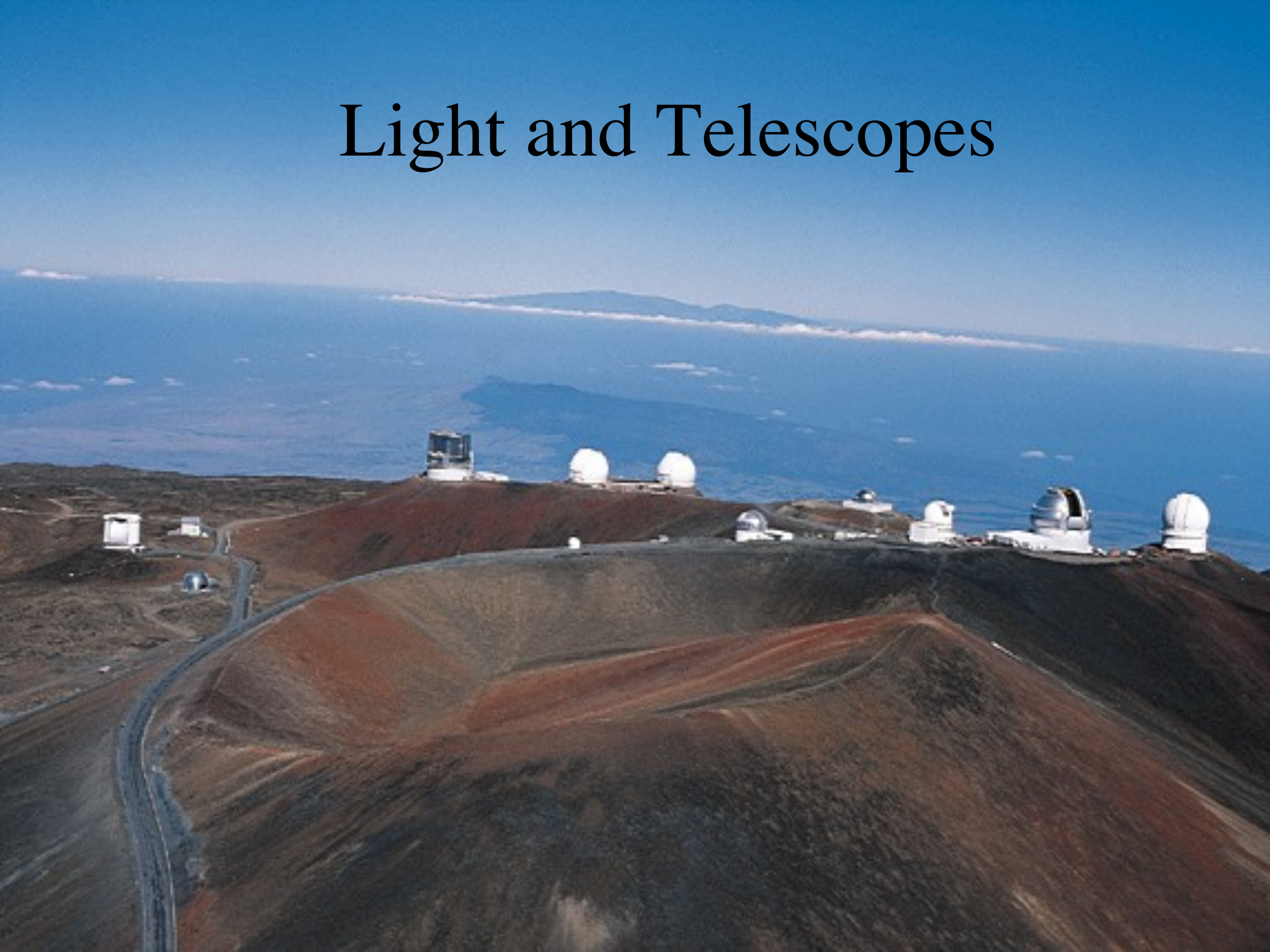
Telescope Names

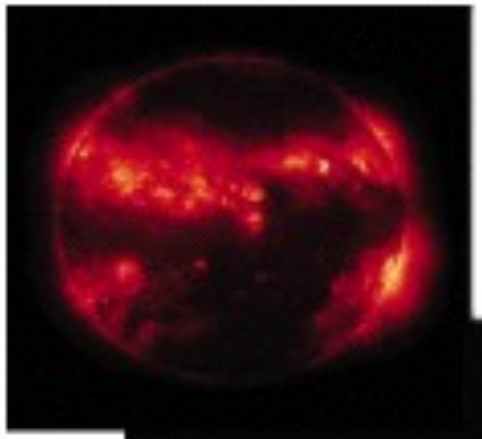
- [x] THE VERY LARGE TELESCOPE
- [x] THE EXTREMELY LARGE TELESCOPE
- [x] THE OVERWHELMINGLY LARGE TELESCOPE (CANCELED)
- [ ] THE OPPRESSIVELY COLOSSAL TELESCOPE
- [ ] THE MIND-NUMBINGLY VAST TELESCOPE
- [ ] THE DESPAIR TELESCOPE
- [ ] THE CATACLYSMIC TELESCOPE
- [ ] THE TELESCOPE OF DEVASTATION
- [ ] THE NIGHTMARE SCOPE
- [ ] THE INFINITE TELESCOPE
- [ ] THE FINAL TELESCOPE

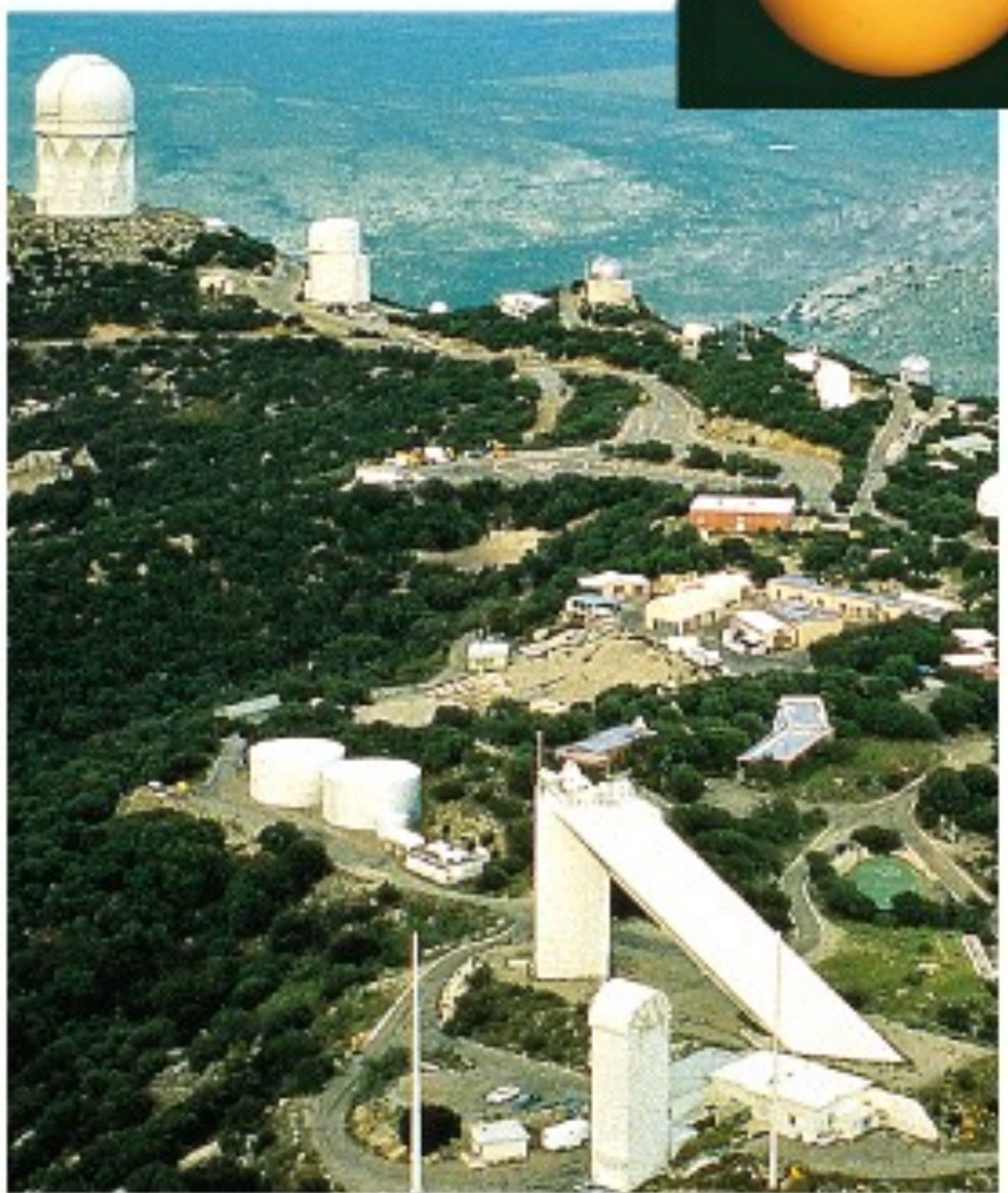
The Thirty Meter Telescope will be renamed The Flesh-Searing Eye on the Volcano.

Light and Telescopes



A Telescopes is a tool used to gather light from objects in the universe





Three main functions of a telescope

Most important!!

