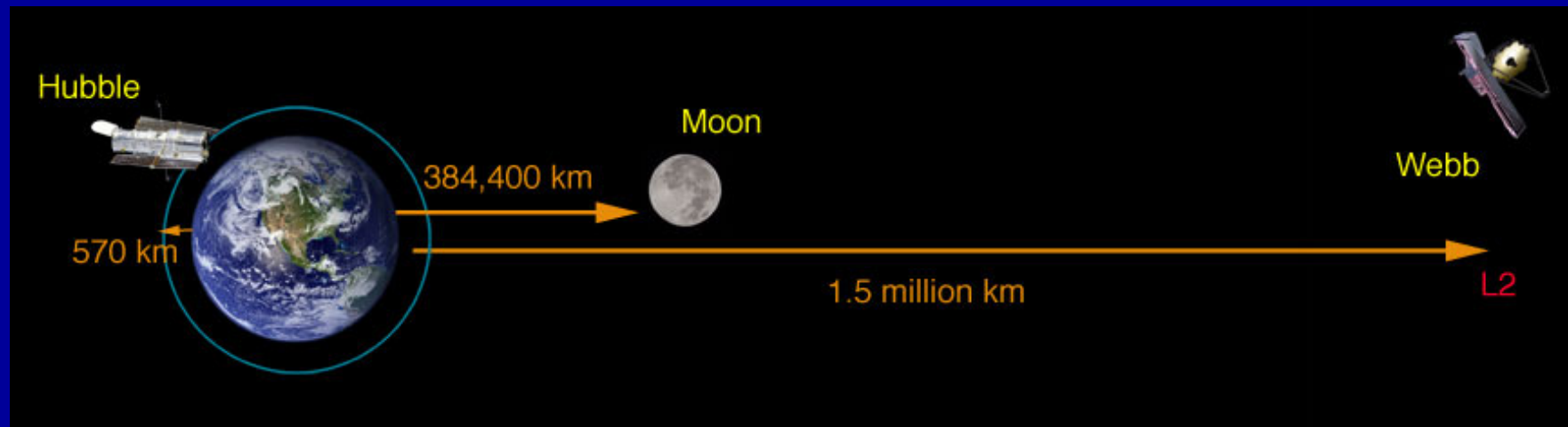
*sunlight*

*heat*

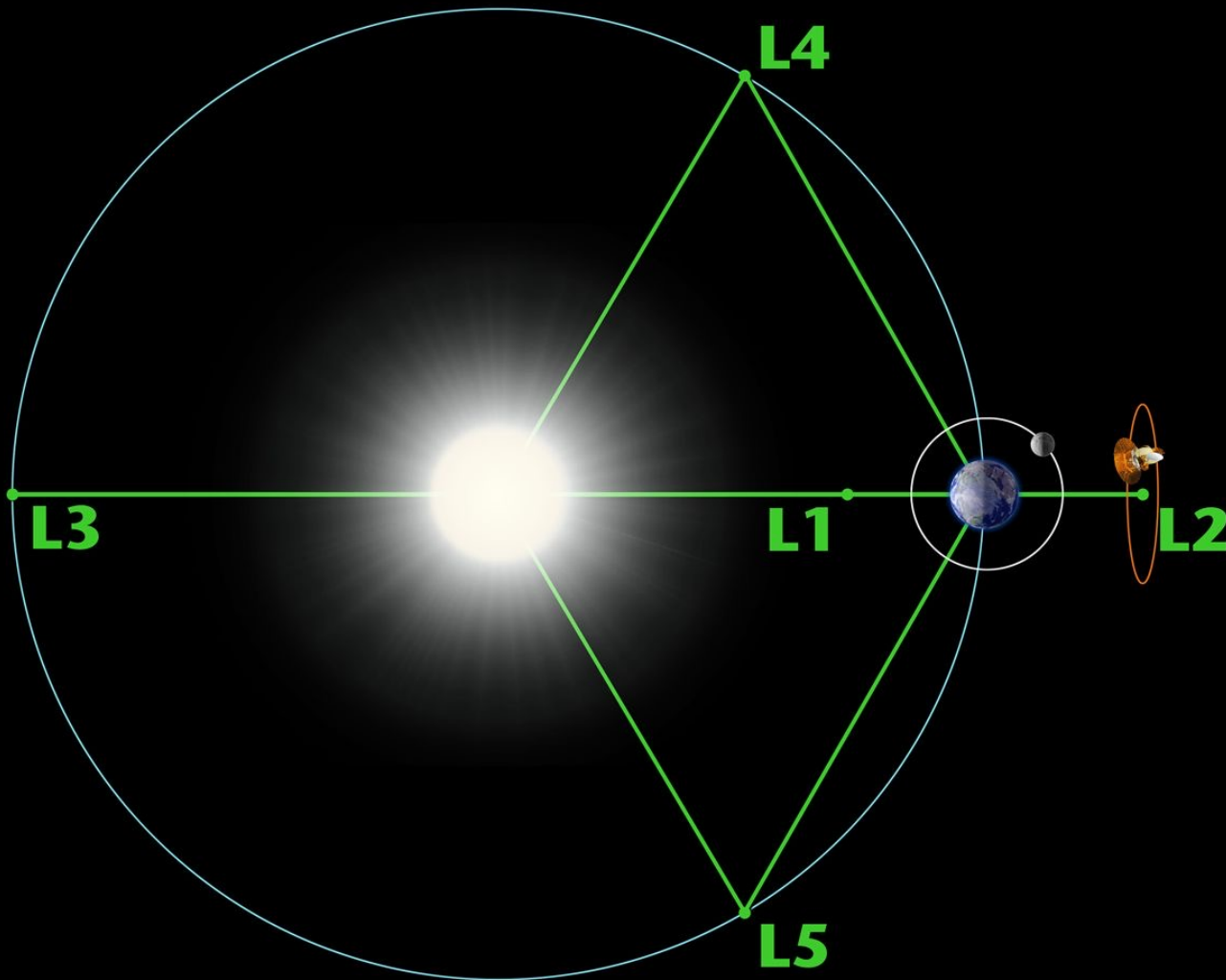
Very little heat gets through all the layers to the cold side of the telescope.







# Lagrange Point 2 orbit



Sun and Earth pull the Satellite into alignment, but the satellite needs thrusters to keep it at the right distance from the Earth.

Fuel is available for orbiting around L2 for almost 20 years.



