

# Live Planetarium Shows

**Today – Sunday 21<sup>st</sup>**

12:30pm, 1:15pm, 2:00pm & 2:45pm

**Tomorrow – Monday 22<sup>nd</sup>**

12:30pm, 1:15pm & 2:00pm



## Measuring the Heavens

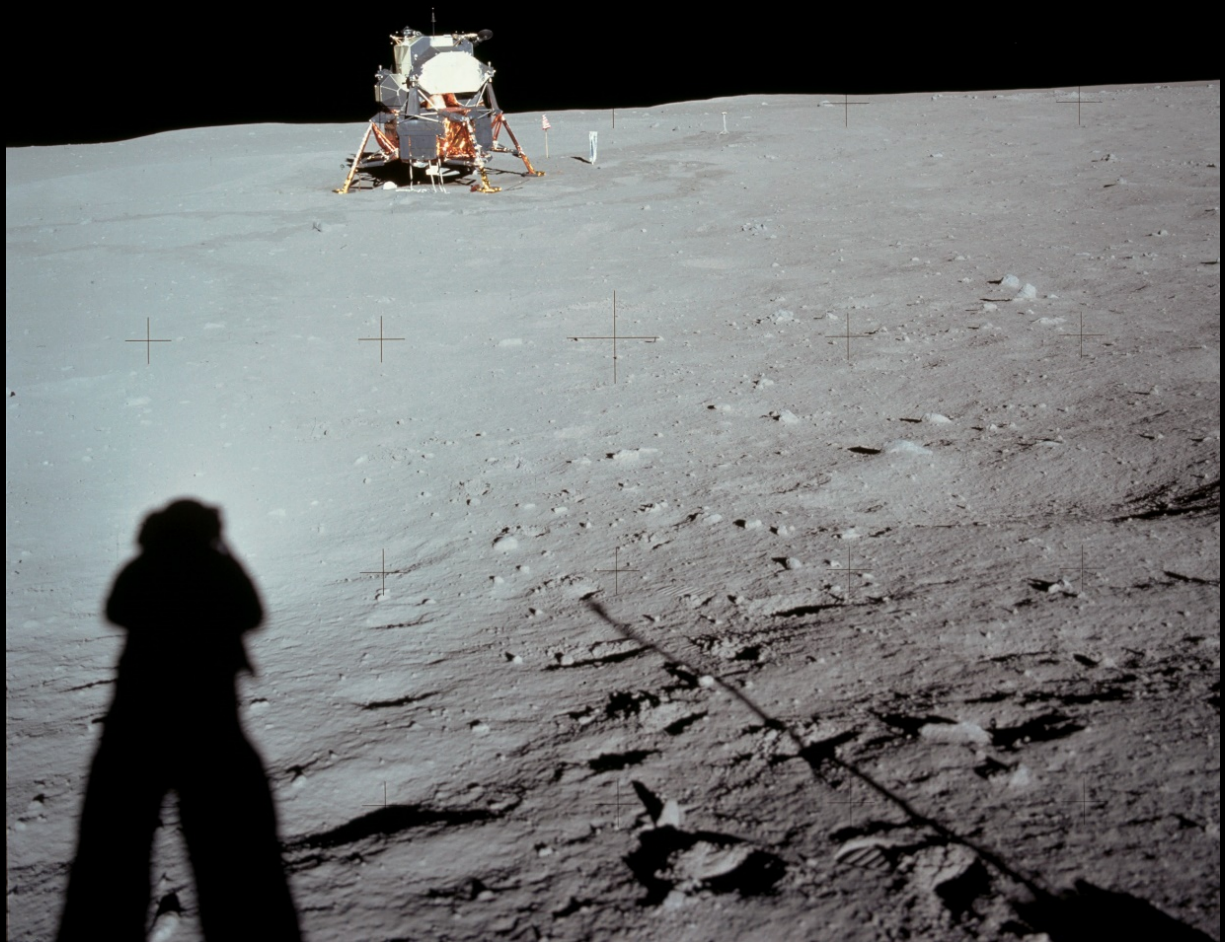
The Tools of Astronomy

Dr. Jonathan Crass











# Measuring the Heavens

## The Tools of Astronomy

Dr. Jonathan Crass



# What tools do we need?

- We need to observe the Universe around us
  - The Solar System
  - The Milky Way
  - Galaxies
  - And beyond
- We need to understand what we see
- We need to predict what is going to happen

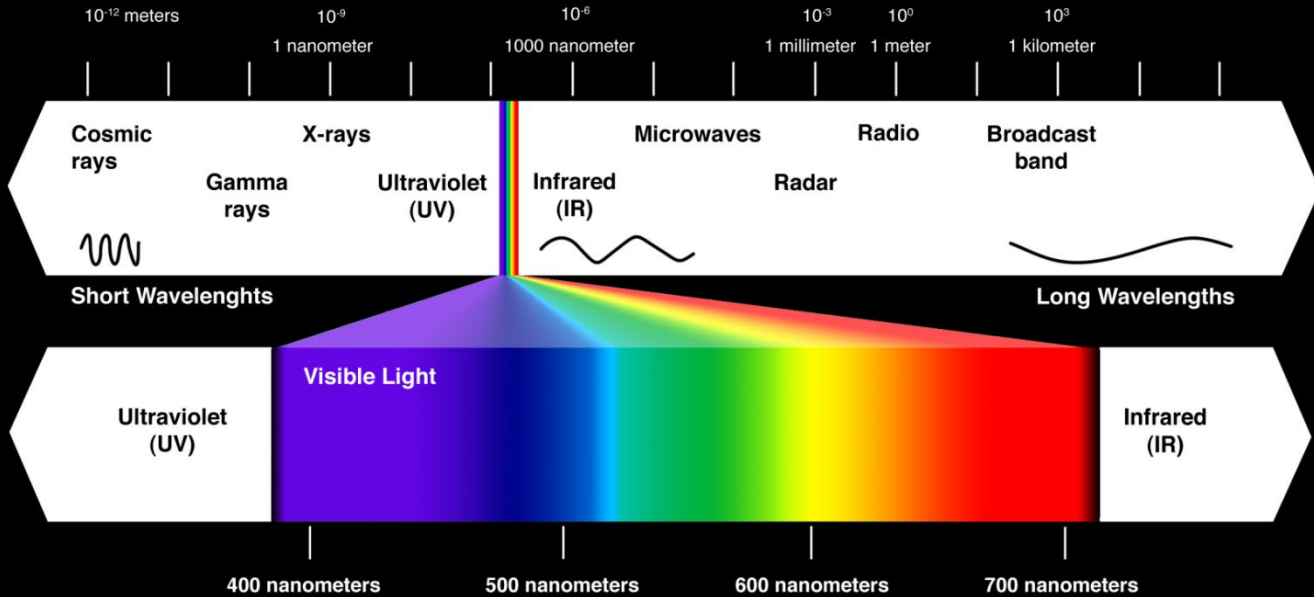
# The Tools of Astronomy

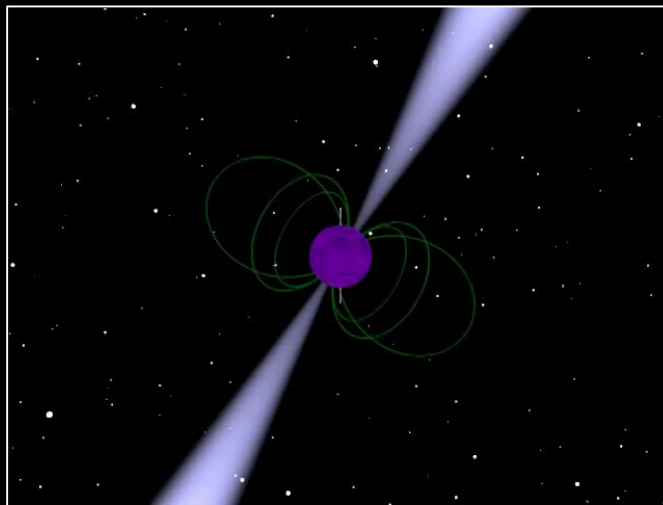
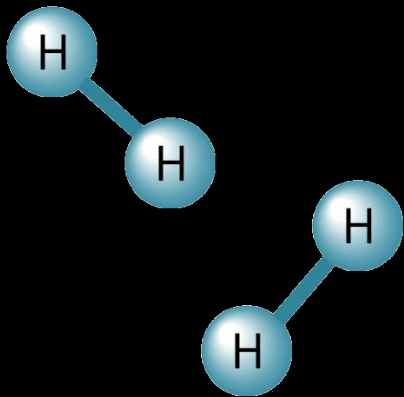
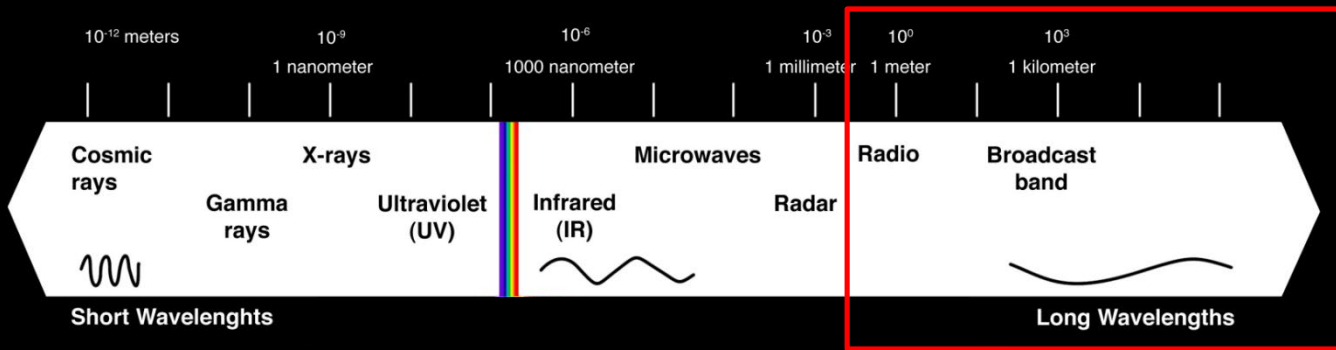
- The Astronomers Toolkit
  - Ground-based telescopes
  - Space telescopes
  - Spacecraft and probes
  - Computing power