- **Gather More Light** – (bigger Is better) *making objects appear brighter*

followed by

- to see fine detail
  (called resolution)

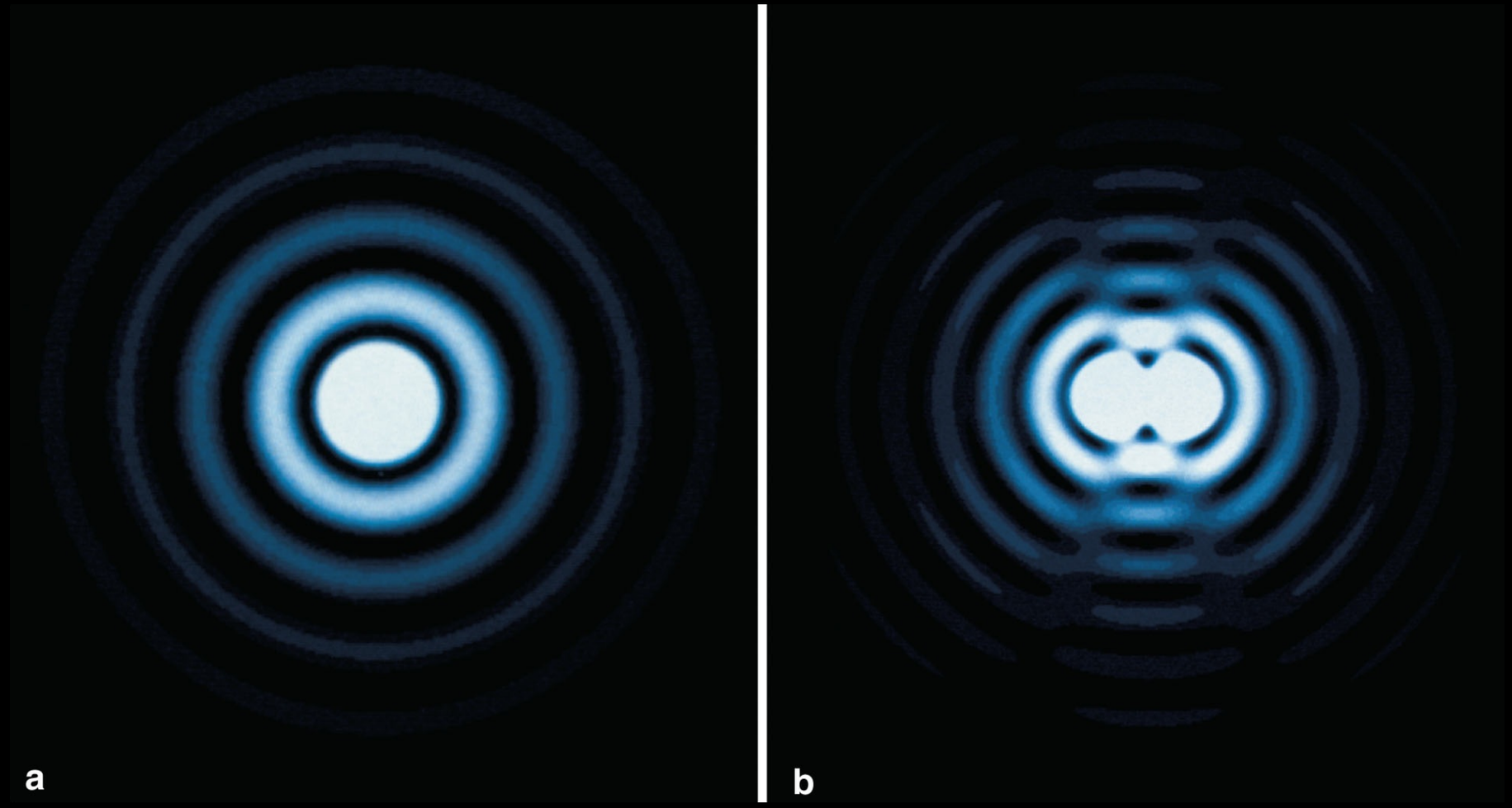
and least important,

- magnify

  magnification = (objective lens focal length / eyepiece lens focal length)

Resolving power refers to the ability of the telescope to reveal fine detail.

- One consequence of the wavelike nature of light is that there is an inevitable small blurring called a diffraction pattern



The bigger the telescope, the greater its resolving power at a given wavelength

Better than

Pismis 24 in NGC 6357

Rolf Olsen 2012
10" Newtonian f/5

10 inch

ESO La Silla Observatory 2010
Danish 1.5m telescope

1.5 m

Hubble Space Telescope 2002

2.4 m

The resolving power of a telescope also depends on the wavelength of light being collected - the longer the wavelength, the worse the resolution for a given telescope size.

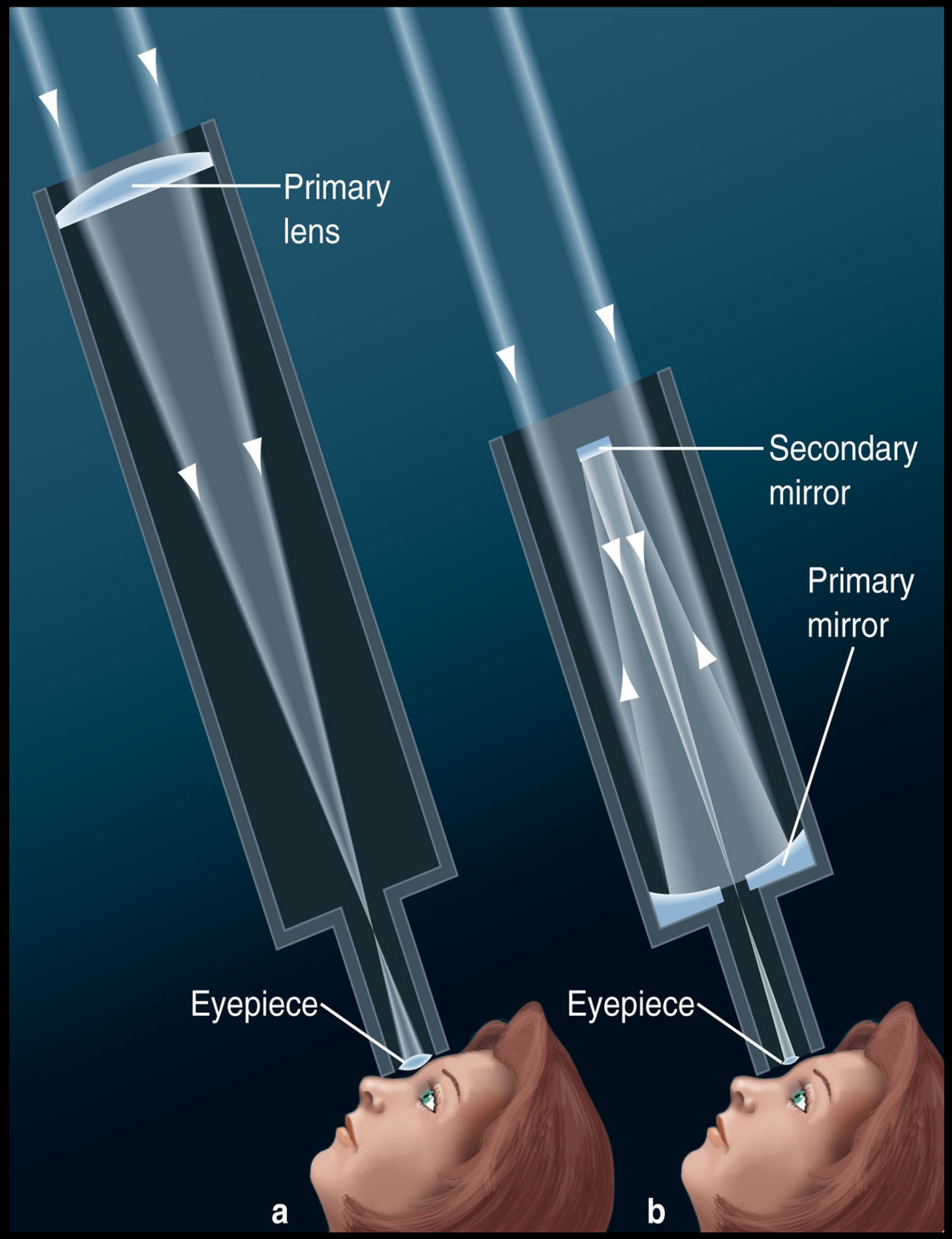
Ex: Radio telescopes need to be larger than optical telescopes.

Which telescope has the best resolving power?

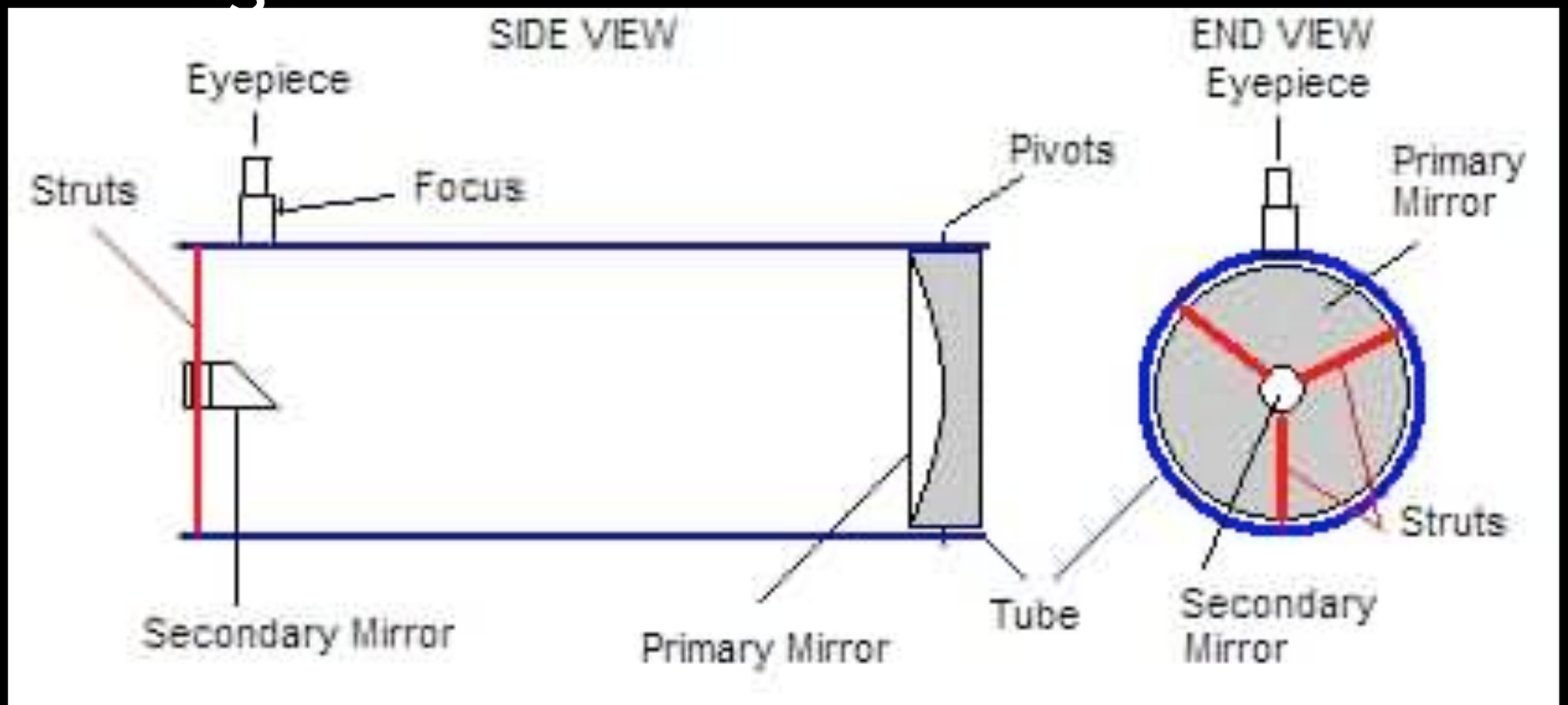
A) A 10 meter infrared telescope
B) A 10 meter optical telescope
C) A 20 meter infrared telescope
D) A 20 meter optical telescope

There are two types of astronomical telescopes.