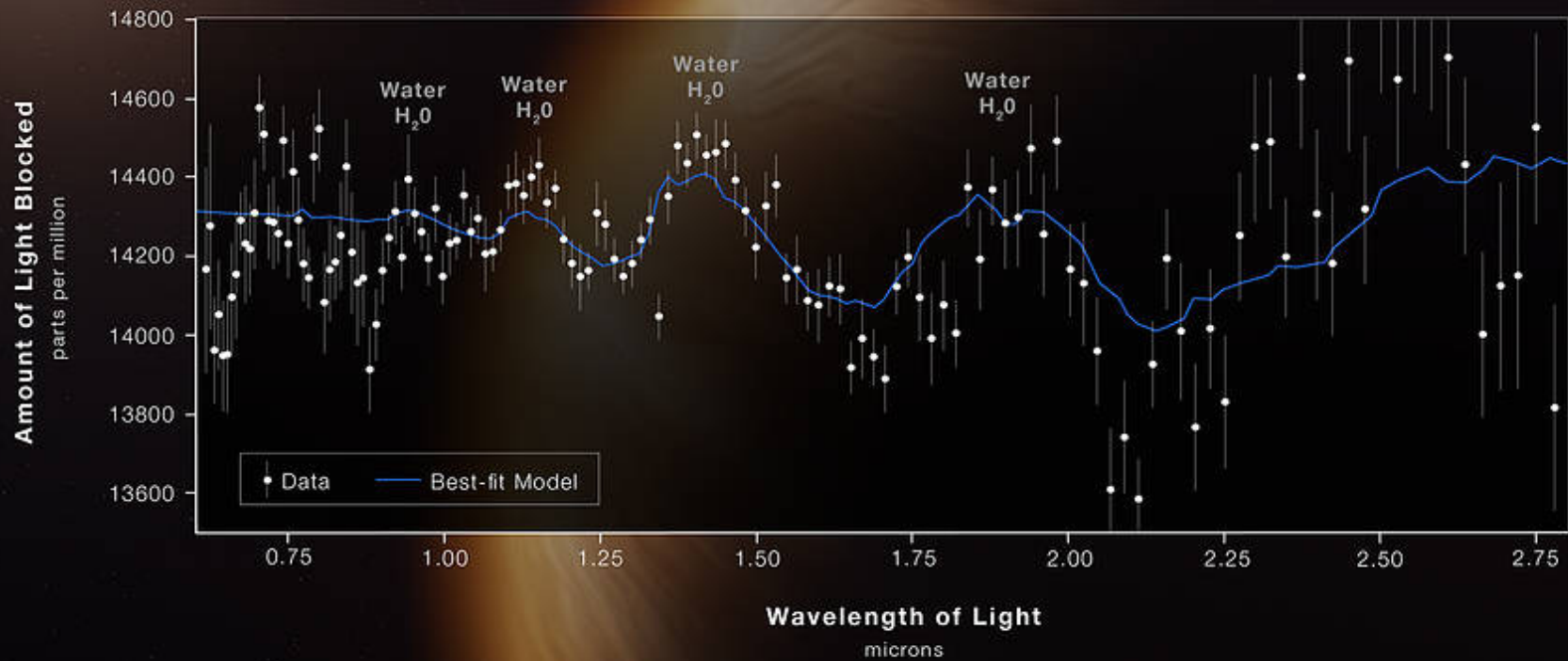




HOT GAS GIANT EXOPLANET WASP-96 b

# ATMOSPHERE COMPOSITION

NIRISS | Single-Object