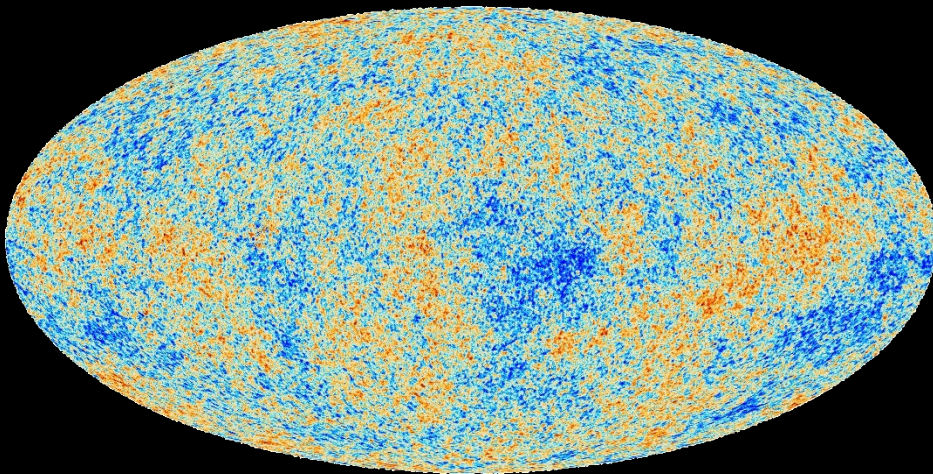
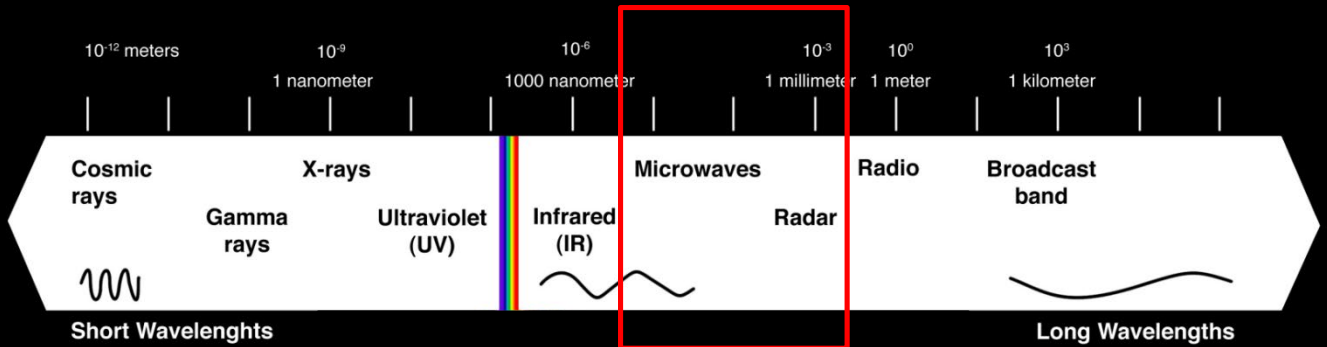
# Observing the Universe