- Refracting telescopes use a lens to gather and focus the light.
- Reflecting telescopes use a mirror.



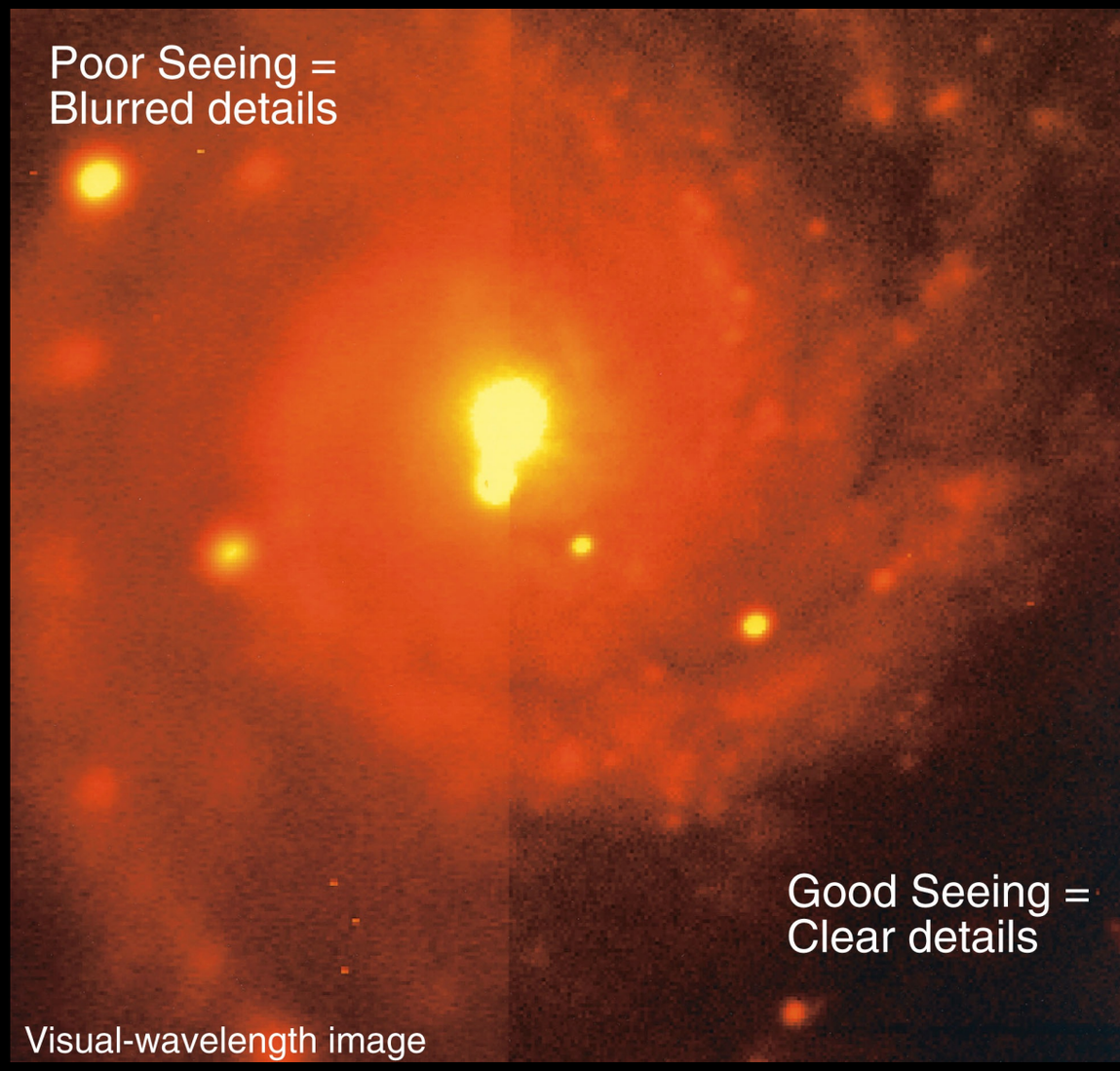
- The main lens in a refracting telescope is called the primary lens.
- The main mirror in a reflecting telescope is called the primary mirror.
- The eyepiece is used to magnify the image



Two other factors limit resolving power

- Optical quality
- Atmospheric conditions

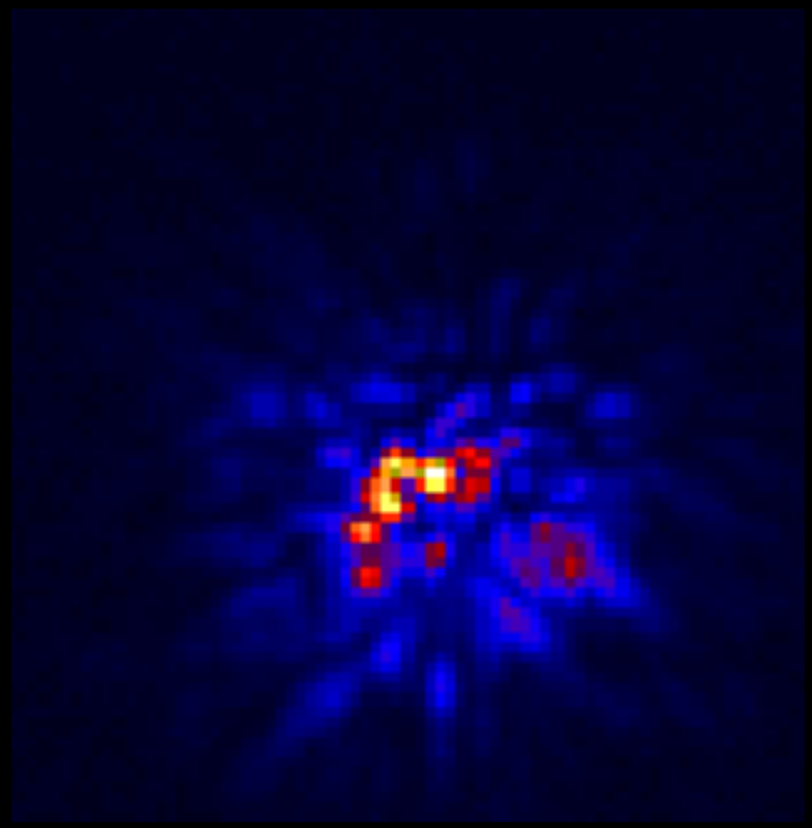
When we look through a telescope, we look through turbulence in Earth's atmosphere, which makes images dance and blur—a condition we call seeing.



Example: Heat waves on the road …

Earth’s atmosphere makes stars twinkle

- A star near the horizon—where you look through more air—will twinkle more than a star overhead.
- A telescope performs best on a high mountaintop—where the air is thin and steady.