Slitless Spectroscopy

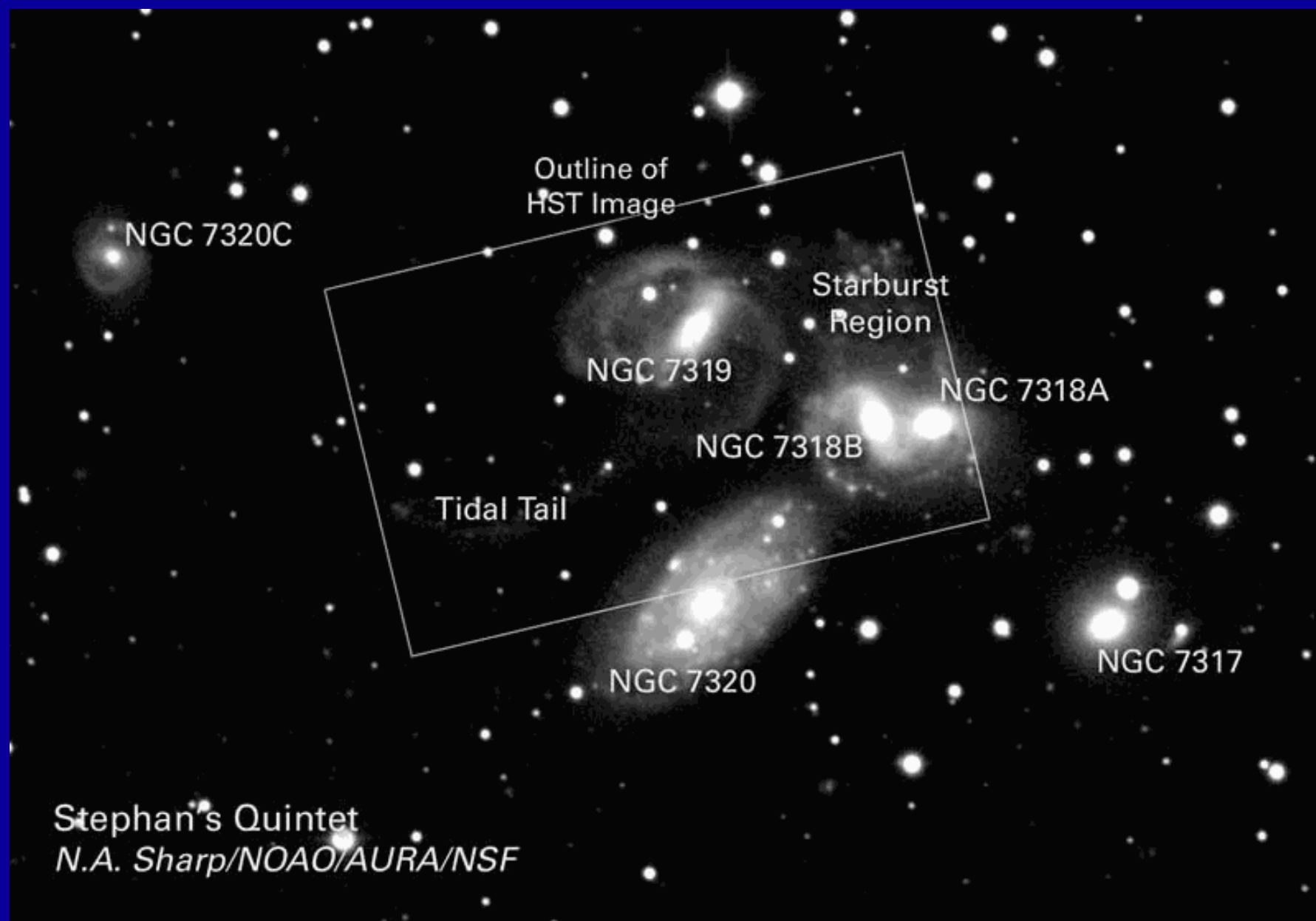


**WEBB**  
SPACE TELESCOPE

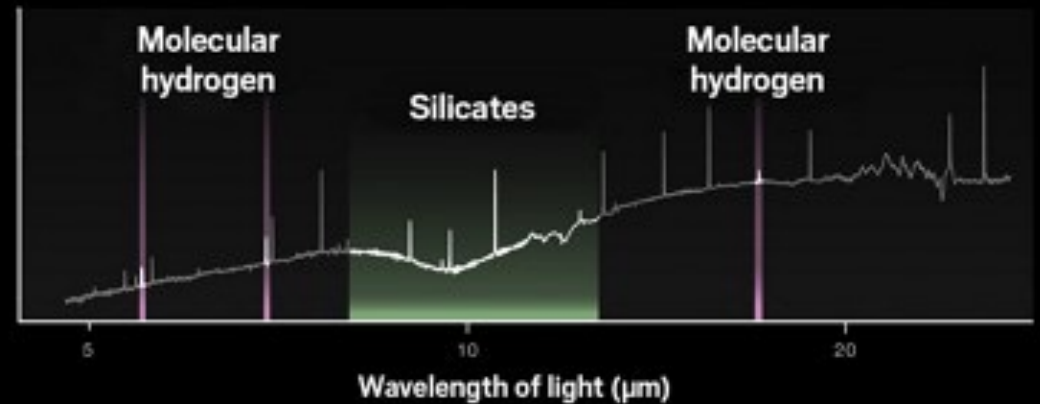