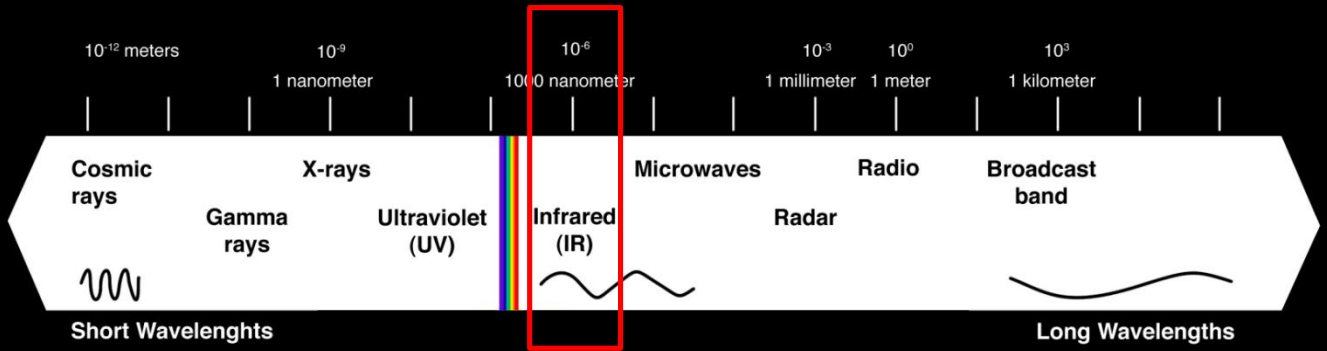


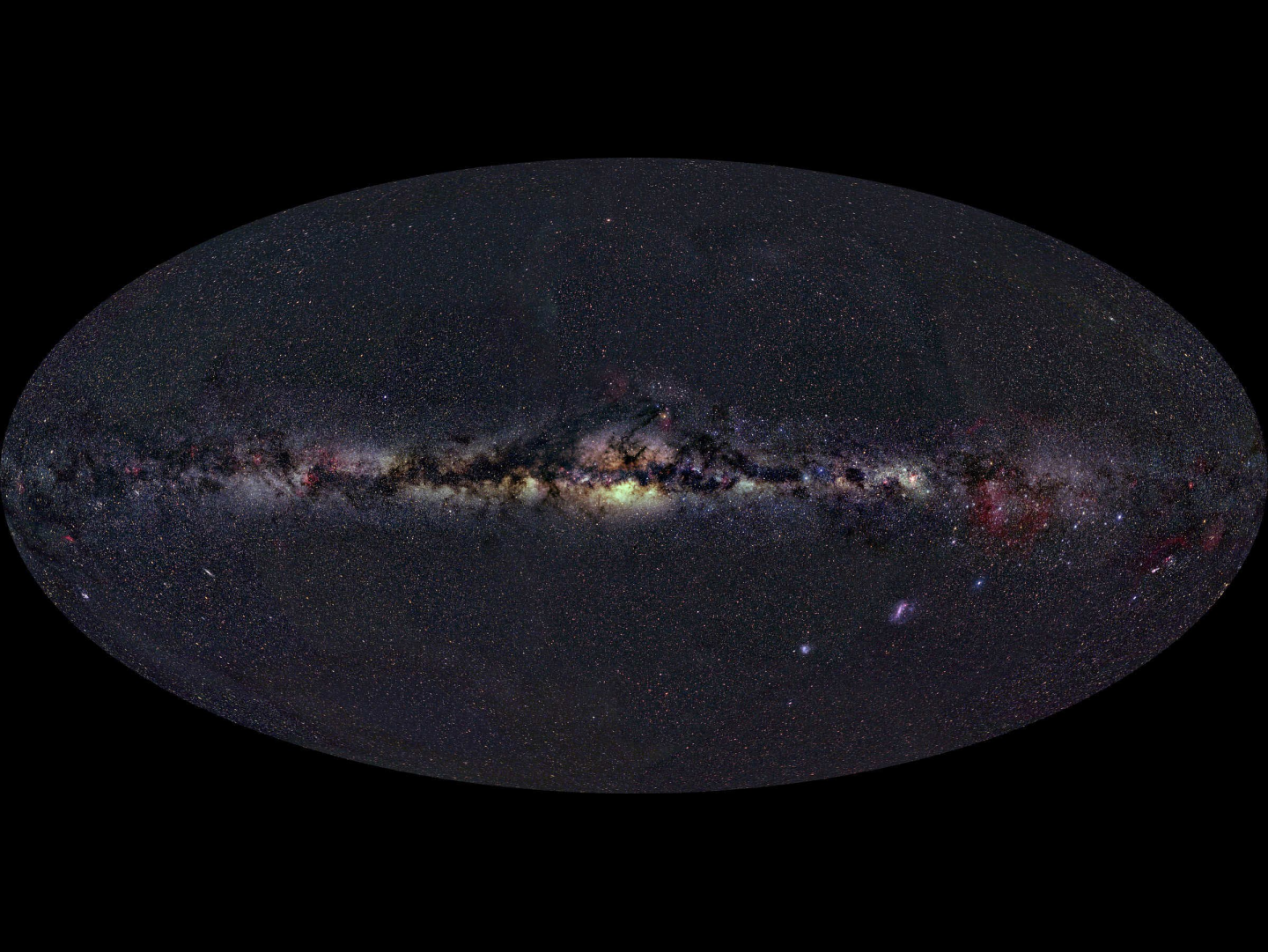


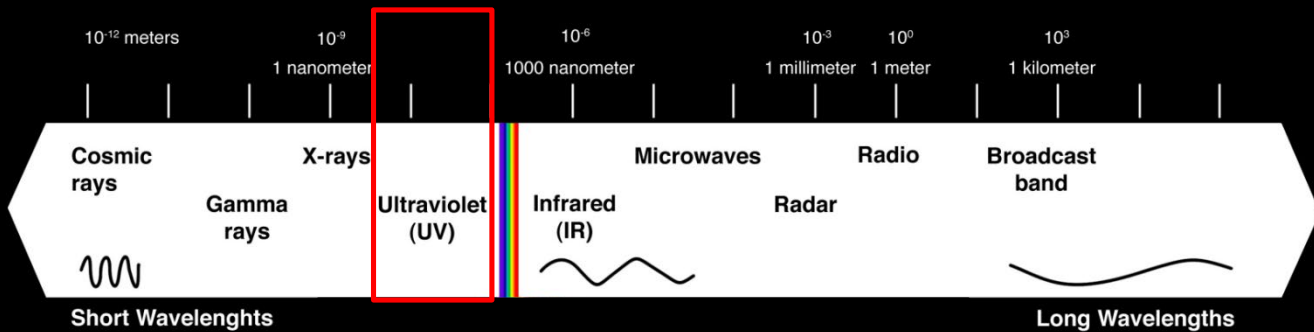






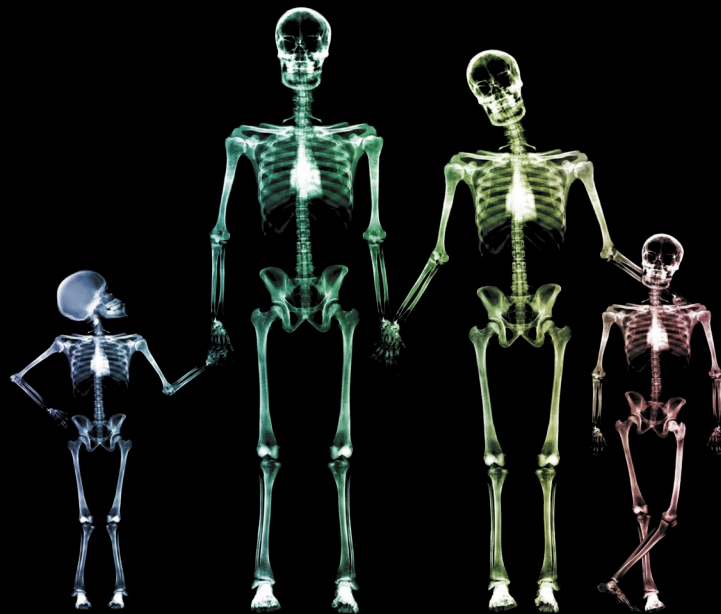
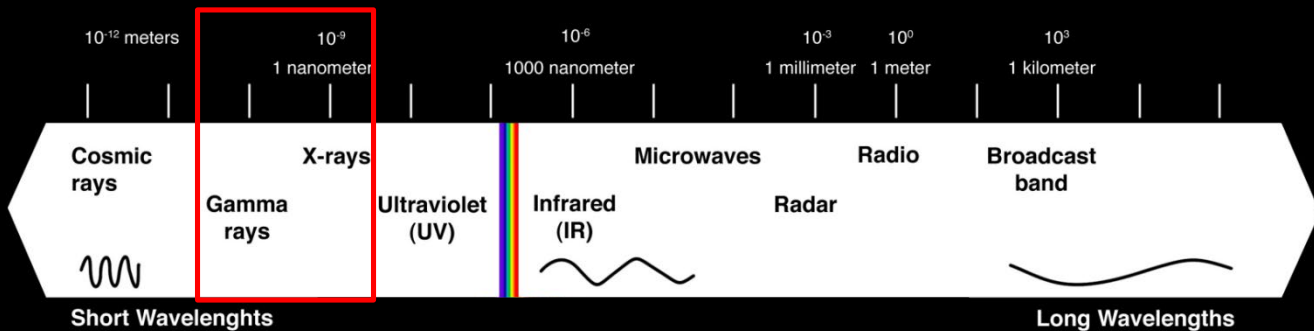


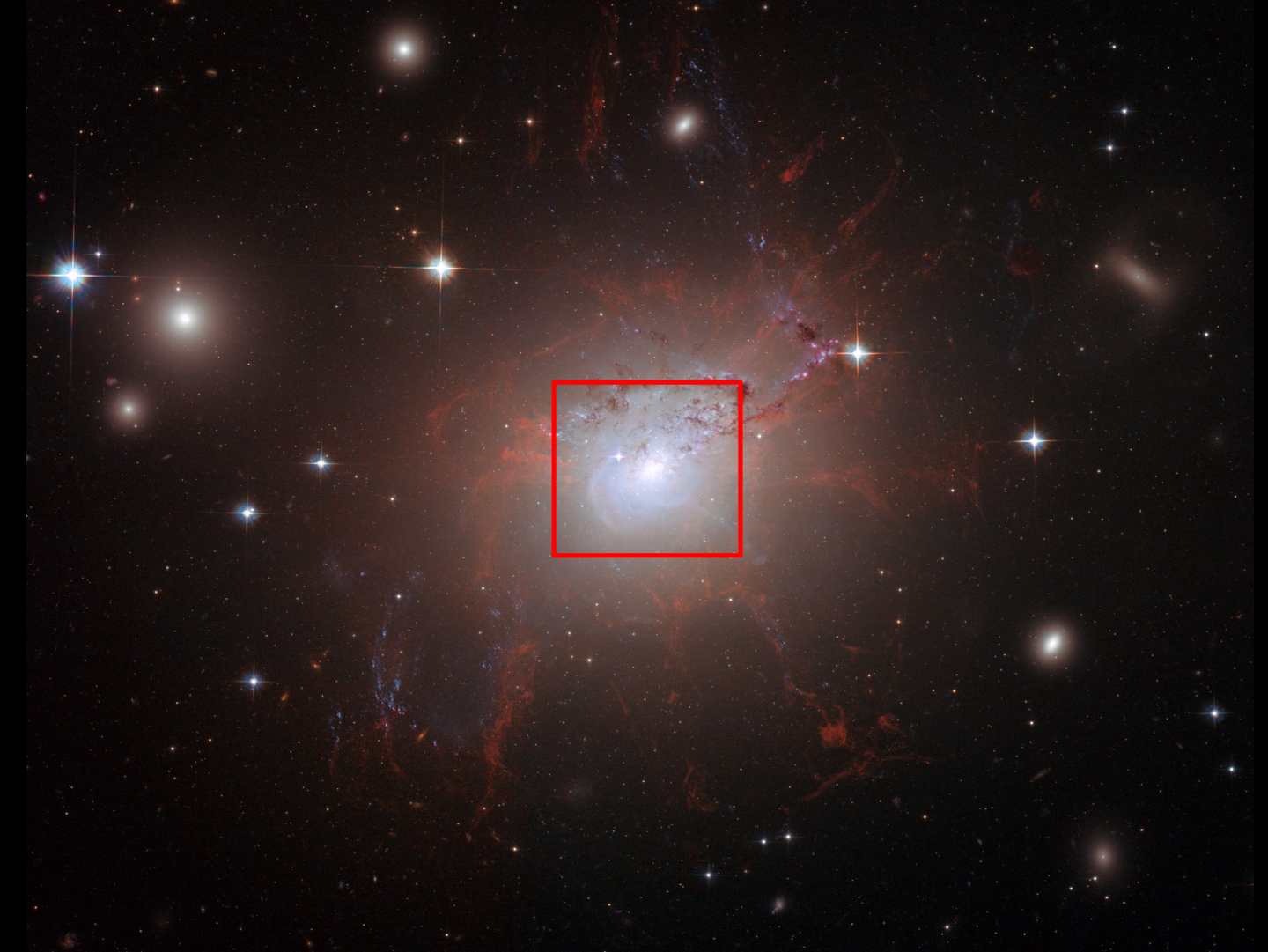










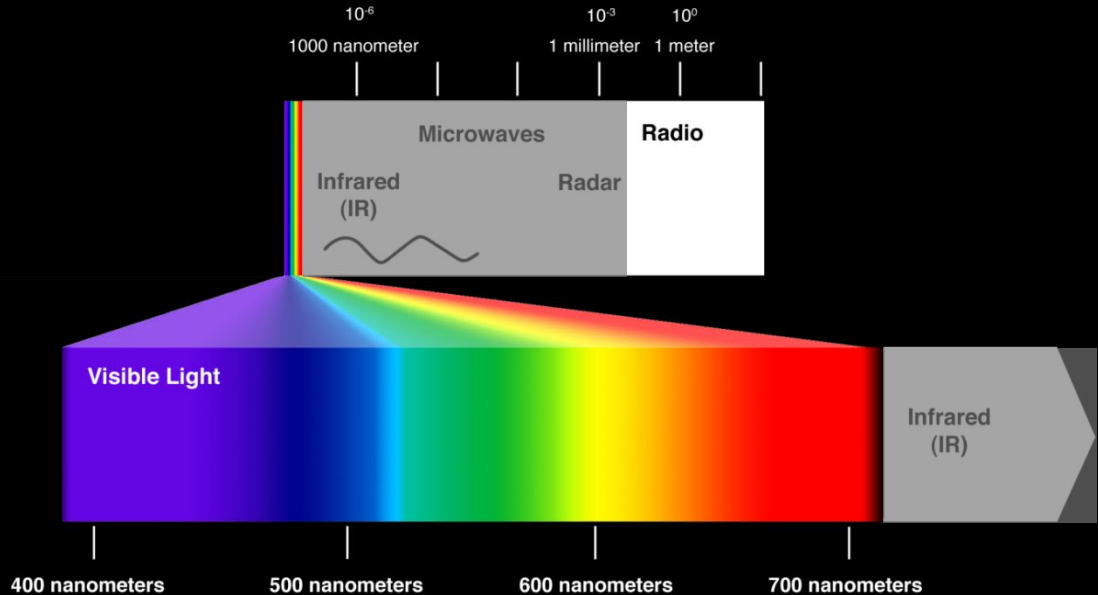


**Ground-based telescopes**

# Ground-based telescopes

1. They're "cheap"
2. They're easier to maintain
3. You can upgrade them
4. You can use different instruments for different types of science