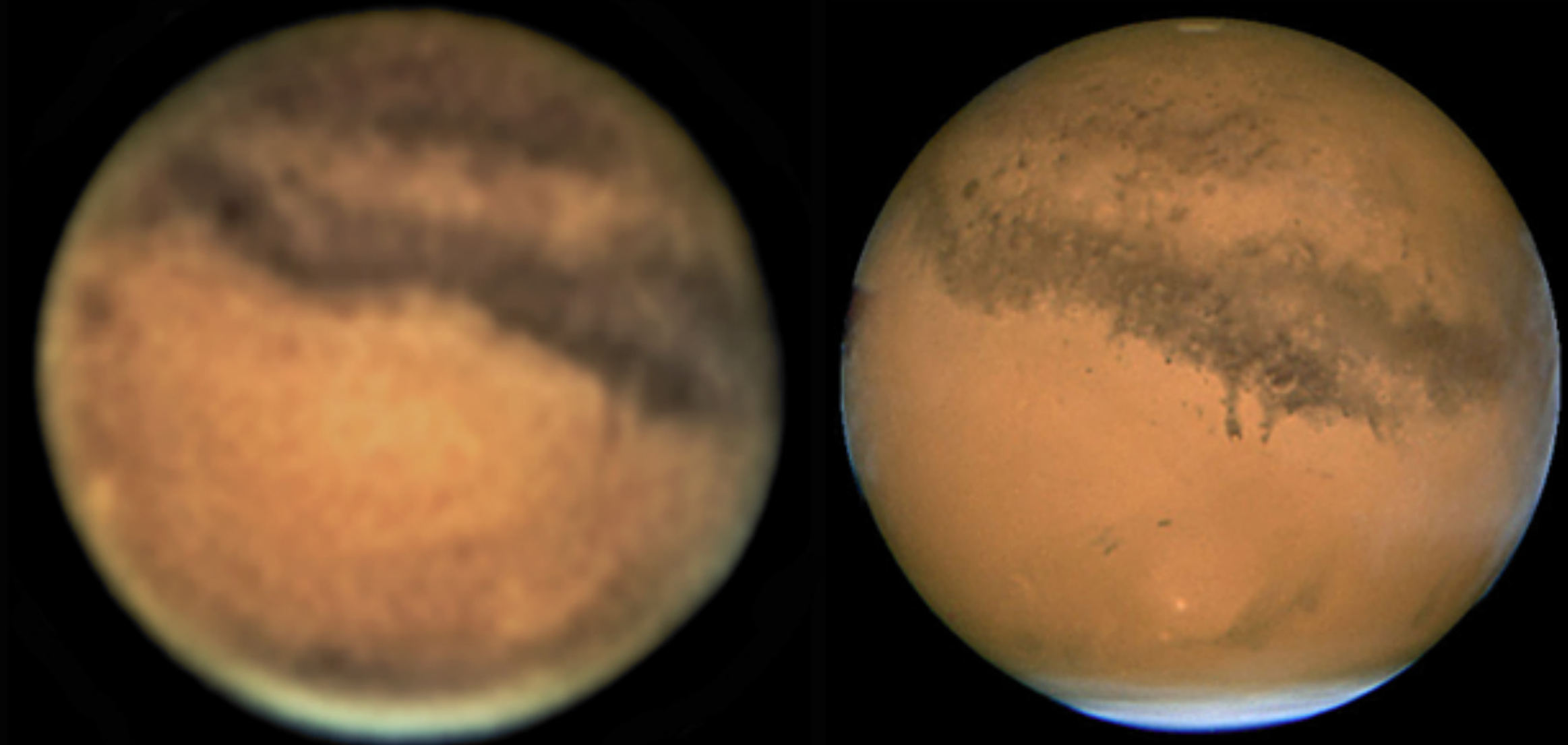


MARS

HOME

NOVEMBER 7, 2005

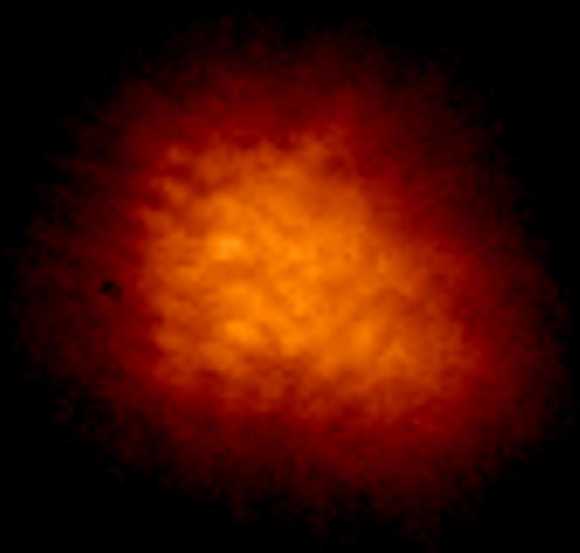
HUBBLE



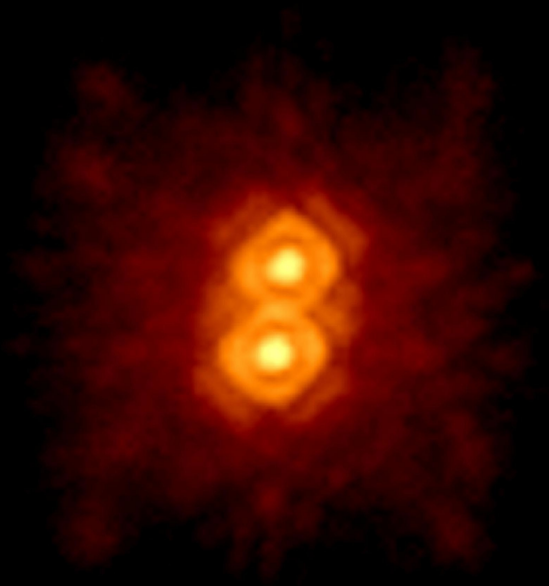
MEADE LX200GPS 10in., CGE MOUNT, TOUCAM 840 PRO
SETTINGS: BRIGHT.=40%, GAMA=0%, SATUR.=30%, SHUTTER=1/25fps
FRAMES=10fps, BAARDER IR-UV FILTER, MEADE #8 YELLOW FILTER
1000 FRAME AVI'S. LOCATION: LAT.+18.41, LONG.-67.14, AGUADILLA, PUERTO RICO
Taken By: EFRAIN MORALES {jaicoa@choicecable.net}

- The effect of atmospheric seeing can be removed by a technique called adaptive optics.
  - Rapid computer calculations adjust the telescope optics and partly compensate for seeing distortions.

Before



After



Great Paris Exhibition Telescope
(lens at the same scale)
Paris, France (1900)

Yerkes Observatory
(40" refractor
lens at the same scale)
Williams Bay,
Wisconsin (1893)

Hooker (100")
Mt Wilson,
California
(1917)

Hale (200")
Mt Palomar,
California
(1948)

(1979-1998) (1999-)
Multi Mirror Telescope
Mount Hopkins, Arizona

BTA-6 (Large Altazimuth Telescope)
Zelenchuksky, Russia
(1975)

Large Zenith Telescope
British Columbia, Canada
(2003)

Gaia
Earth-Sun L2 point
(2014)

Kepler
Earth-trailing
solar orbit
(2009)

James Webb Space Telescope
Earth-Sun L2 point
(planned 2018)

Hubble Space Telescope
Low Earth
Orbit
(1990)

Tennis court at the same scale

Large Sky Area Multi-Object Fiber Spectroscopic Telescope
Hebei, China
(2009)

Hobby-Eberly Telescope
Davis
Mountains,
Texas (1996)

Large Binocular Telescope
Mount Graham,
Arizona (2005)

Very Large Telescope
Cerro Paranal, Chile
(1998-2000)

Magellan Telescopes
Las Campanas,
Chile (2000/2002)

Gran Telescopio Canarias
La Palma,
Canary Islands,
Spain (2007)

Southern African Large Telescope
Sutherland,
South Africa
(2005)

Keck Telescope
Mauna Kea, Hawaii
(1993/1996)

Gemini North
Mauna Kea,
Hawaii (1999)

Subaru Telescope
Mauna Kea,
Hawaii (1999)

Gemini South
Cerro Pachón,
Chile (2000)

Large Synoptic Survey Telescope
El Peñón, Chile
(planned 2020)

Giant Magellan Telescope
Las Campanas Observatory,
Chile (planned 2020)

Thirty Meter Telescope
Mauna Kea, Hawaii (planned 2022)

European Extremely Large Telescope
Cerro Armazones,
Chile (planned 2022)

Human
at the
same scale

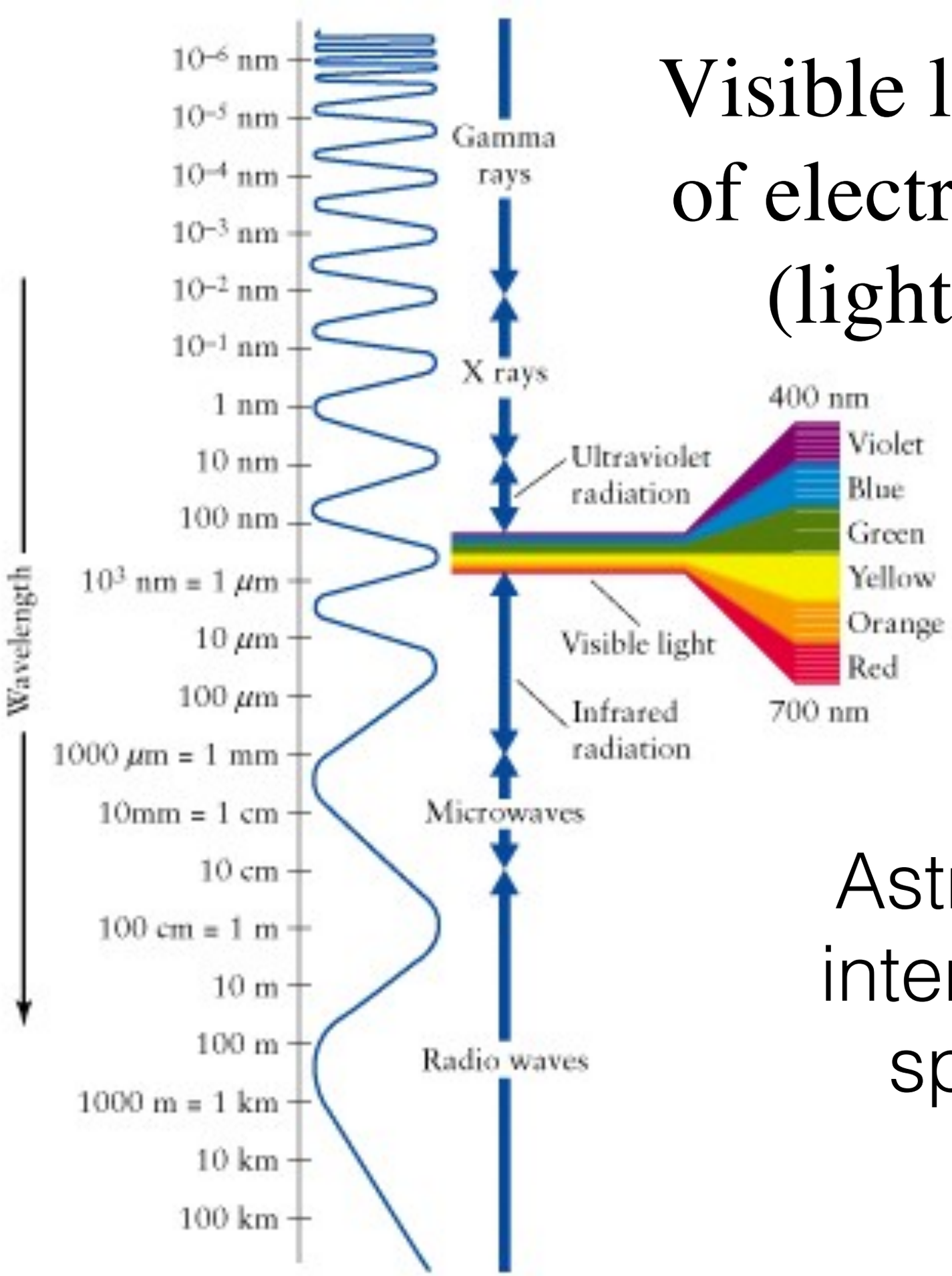
0 5 10 m
0 10 20 30 ft

Overwhelmingly Large Telescope
(cancelled)
Arecibo radio telescope at the same scale