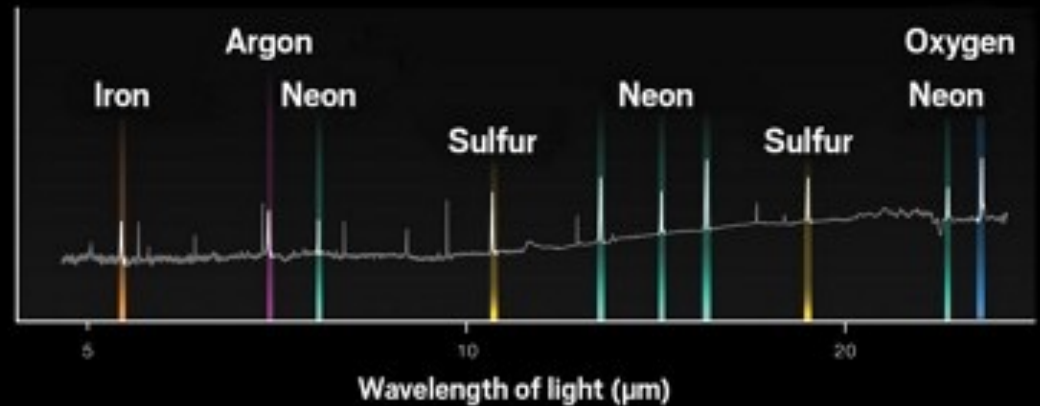
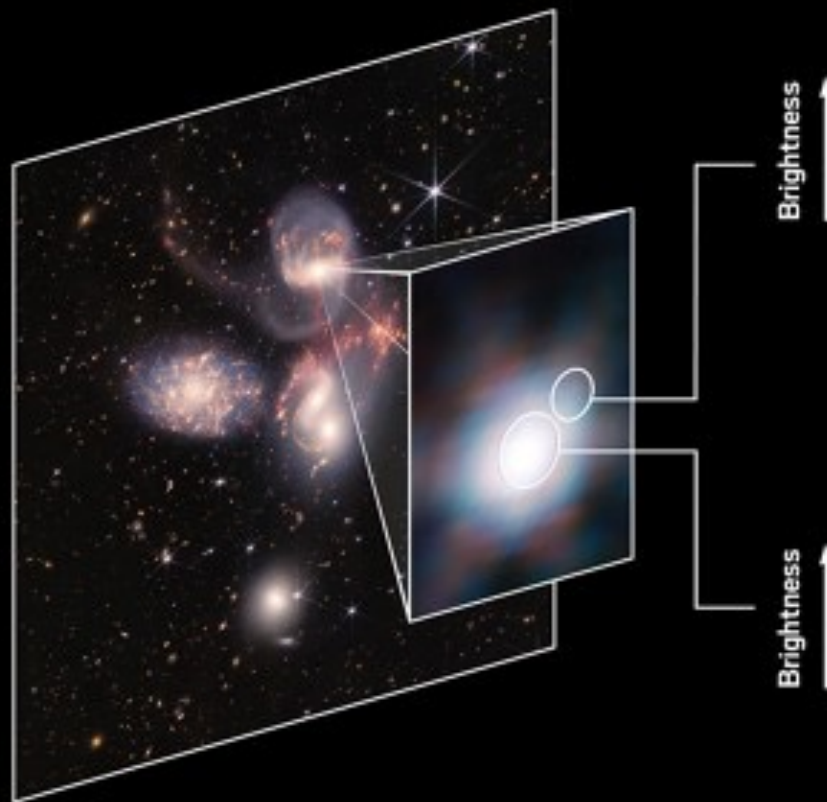
# Four galaxies interacting







