Modern Astronomical Telescopes

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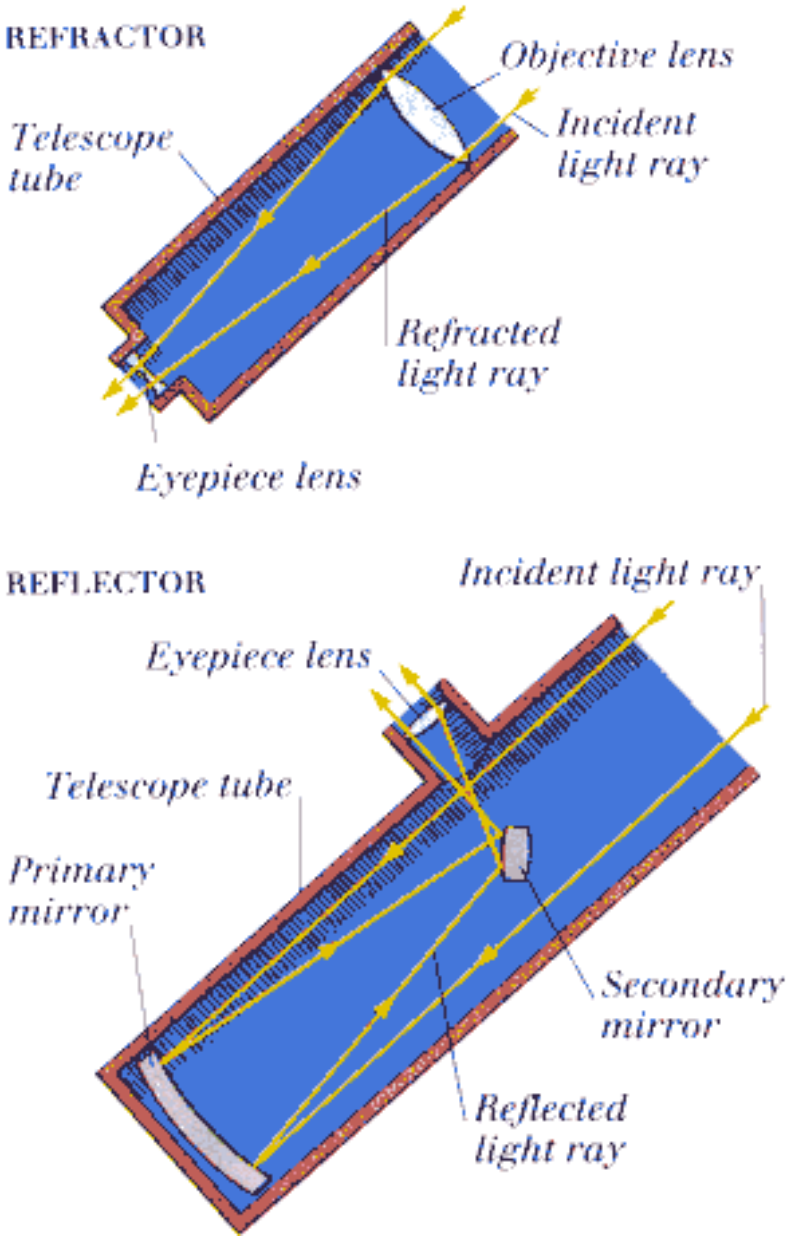
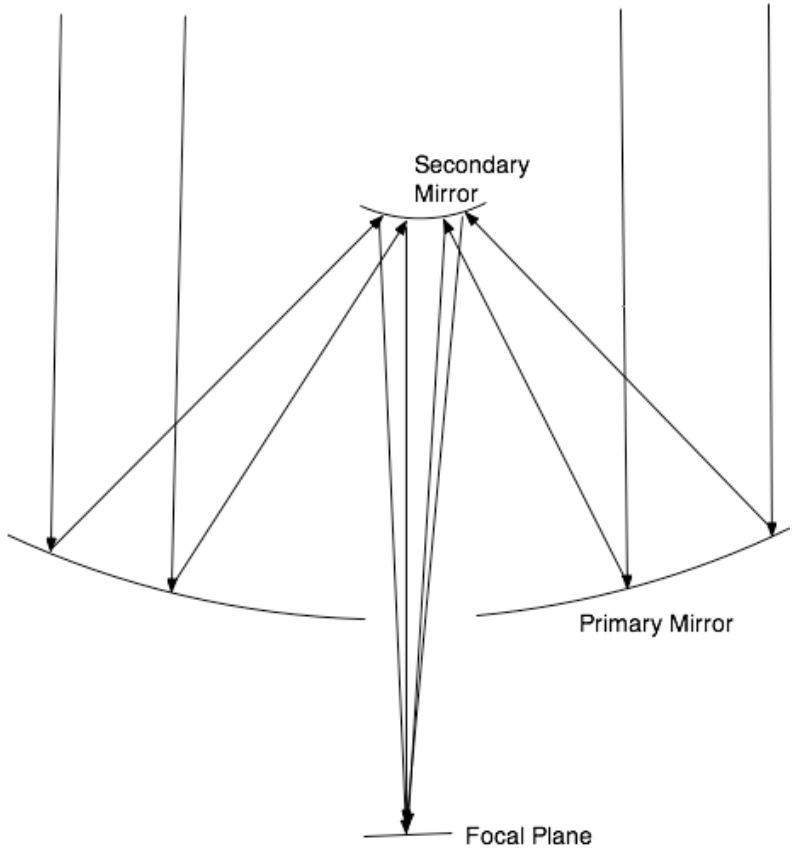
Telescopes