Basketball court at the same scale

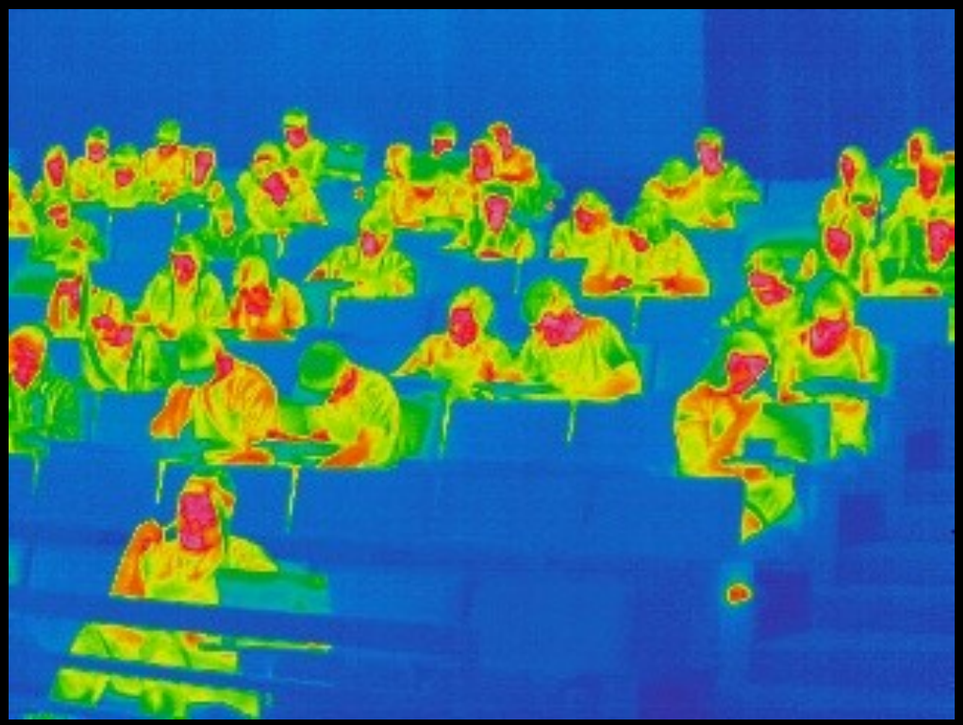

700 nm
600 nm
500 nm
400 nm

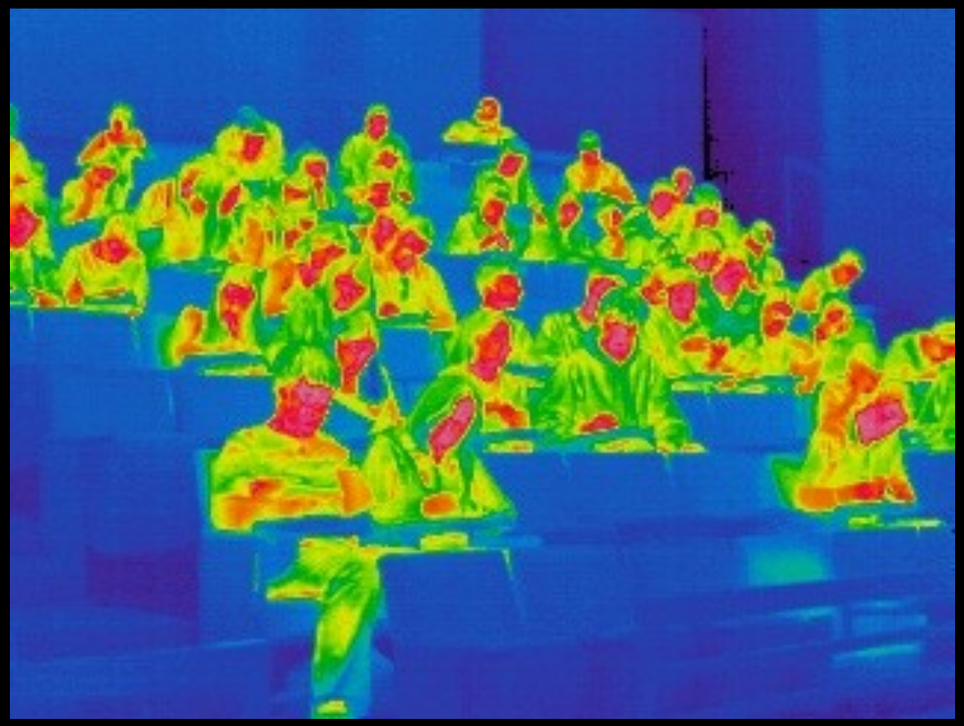
Visible light is only one type of electromagnetic radiation (light) emitted by stars



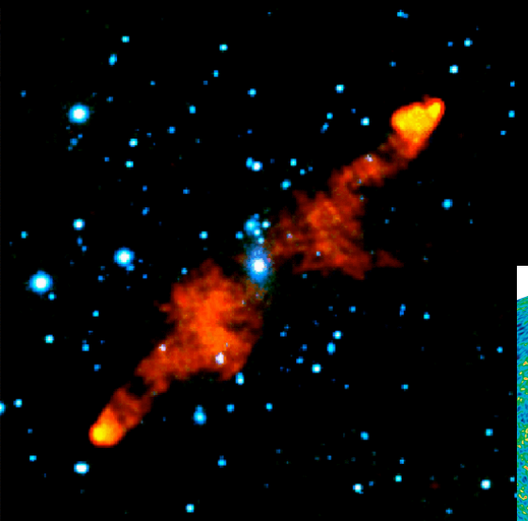
Astronomers are truly interested in the entire spectrum of Light!

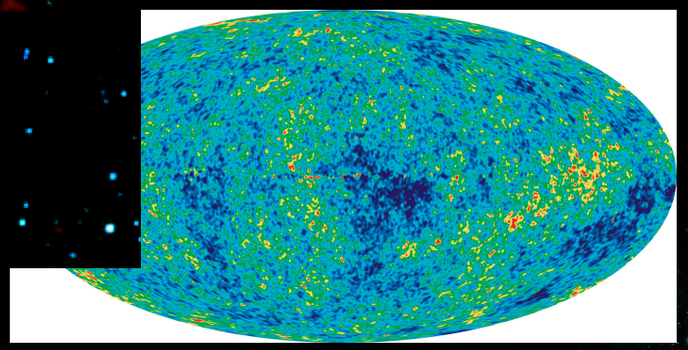
Consider a Class as Seen in Different Wavelengths of Light!

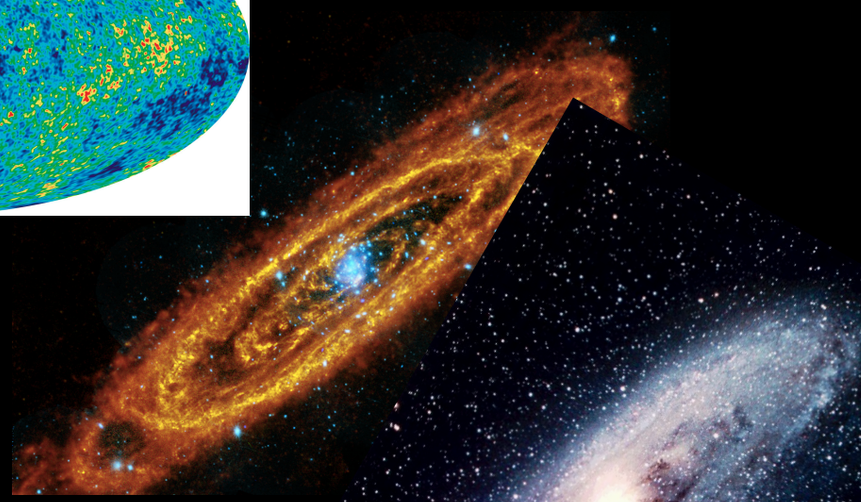


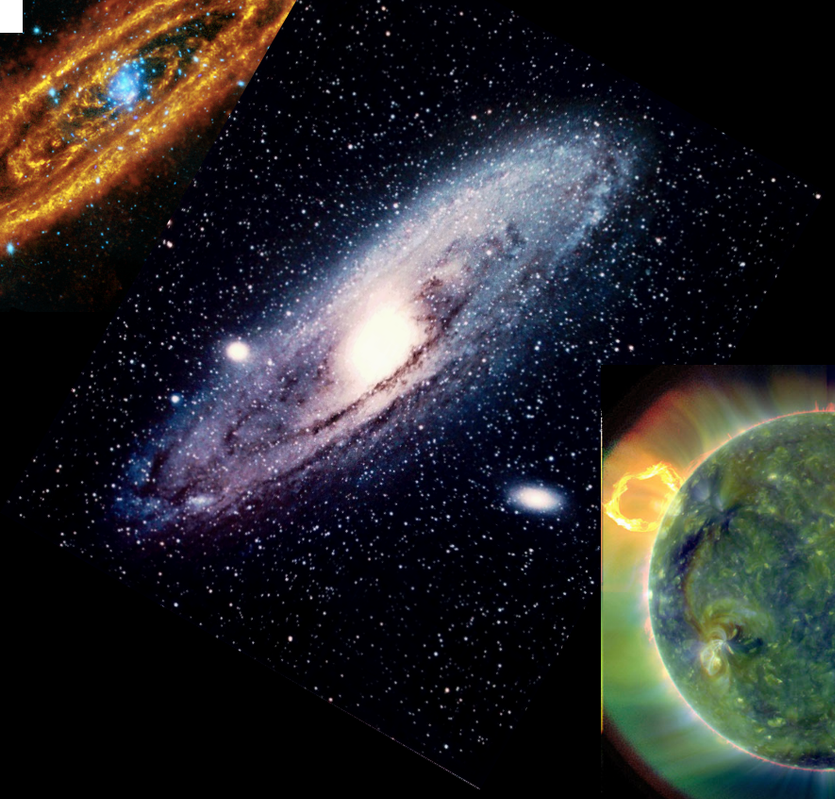


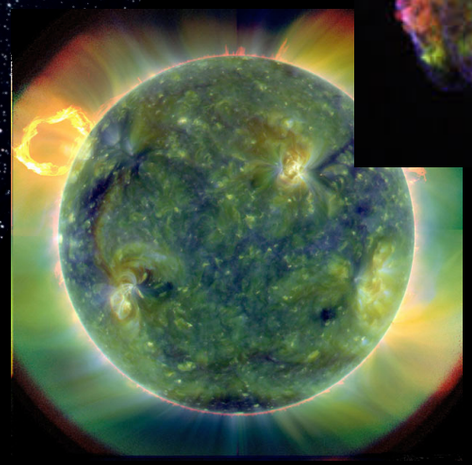
Telescopes collect electromagnetic radiation over the entire spectrum! Radio -> Gamma Rays!