# What can we see on the ground?







Lovell Telescope – 76.2m





# Why are radio telescopes so large?

- Sensitivity



# Why are radio telescopes so large?

- All telescopes are limited in resolution

$$\text{Resolution} = 1.22 \times \frac{\text{Wavelength}}{\text{Telescope Diameter}}$$

- Depends on:
  - Telescope diameter
  - Wavelength



Largest Filled Aperture

Arecibo Radio Telescope – 305m



Largest Filled Aperture

Five hundred meter Aperture Spherical Telescope – 500m



Largest Fully Steerable

Green Bank Telescope – 100x110m

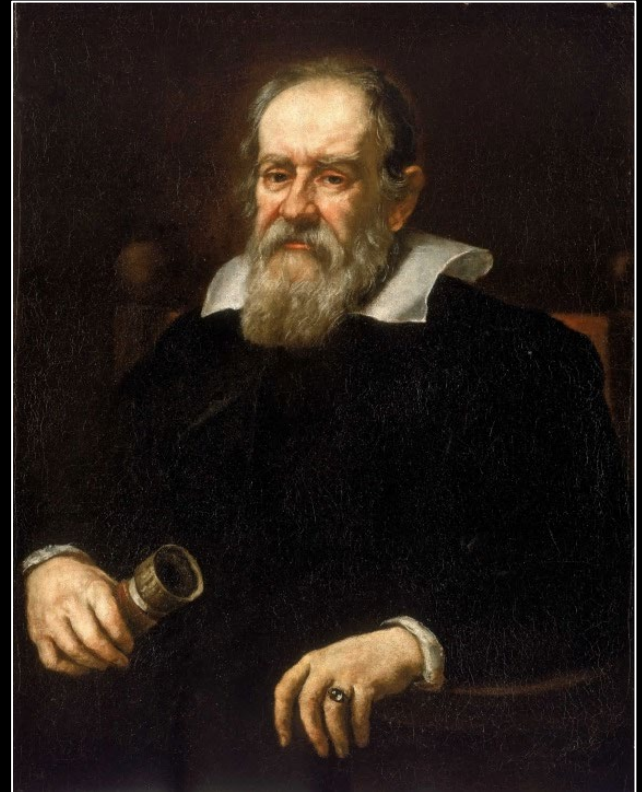


Largest Overall

RATAN-600 – 576m

# Optical Telescopes

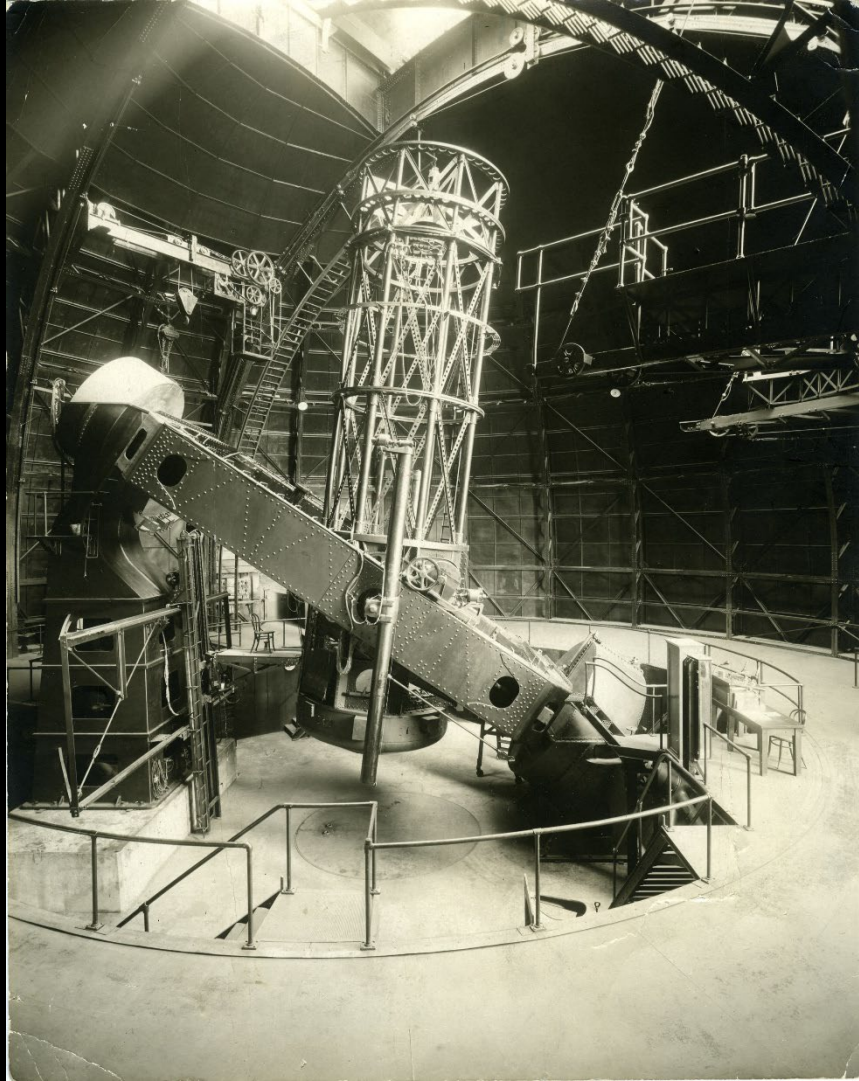
- Galileo – 1609



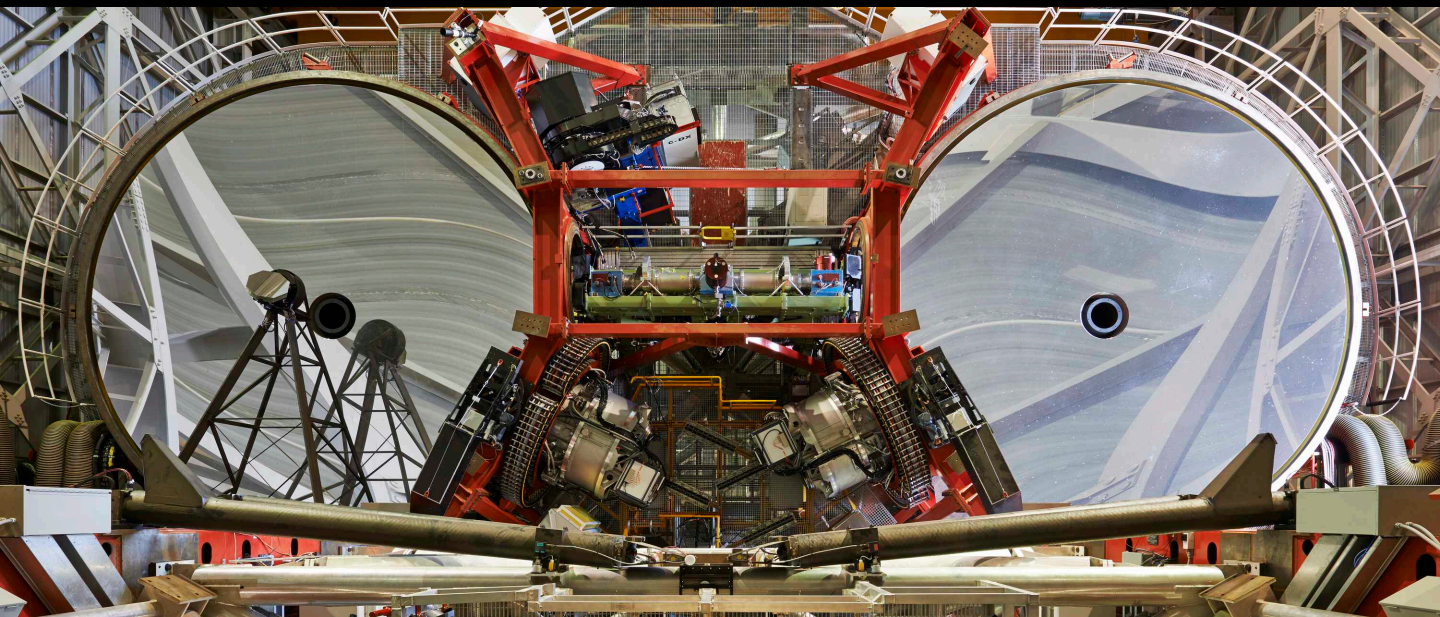


Northumberland Telescope,  
University of Cambridge, 11.6in





Hale Telescope,  