# What spectroscopy can do



# Scientific Objectives (stay tuned)

- First generation stars
- See stellar formation in opaque dust clouds, study the stellar life cycle
- See the faintest early galaxies
- Study atmospheres of planets



HST image of Carina nebula  
Star-forming region with impenetrable dust





# JWST: Cosmic Cliffs

7600 light-years away in what's called the Carina Nebula







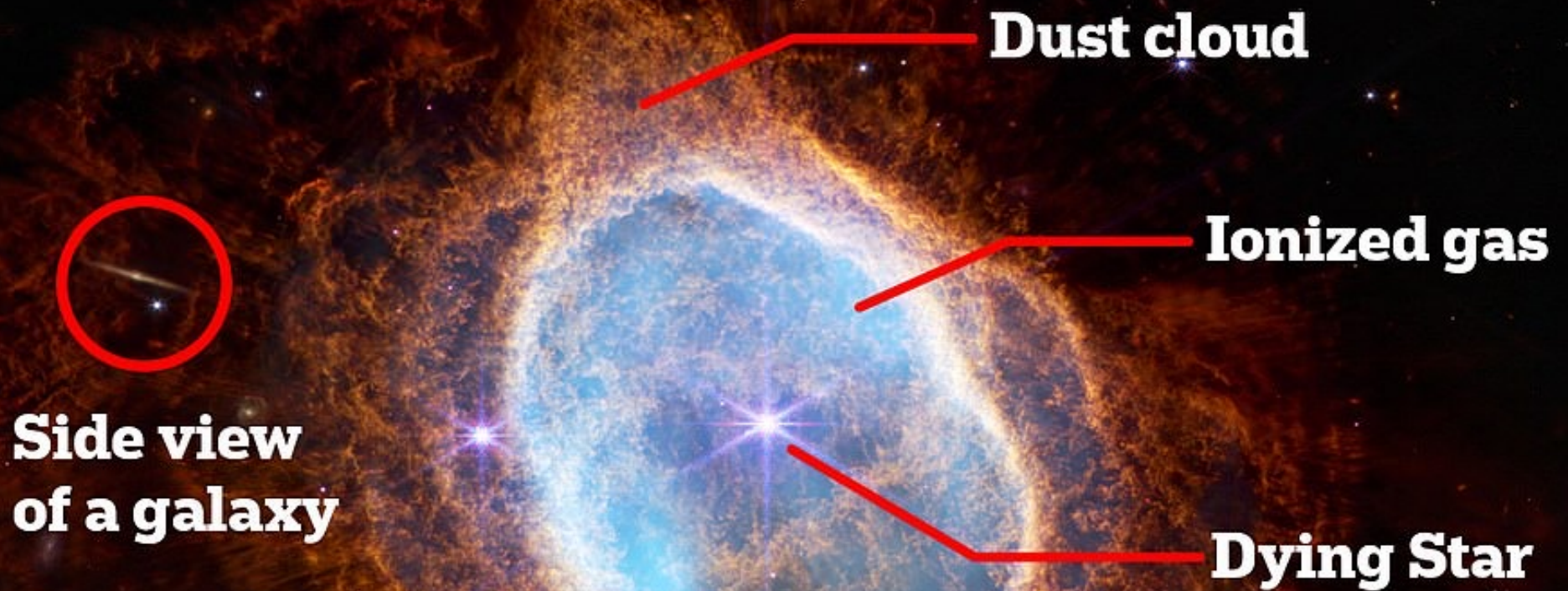
## Images of the cartwheel Galaxy

From HST + X-ray to  
JWST infrared





# SOUTHERN RING NEBULA



# Southern Ring Nebula



HST

JWST

JWST: hydrocarbons forming on dust grains  
Dead star revealed next to known star