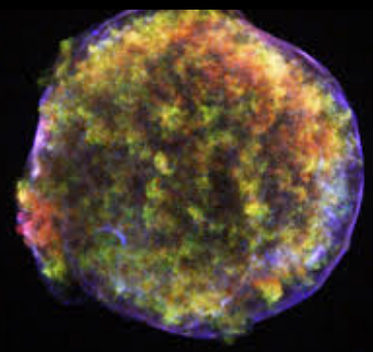








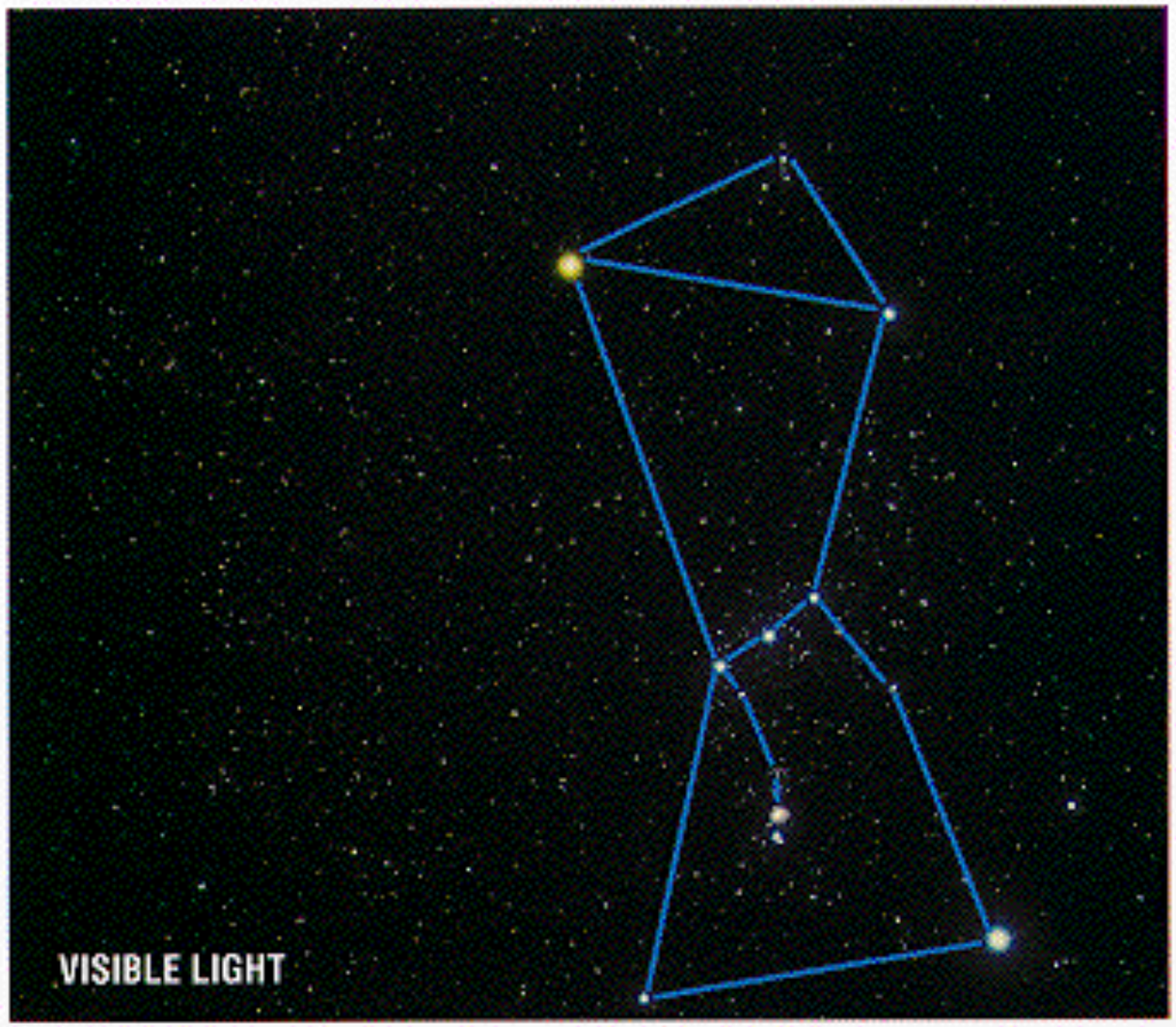


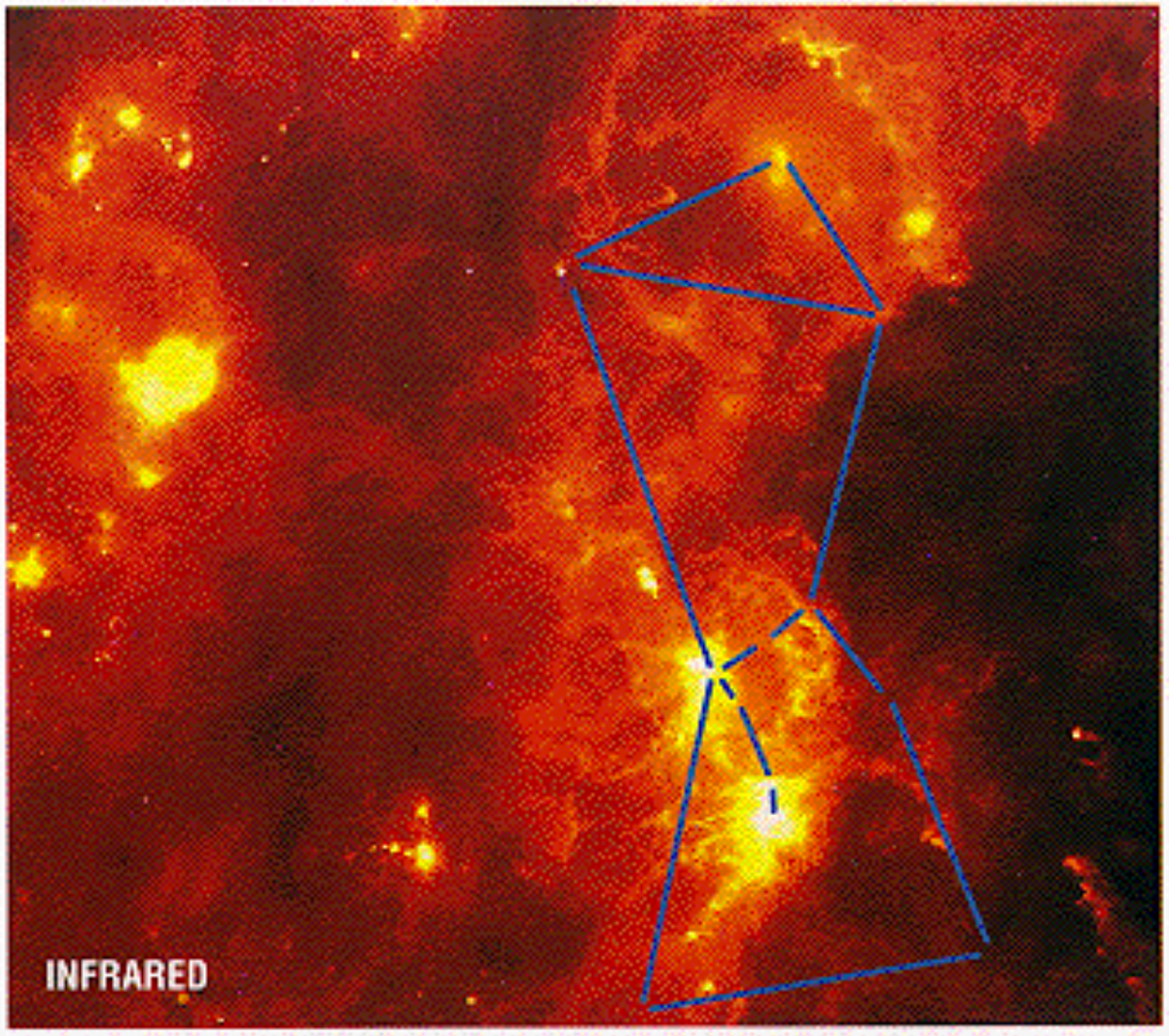


National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

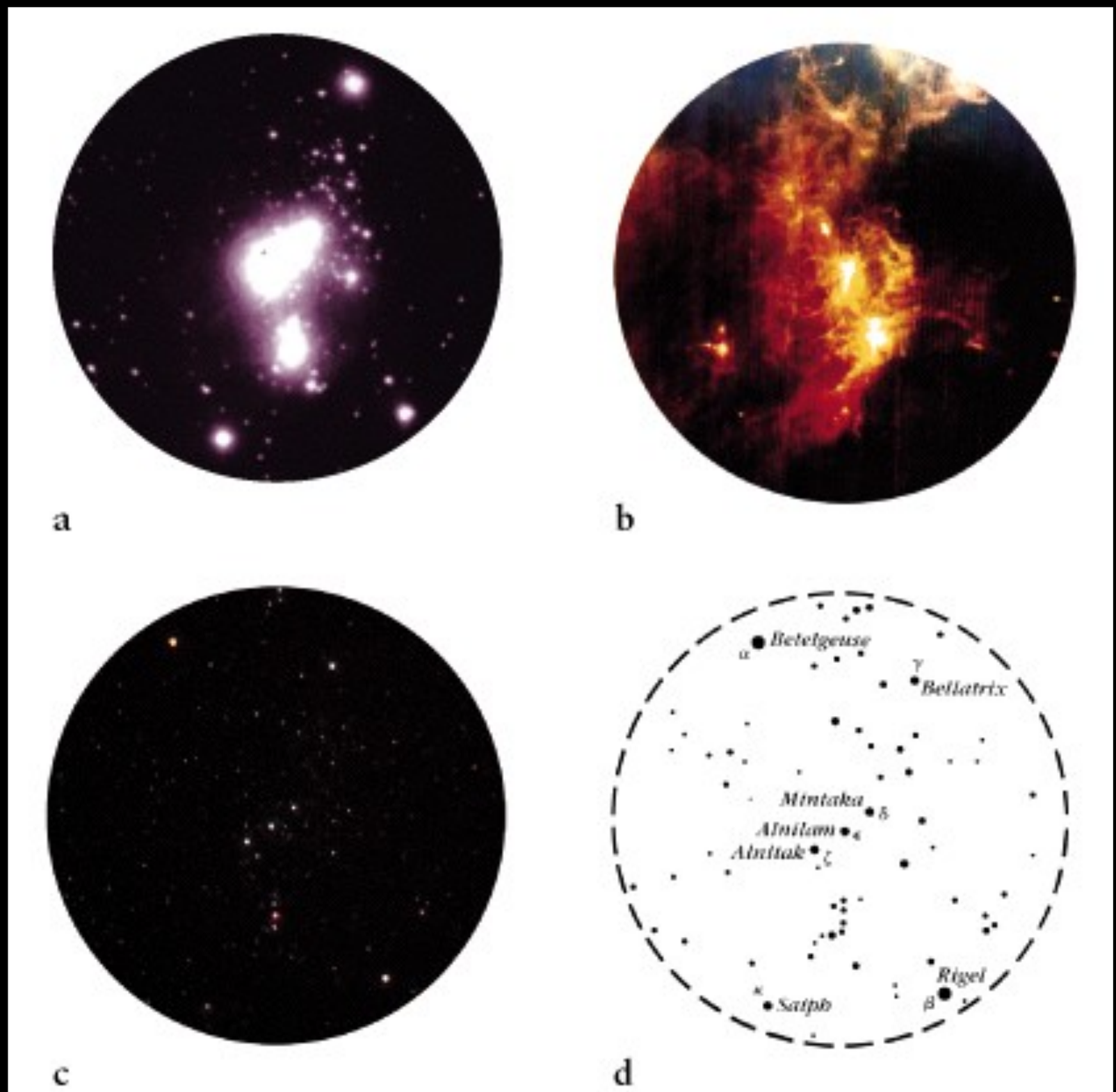
Infrared Astronomy: More than Our Eyes Can See