CA, USA – 60in

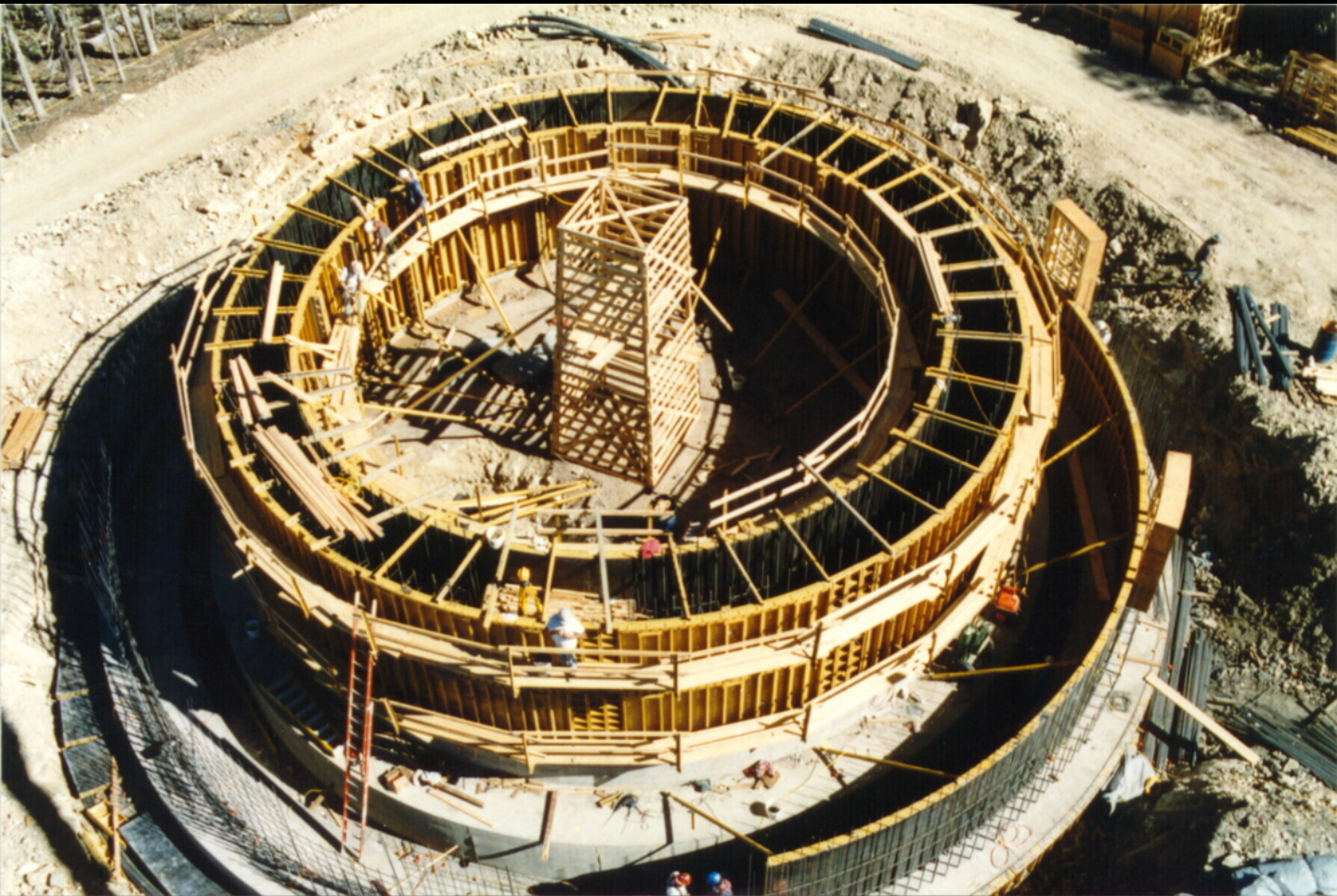


Large Binocular Telescope, AZ, USA – 2 × 8.4m

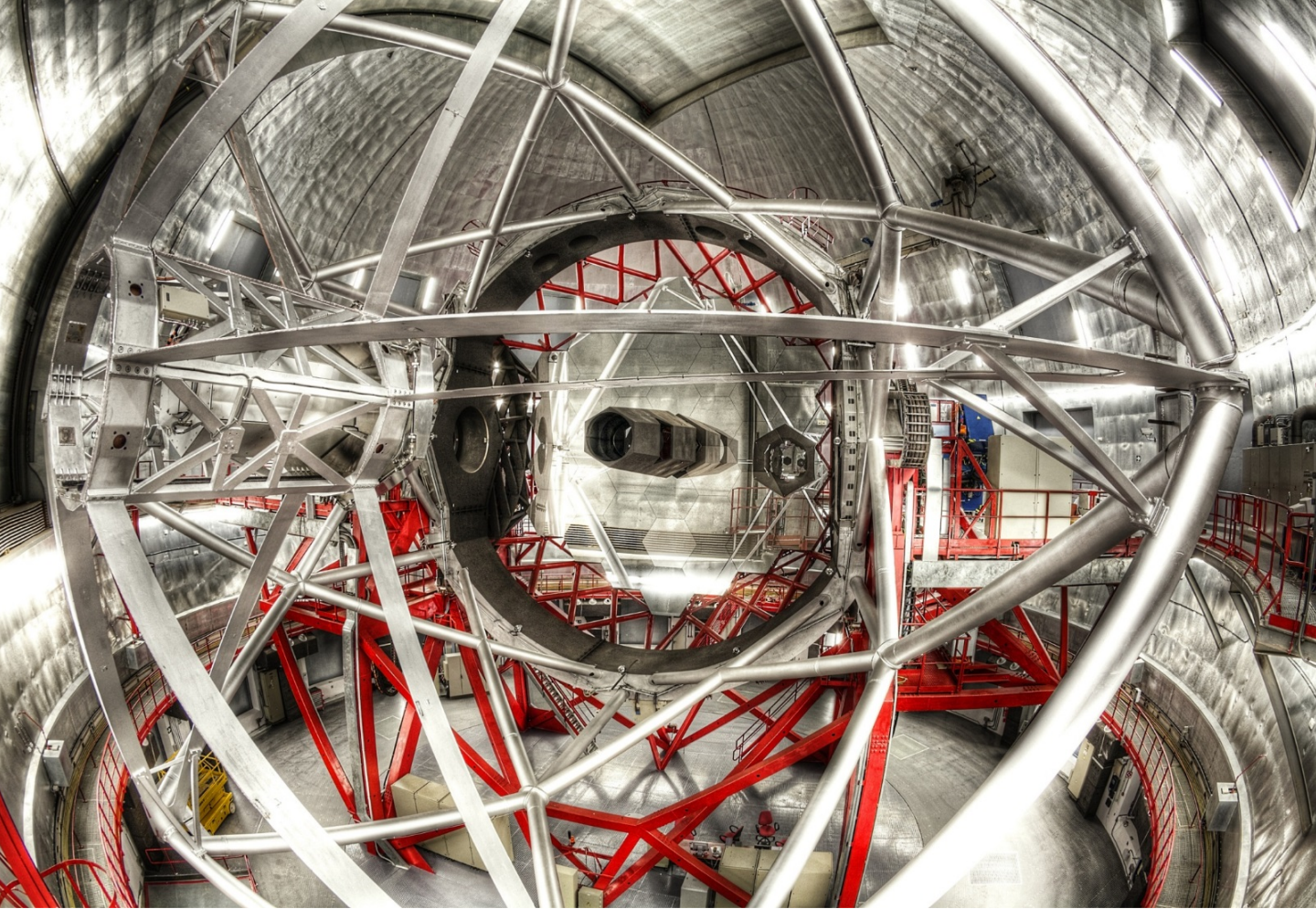


Large Binocular Telescope, AZ, USA – 2 × 8.4m





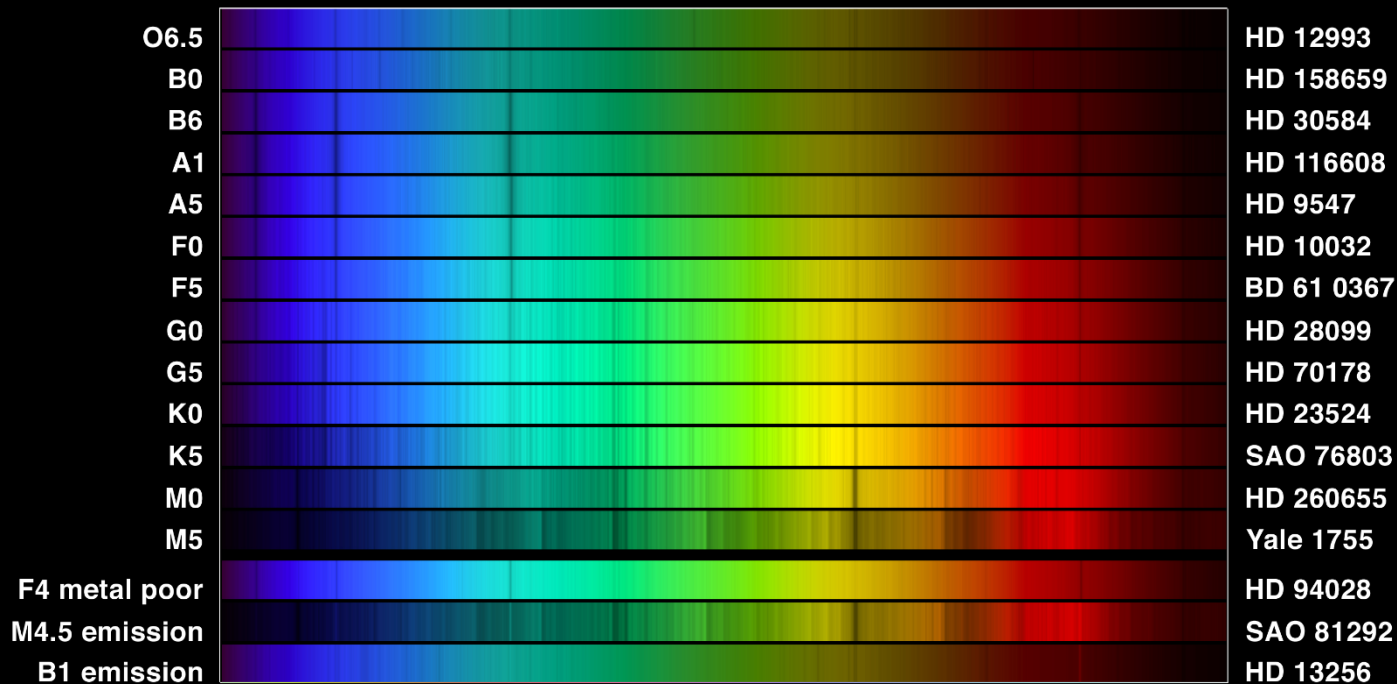




Gran Telescopio Canarias – 10.4m



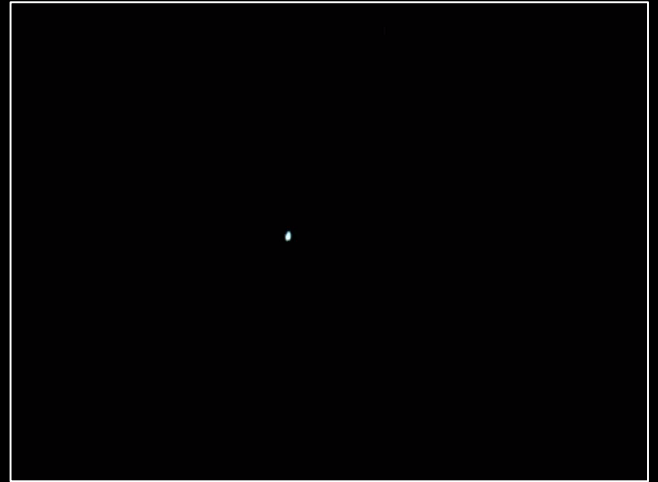




# The problem with big telescopes

- We have an atmosphere...