# Colliding galaxies stimulate star formation



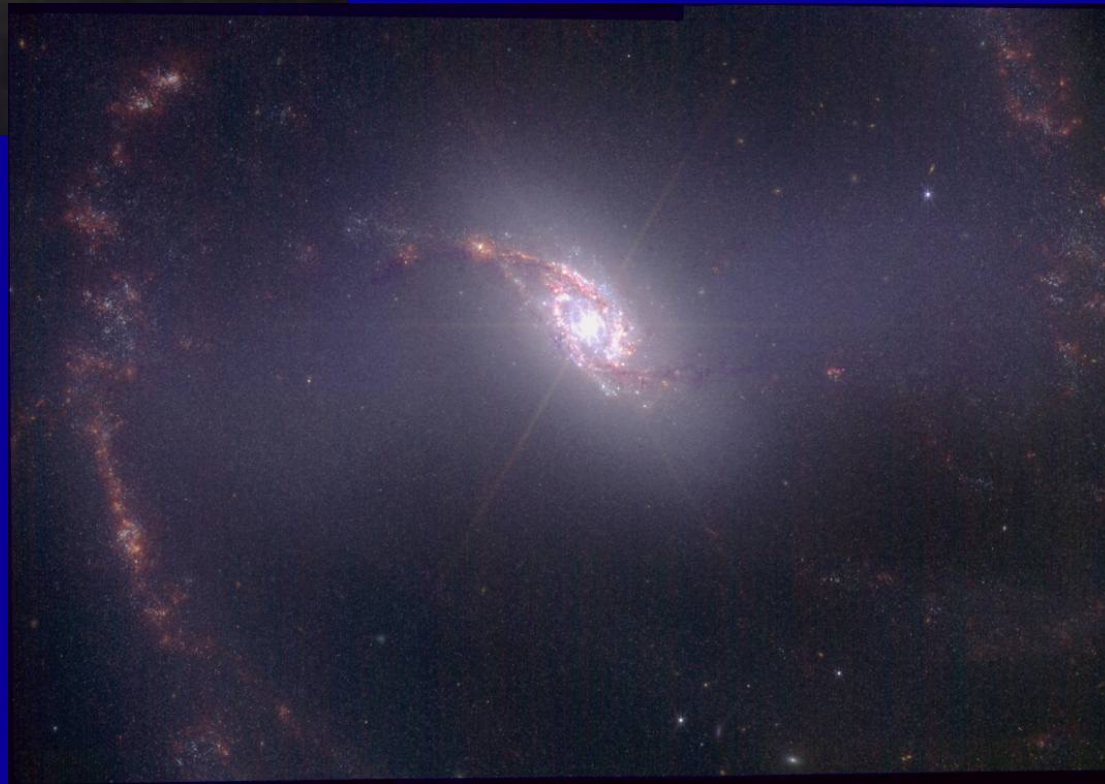


# JWST discoveries

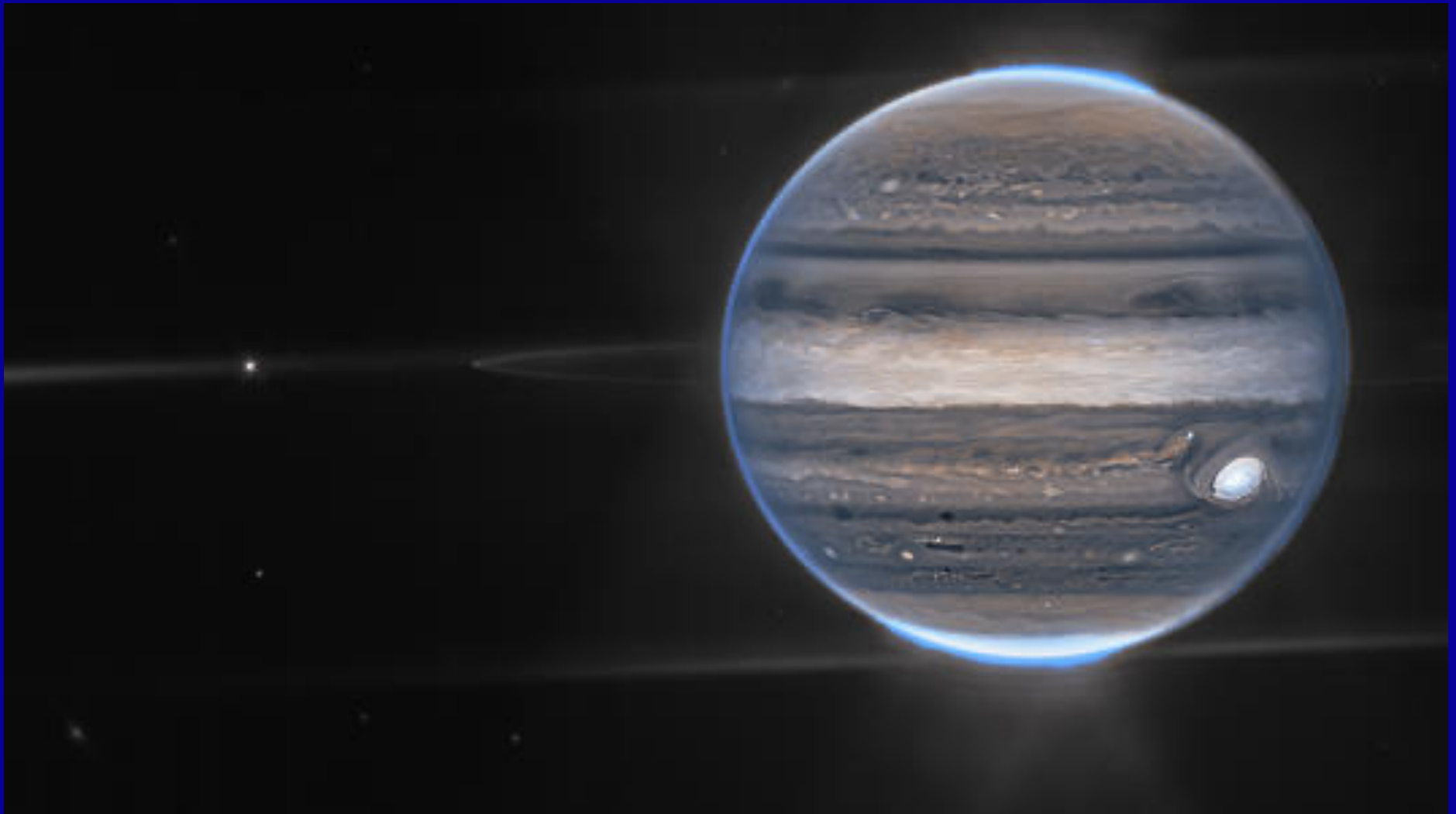