Observations at other wavelengths are revealing previously invisible sights

UV

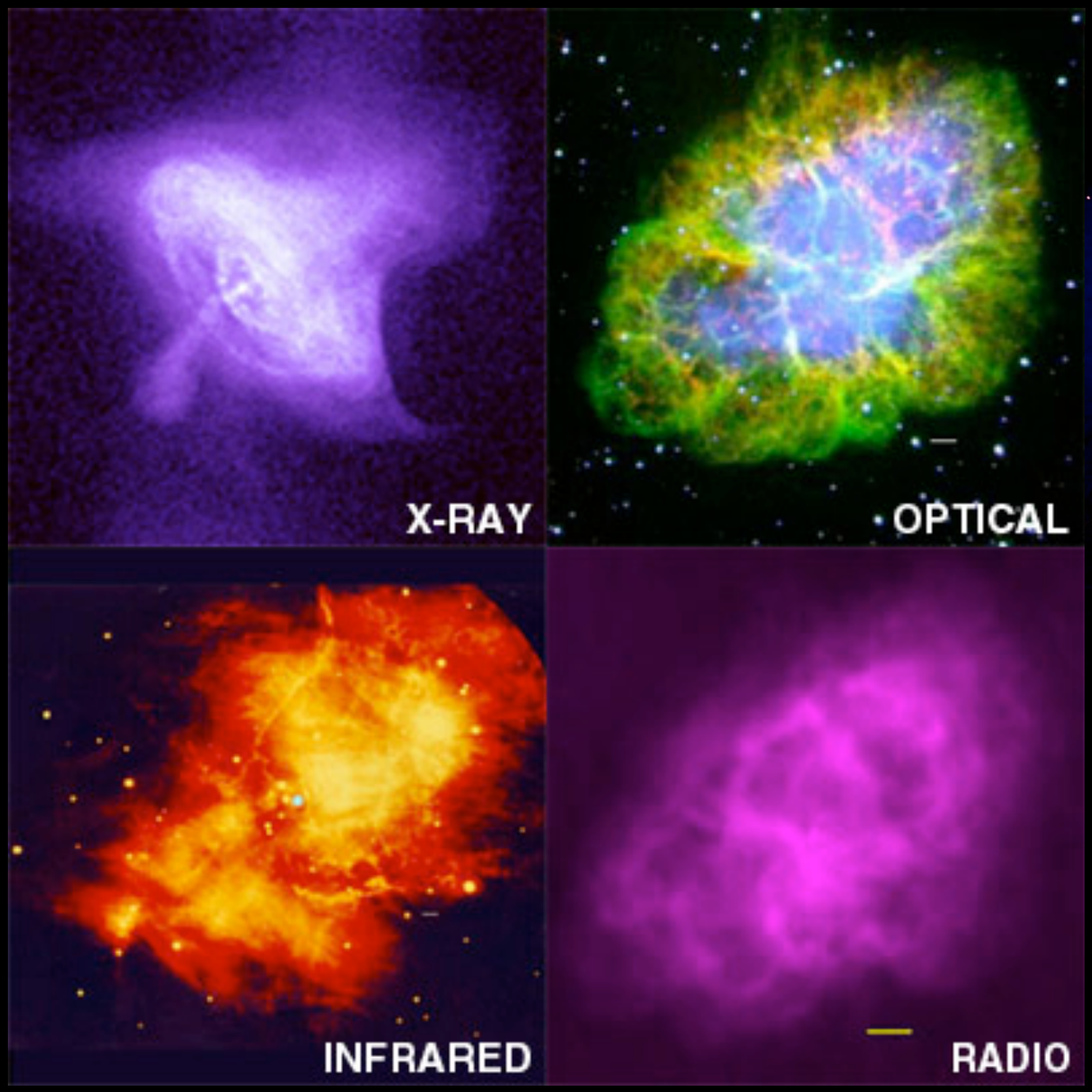


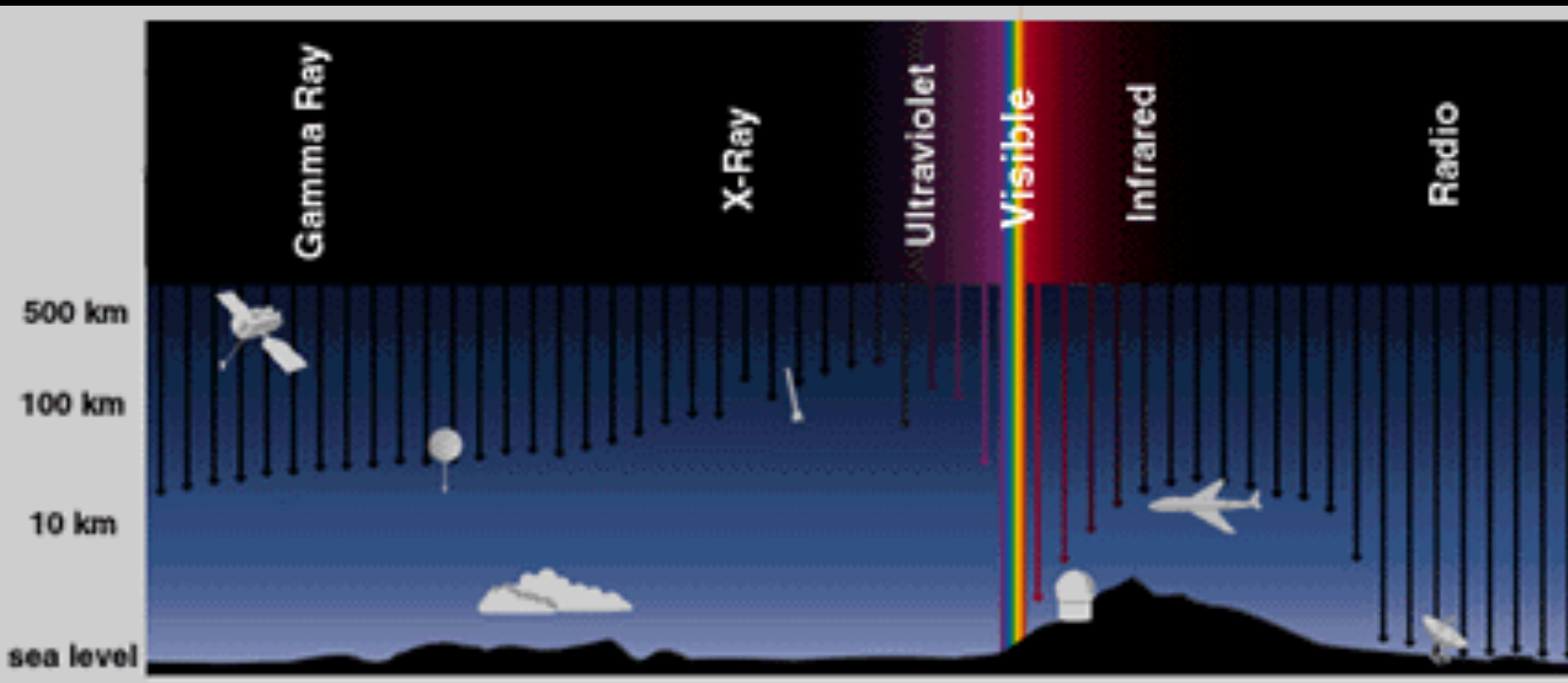
infrared

Ordinary visible

Map of Orion region

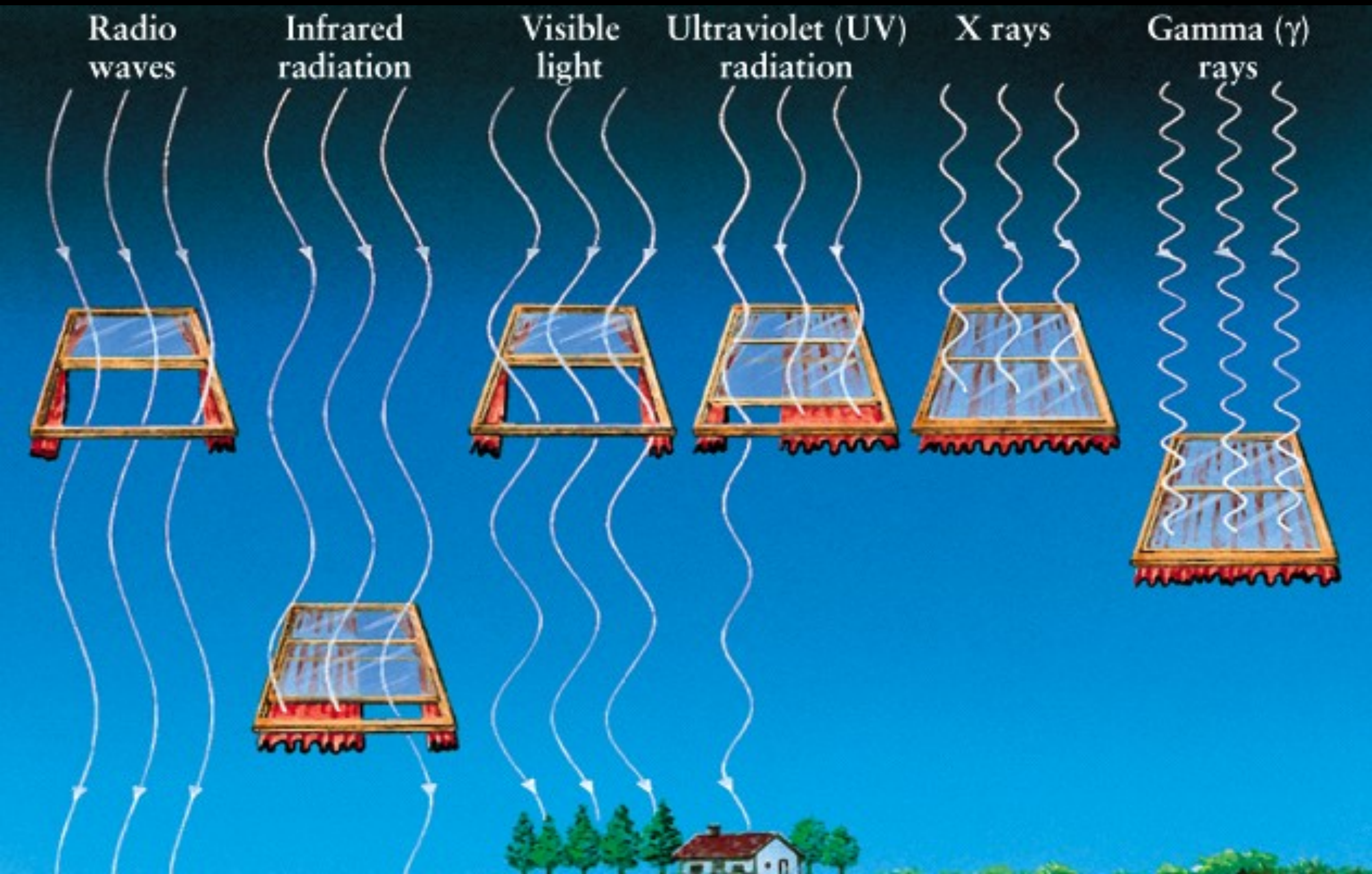
We can combine images from different telescopes





Astronomers use different instruments to look at light of different wavelengths - sometimes, we even have to go above Earth’s atmosphere.