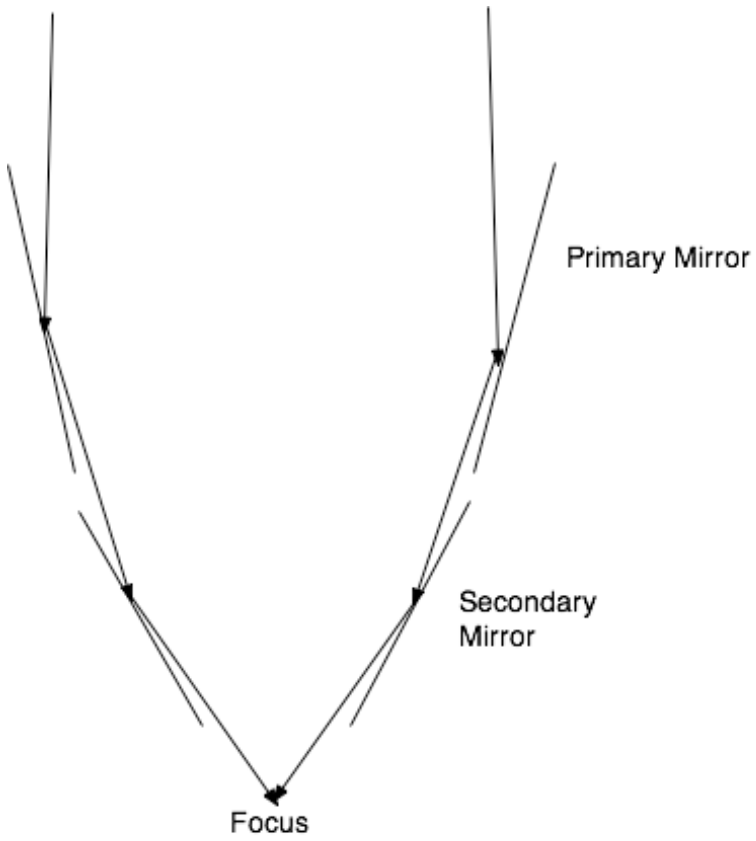
- Refractive telescopes
  - Transparent glass
  - Traditional telescopes
  - Chromatic aberration and absorption
- Reflective telescopes
  - No chromatic aberration
  - All modern telescopes
- Telescopes working at different wavelengths
  - Radio telescopes: Wavelengths 1 cm to 1000 cm (1cm=10000 μm)
  - Infrared telescopes: Wavelengths 1 to 30 μm (1 μm =10000 Angstroms)
  - Visible telescopes: Wavelengths 3000 to 7000 Angstroms
  - Ultraviolet telescopes: Wavelengths 1000 to 3000 Angstroms
  - X-ray telescopes: Wavelengths 0.1 to 100 Angstroms


REFRACTOR
Objective lens
Incident light ray
Telescope tube
Refracted light ray
Eyepiece lens
REFLECTOR
Incident light ray
Eyepiece lens
Telescope tube
Primary mirror
Secondary mirror
Reflected light ray

Typical Space Telescope Design



X-Ray Telescope



Manufacture of Telescopes

- Specify the mathematical prescription
- Fabricate mirrors/lens as close to the mathematical prescription as possible
  - The degree of precision is determined by the wavelength
- Mount/align the mirrors to required precision, again measured by the wavelength of the light
- Mount detectors/cameras at the focal plane