- There's a finite size single telescope we can build

# Atmospheric Turbulence



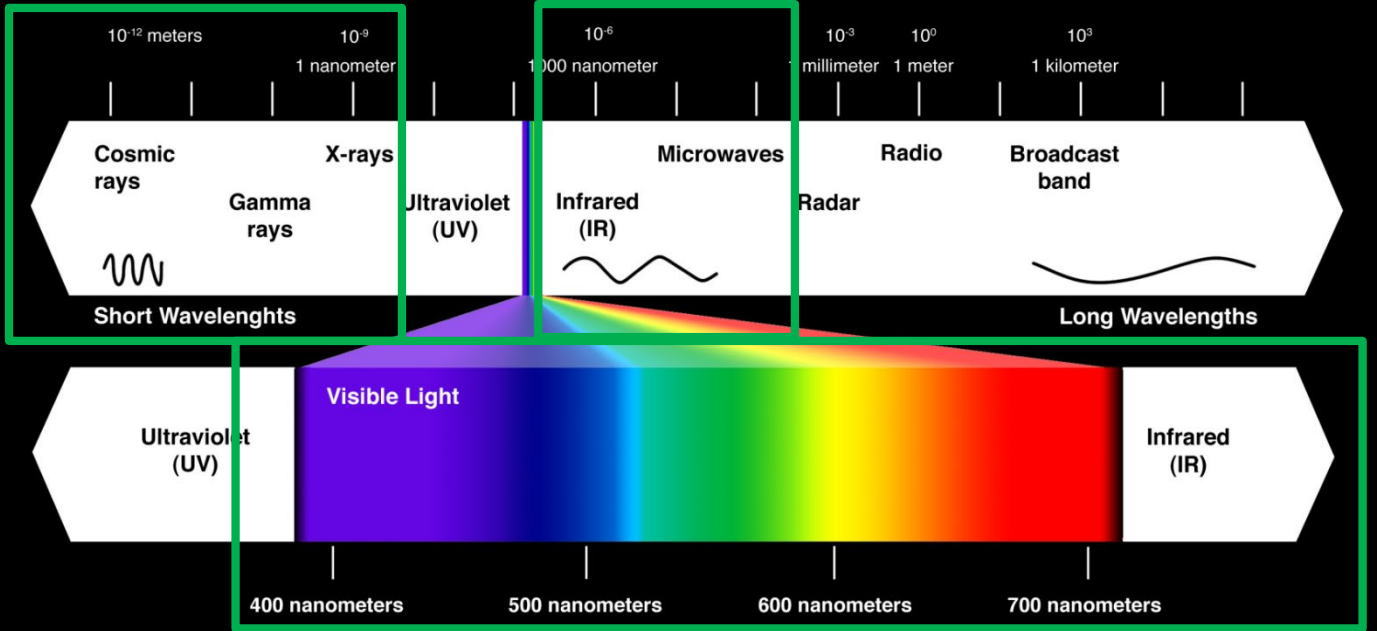
# Correcting for the atmosphere

- The simple option:
  - Go to space!
- Correct for the effects on the ground

\$ £ €



# Space Telescopes



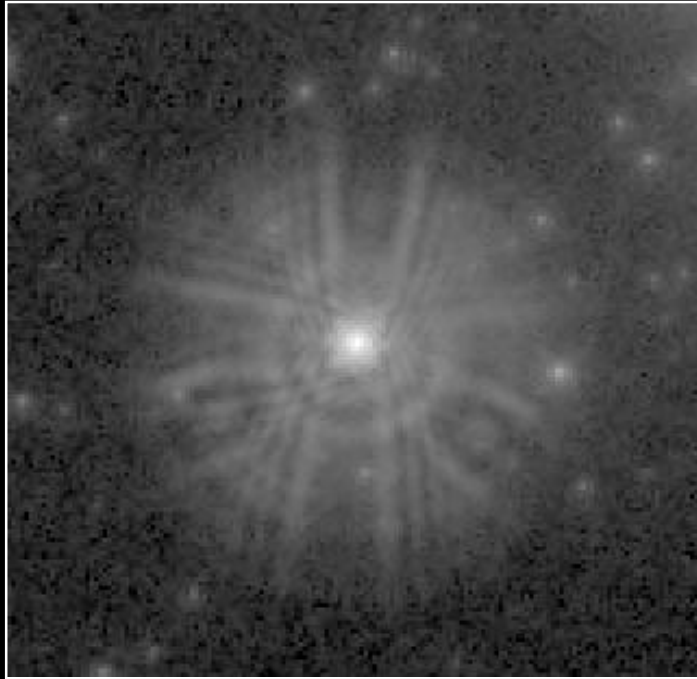




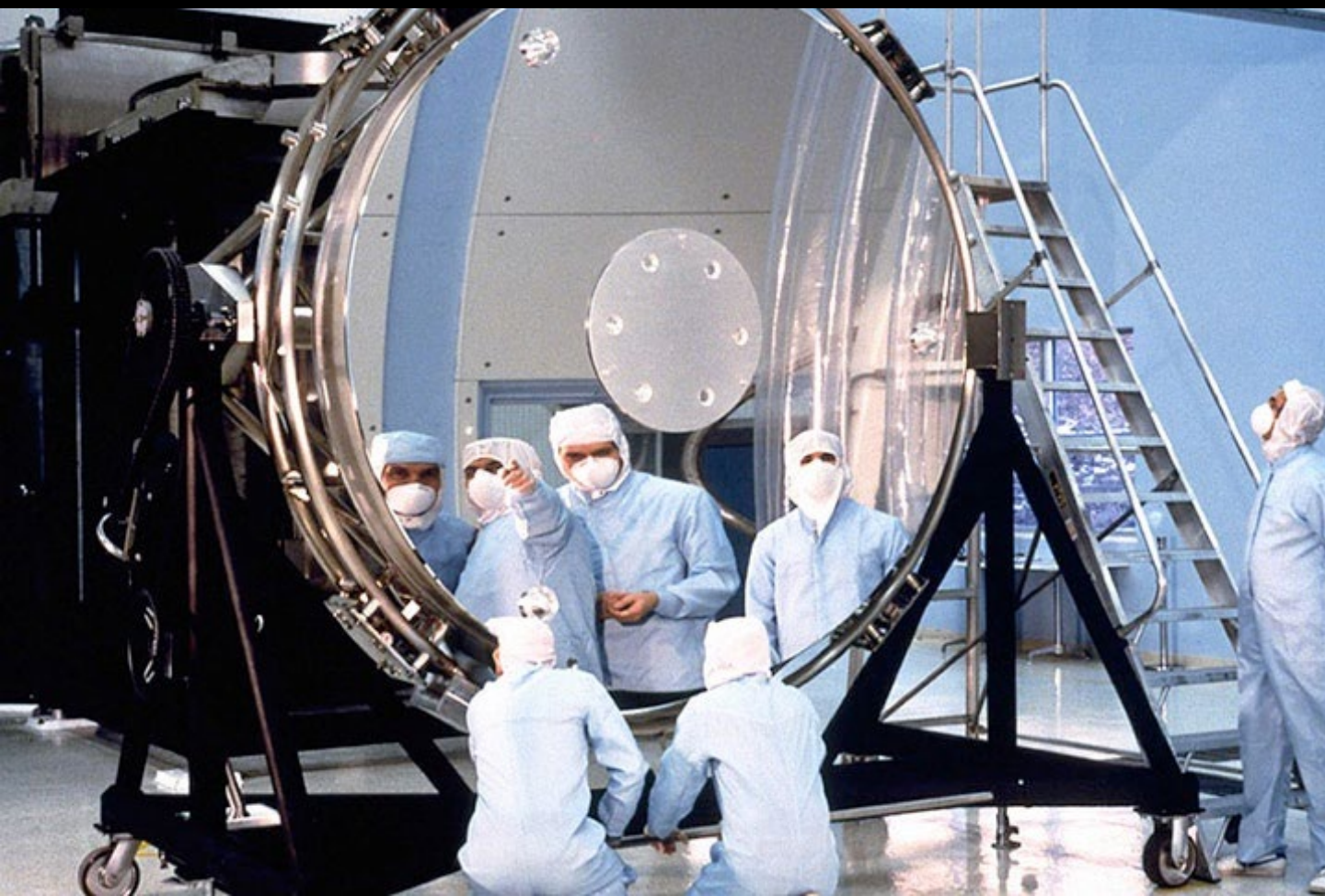


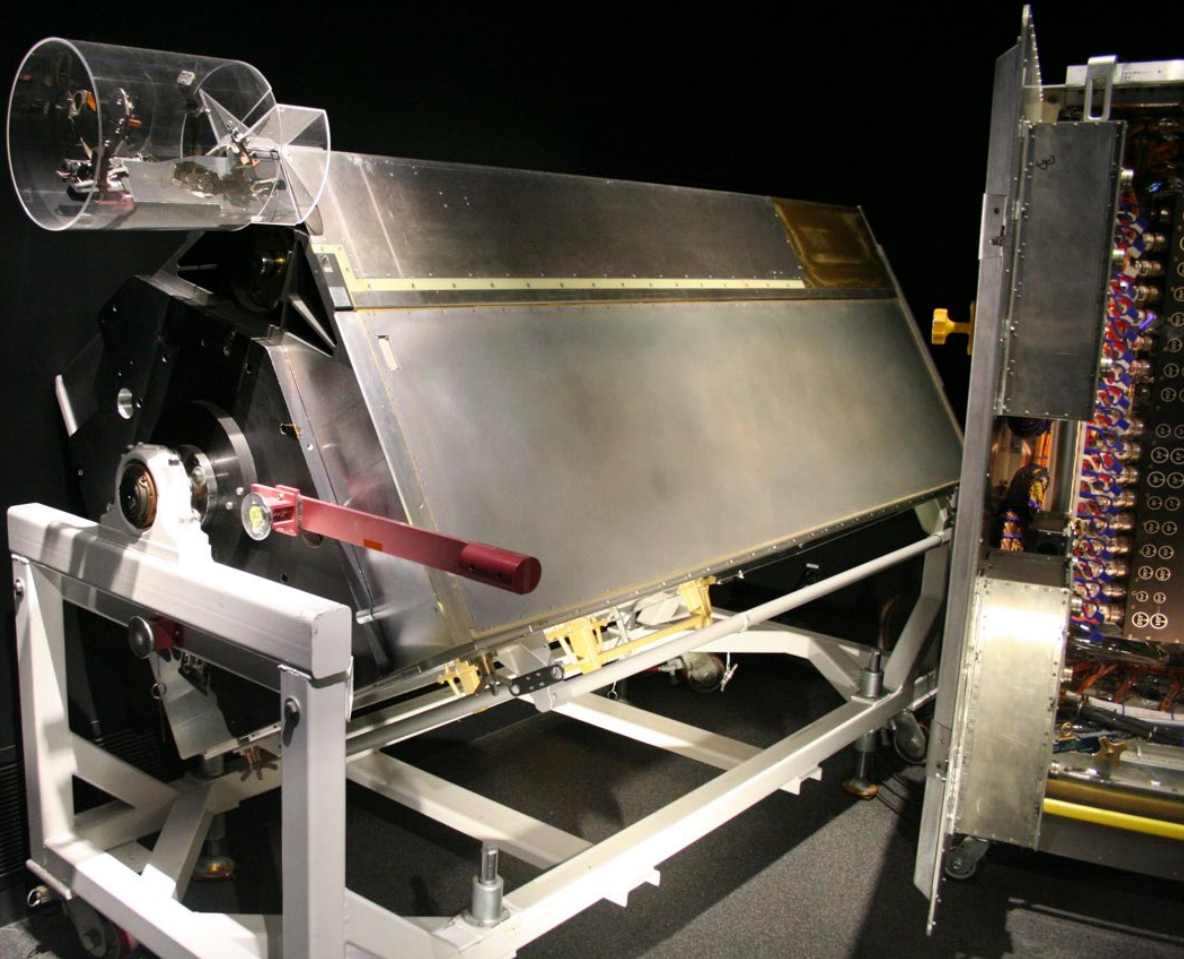