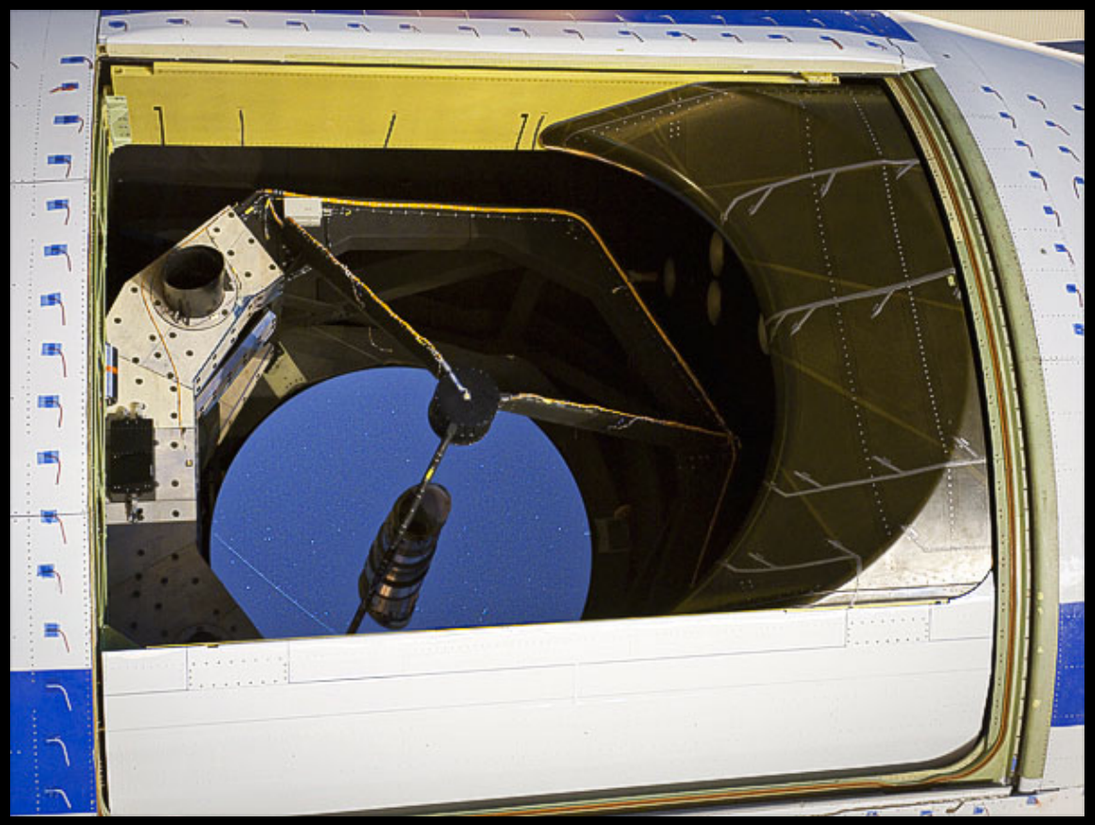
Not all electromagnetic radiation can penetrate Earth's atmosphere.



mid-Infrared

The Stratospheric Observatory for Infrared Astronomy (SOFIA)

- This is a Boeing 747-P aircraft that carries a 2.5-m (100-in.) telescope to the fringes of the atmosphere.



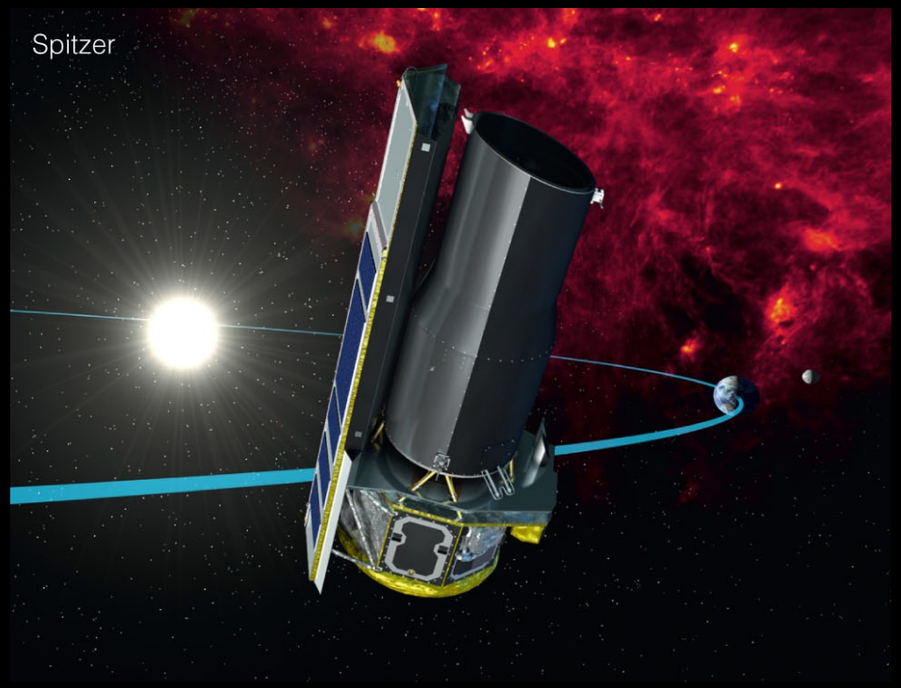
THREE reasons to go to space

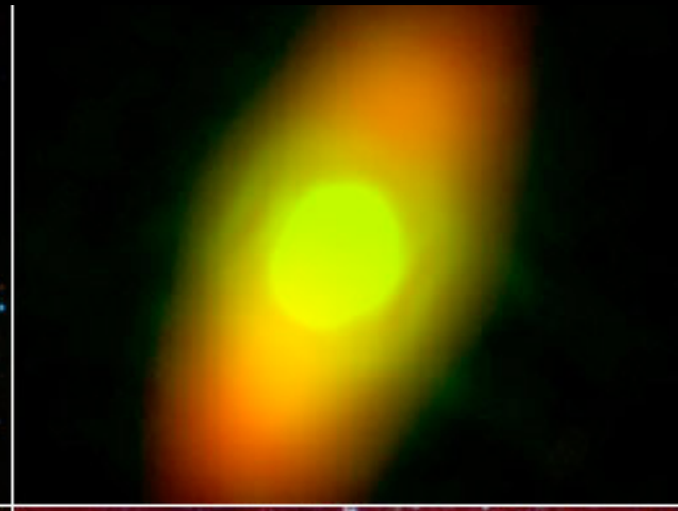
1) Can observe stars in Northern and Southern hemisphere
2) Can escape the Earth's atmosphere
3) Wavelengths in the far-ultraviolet, X-ray, and gamma-ray ranges—are completely absorbed by the ozone layer extending from 20 km to about 40 km above Earth's surface.

Spitzer telescope

Infrared

- The most sophisticated of the infrared telescopes put in orbit
- It still needs to be cooled to –269°C (–452°F).

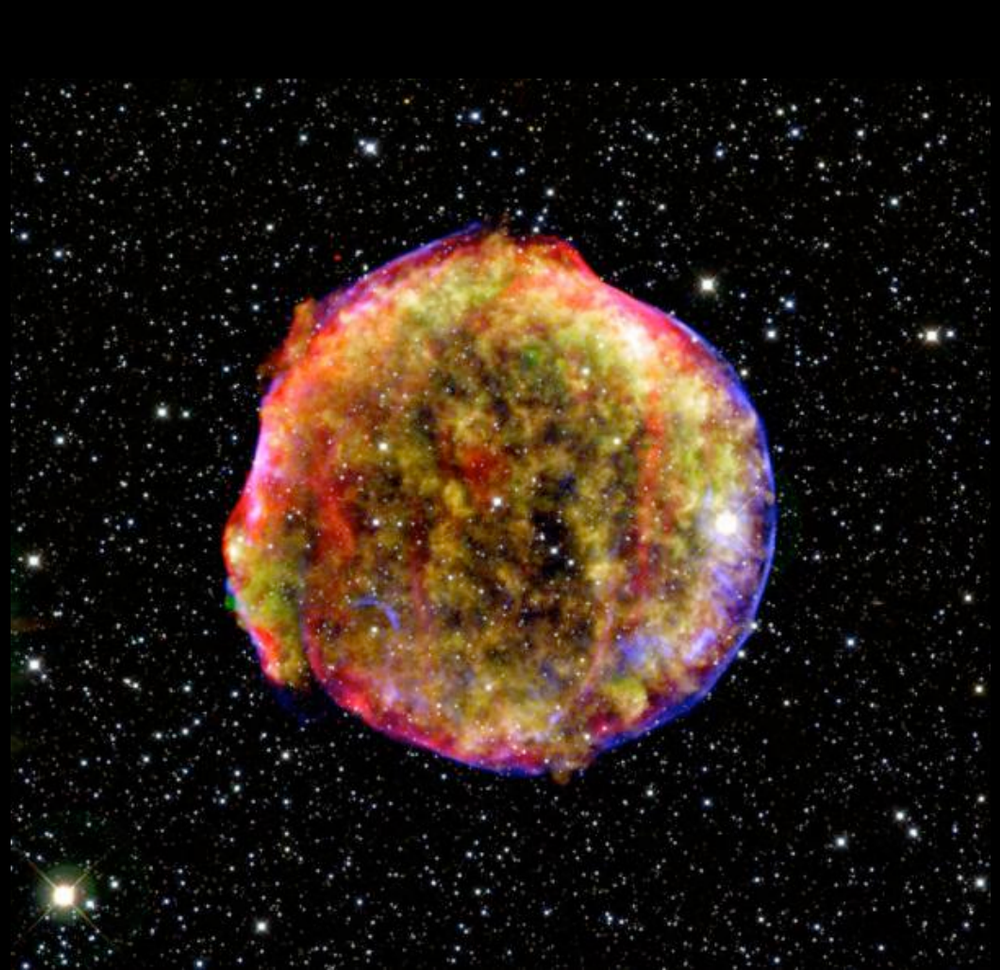




Chandra telescope

Xrays

- The largest X-ray telescope to date, it was launched in 1999 and orbits a third of the way to the moon.
- Focusing X rays is difficult because they penetrate into most mirrors



The future means bigger telescopes in space and on the ground …

See fainter
See further
See more
See what we have never seen before

Thirty Meter Telescope

James Webb Space Telescope

Telescope review

1) The bigger the better for both collecting photons (seeing faint) and resolution (seeing detail)

2) The atmosphere blurs the light from objects AND blocks UV, gamma ray and Xray light requiring telescopes in space or on mountain tops

3) Ground based telescopes can use adaptive optics to un-blur the light

4) The longer the wavelength of the light, the bigger the telescope needs to be to recover its ability to see detail - radio telescopes are huge!

5) Interferometers (multiple telescopes) can combine their light to mimic large telescopes

6) Different parts of the EM spectrum reveal different physical processes from the astronomical object