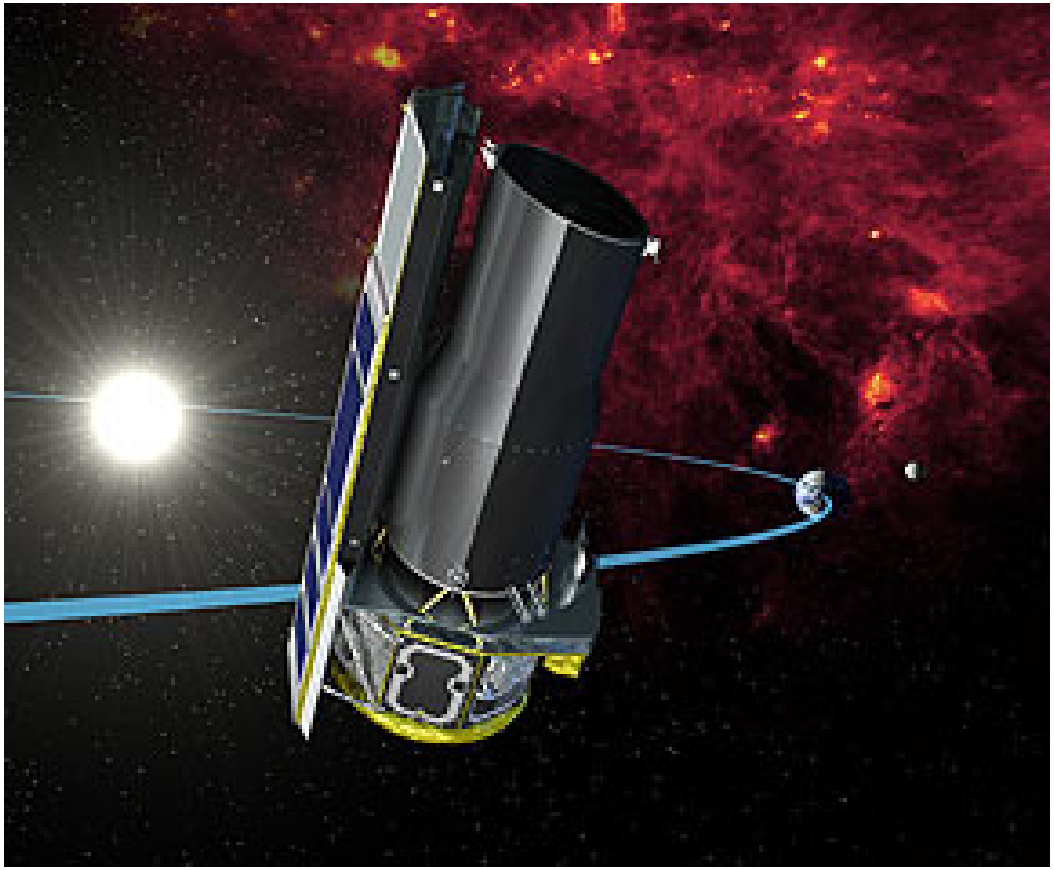
The Hubble Space Telescope Mirror

- 2.4 m in diameter, prescribed to be hyperbolic in shape
- It is precise to within 1/20 of a wave (6328 Angstroms) or 30 nano-meter (10^{-9}meters)
- This is equivalent to flattening the entire earth surface such that no places are higher or lower than the average by more than 6 cm!
- But…..

The Arecibo 305-m Radio Telescope (6-0.03m wavelength)