**PIX NIXED AS HUBBLE SEES DOUBLE**









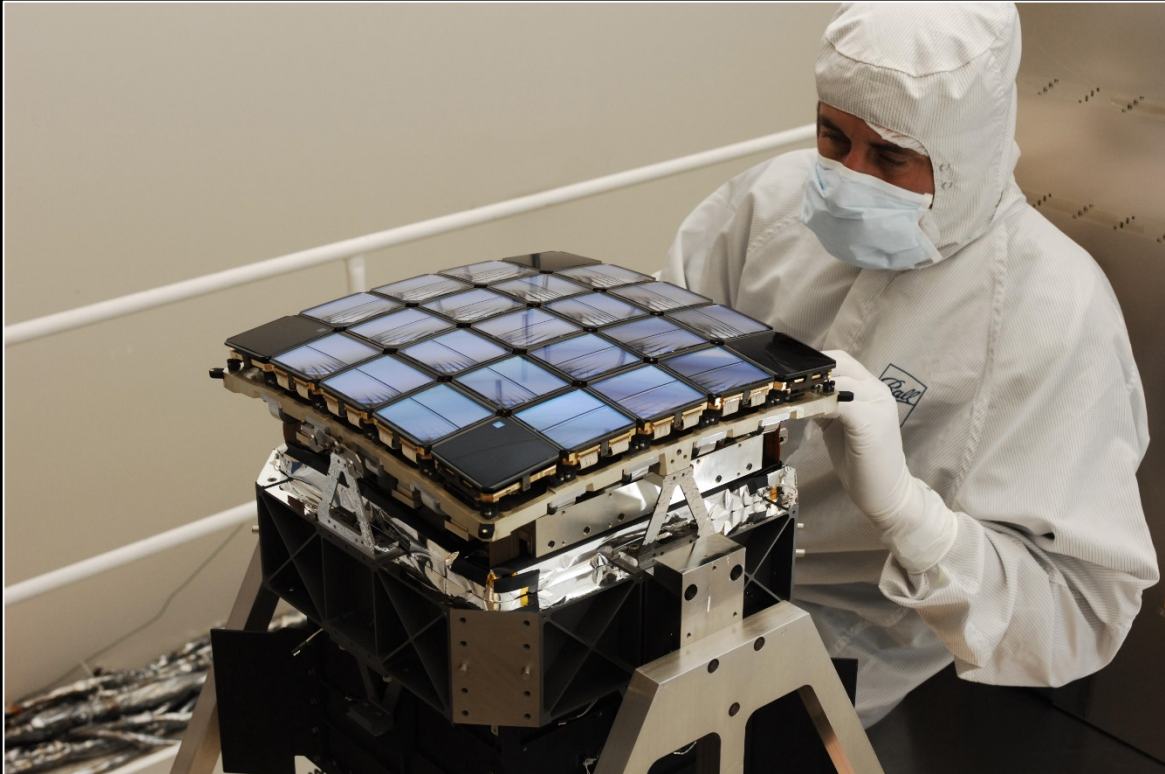


# **Astronomy Images**

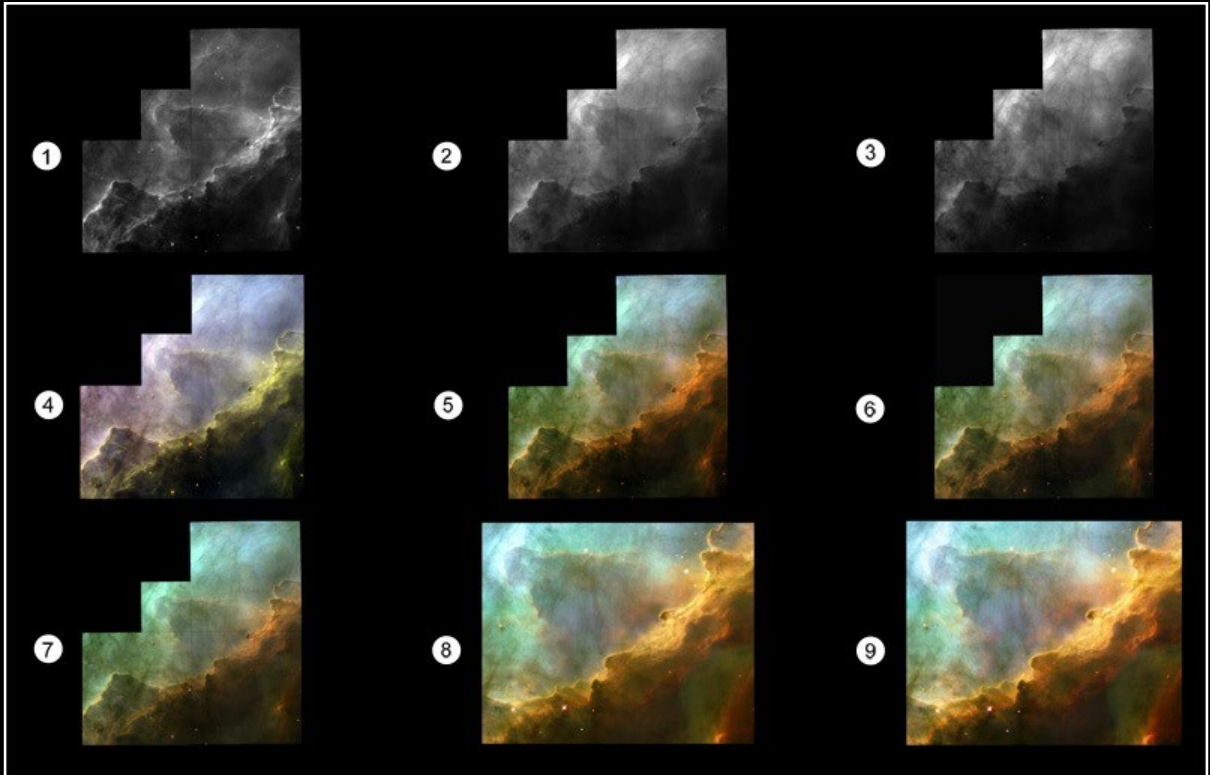
# What astronomy images mean?

- We've all seen the fantastic astronomy images, but what do they mean?

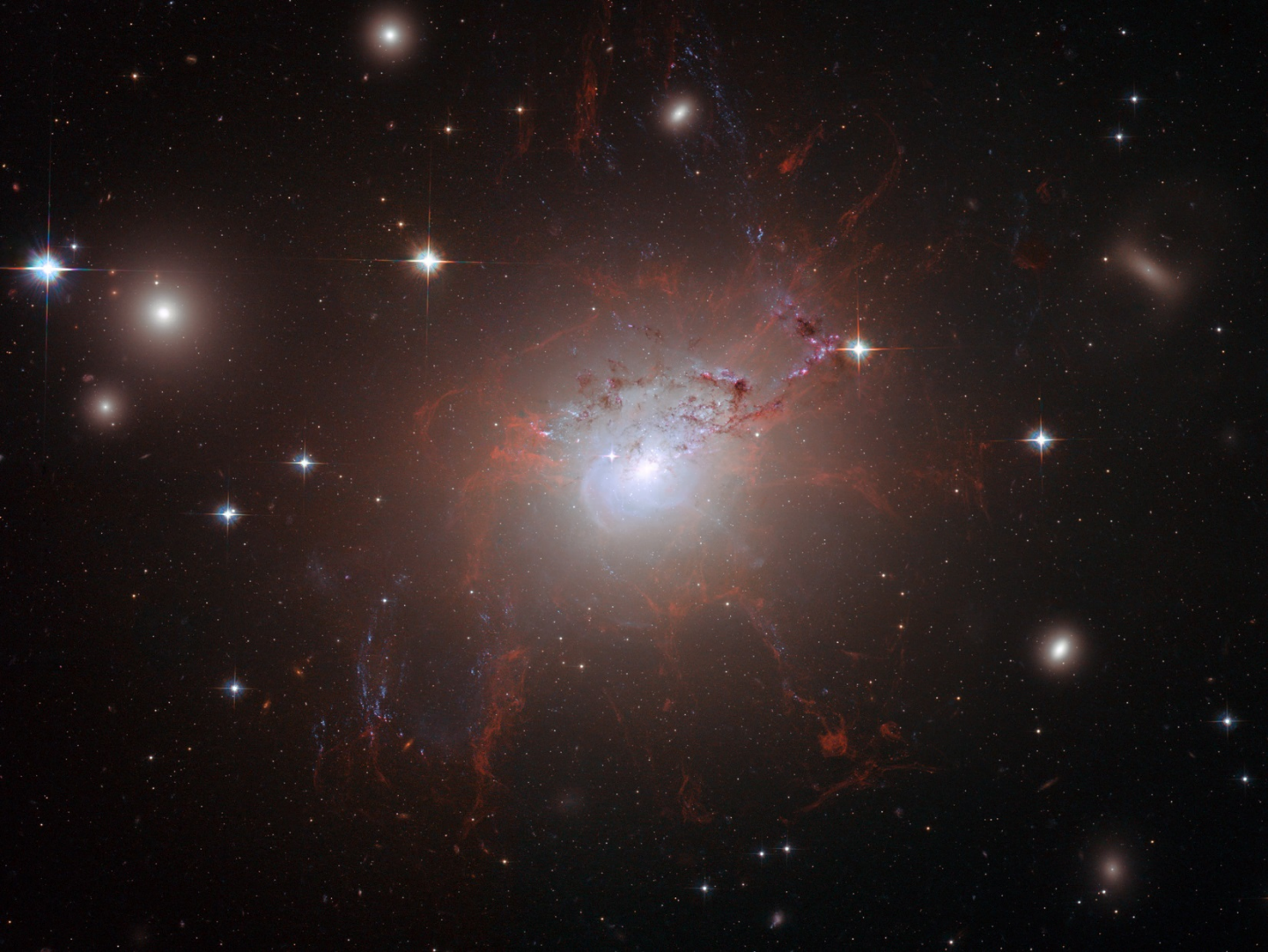
# Astronomy Detectors

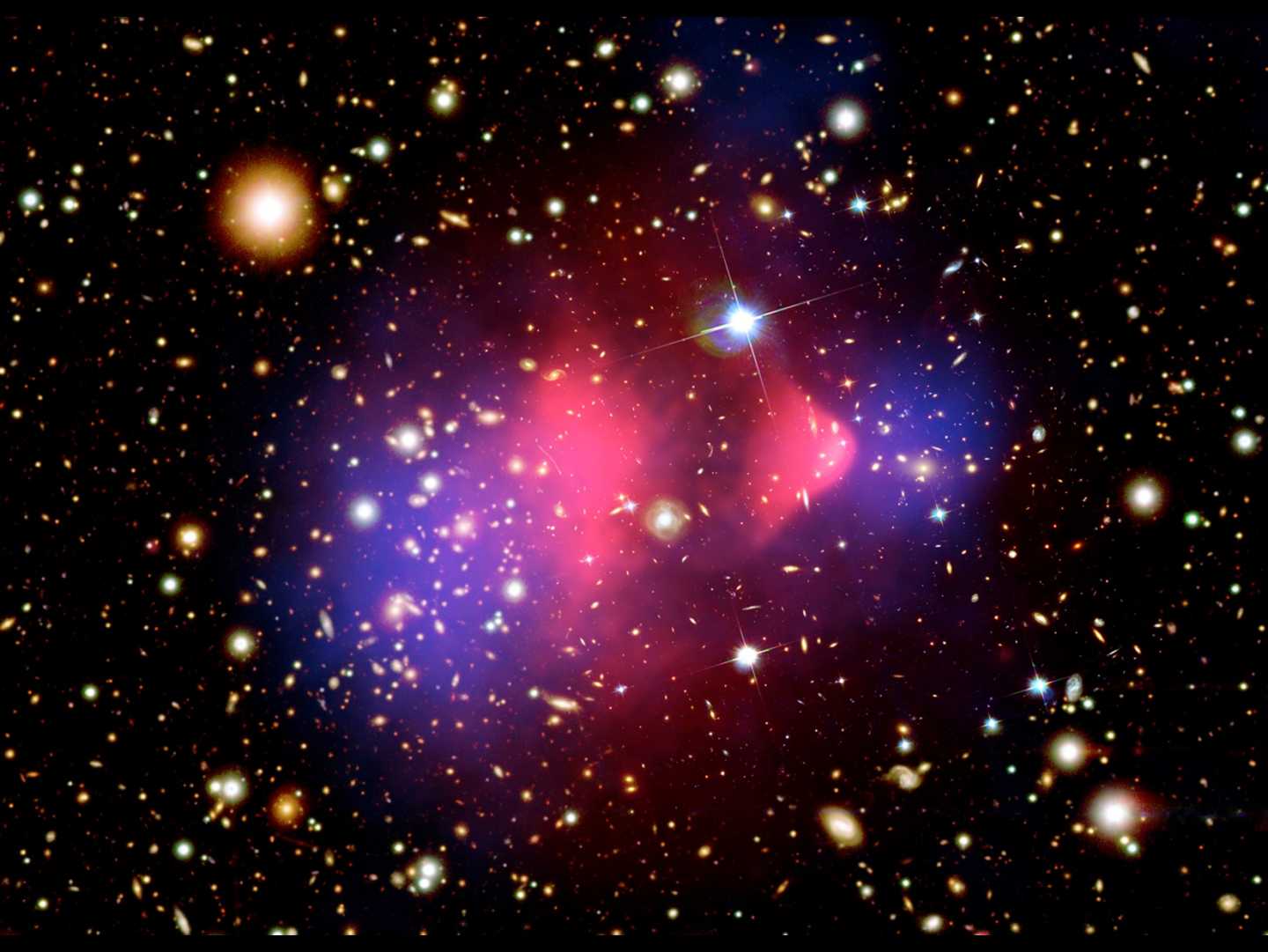


# Image processing









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