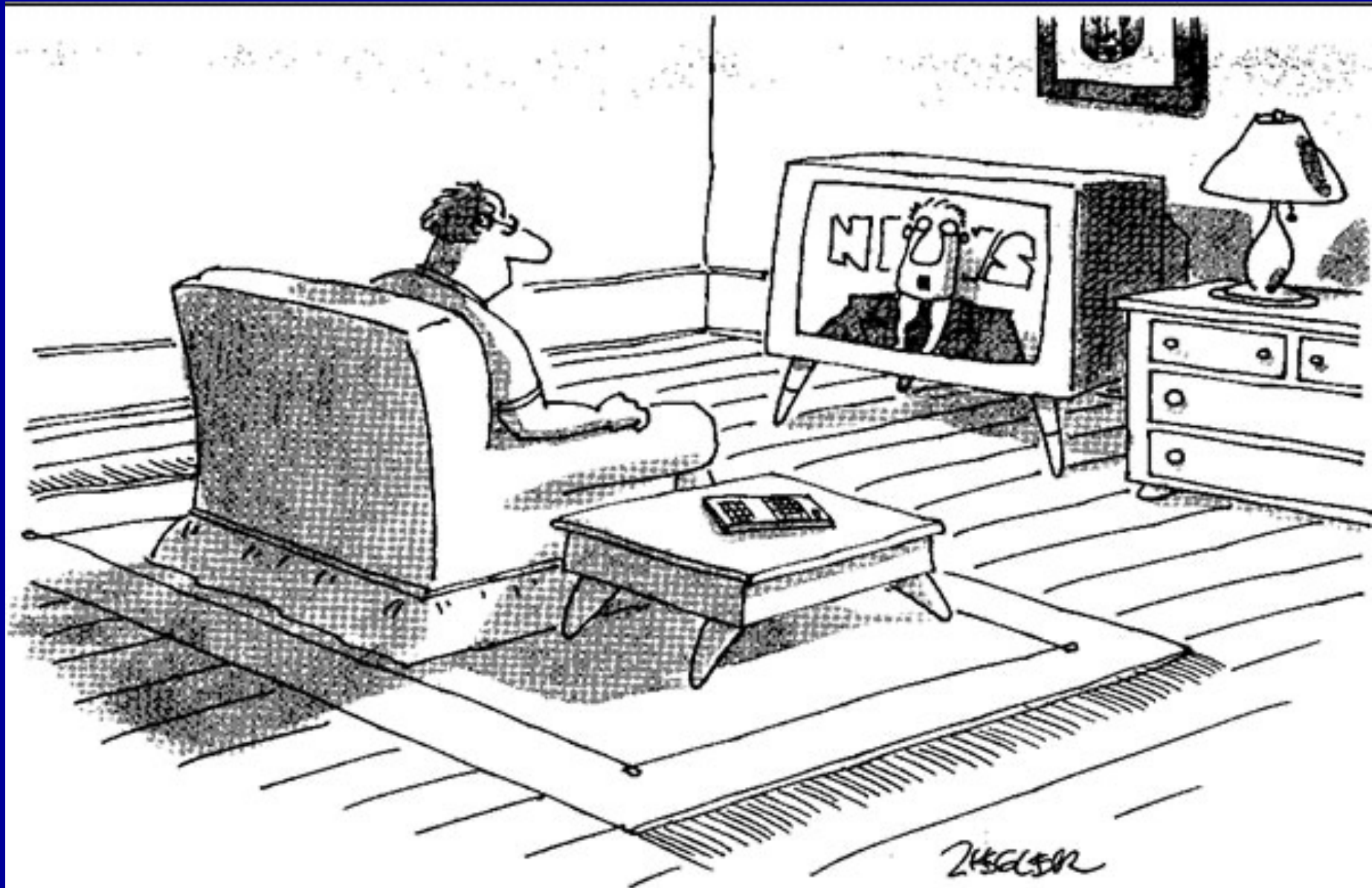
Above, a supernova, an exploding star

Right: a small galaxy orbiting  
around the Milky Way



# Jupiter by JWST





*"Scientists confirmed today that everything we know about the structure of the universe is wrongedy-wrong-wrong."*