The Spitzer Space Telescope

Infrared: 1 to 30μm



The Keck Telescopes

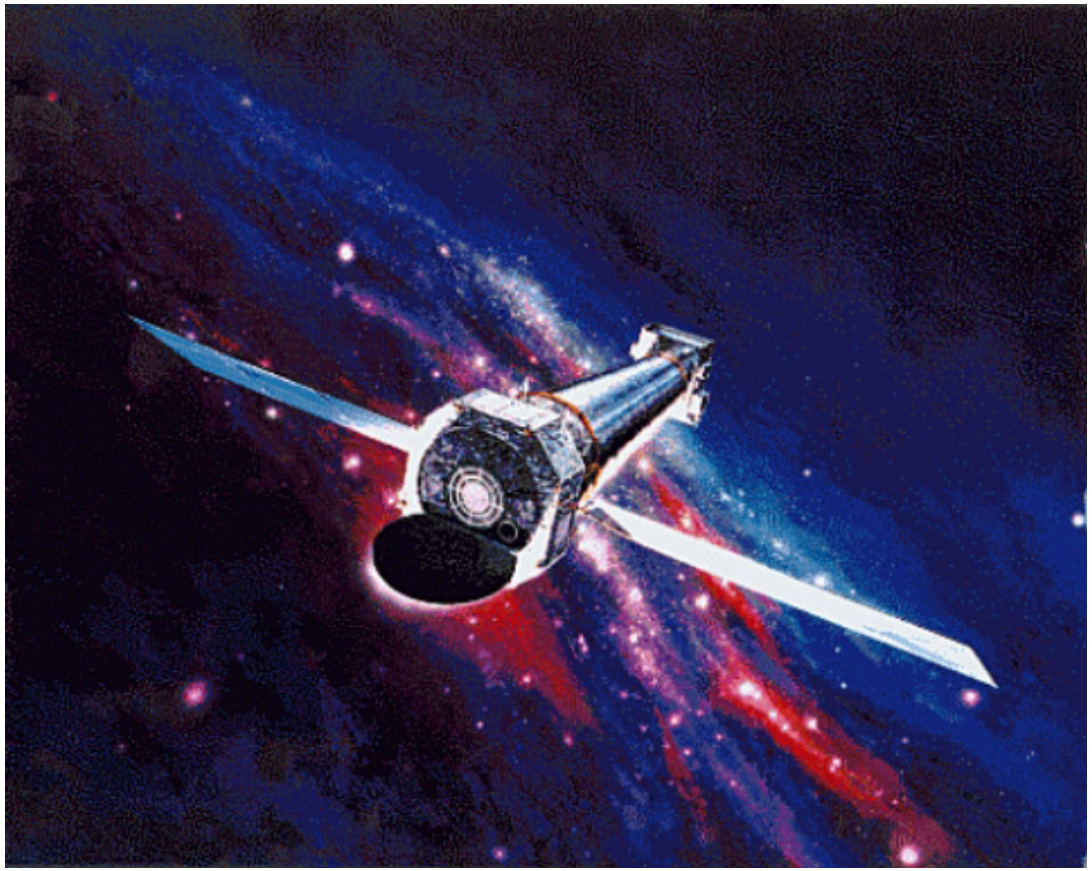
Largest optical telescopes in the world: 10m in diameter

The Hubble Space Telescope

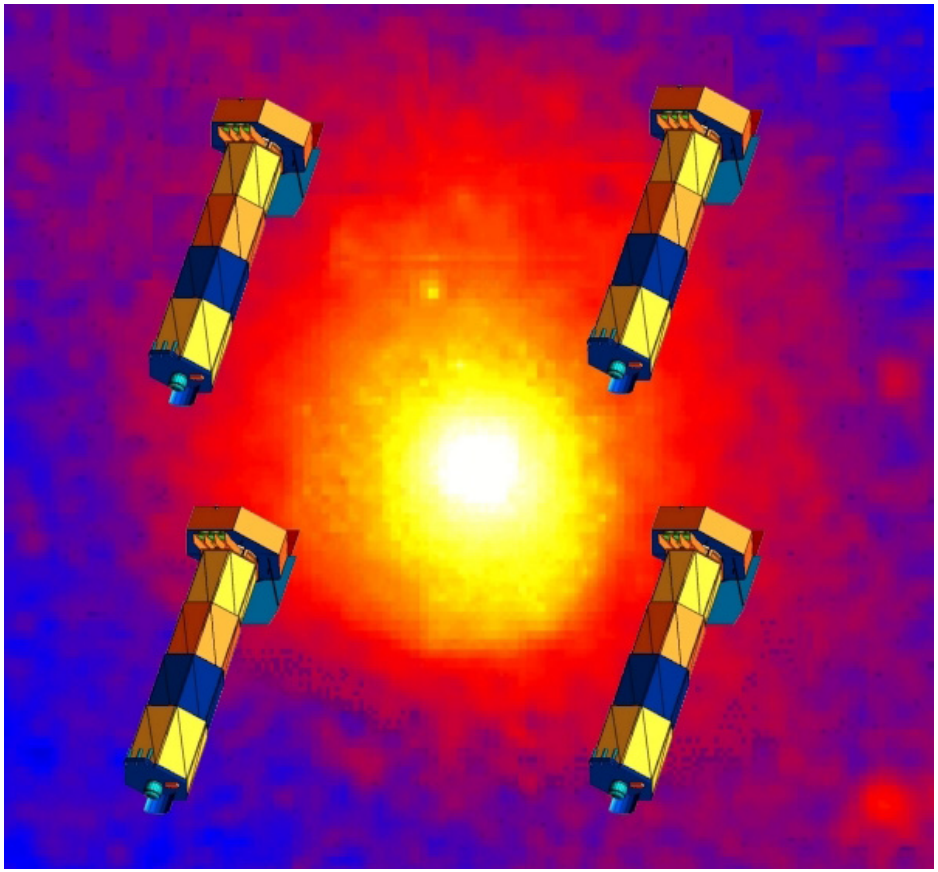
Visible and Ultraviolet

The Chandra X-ray Observatory

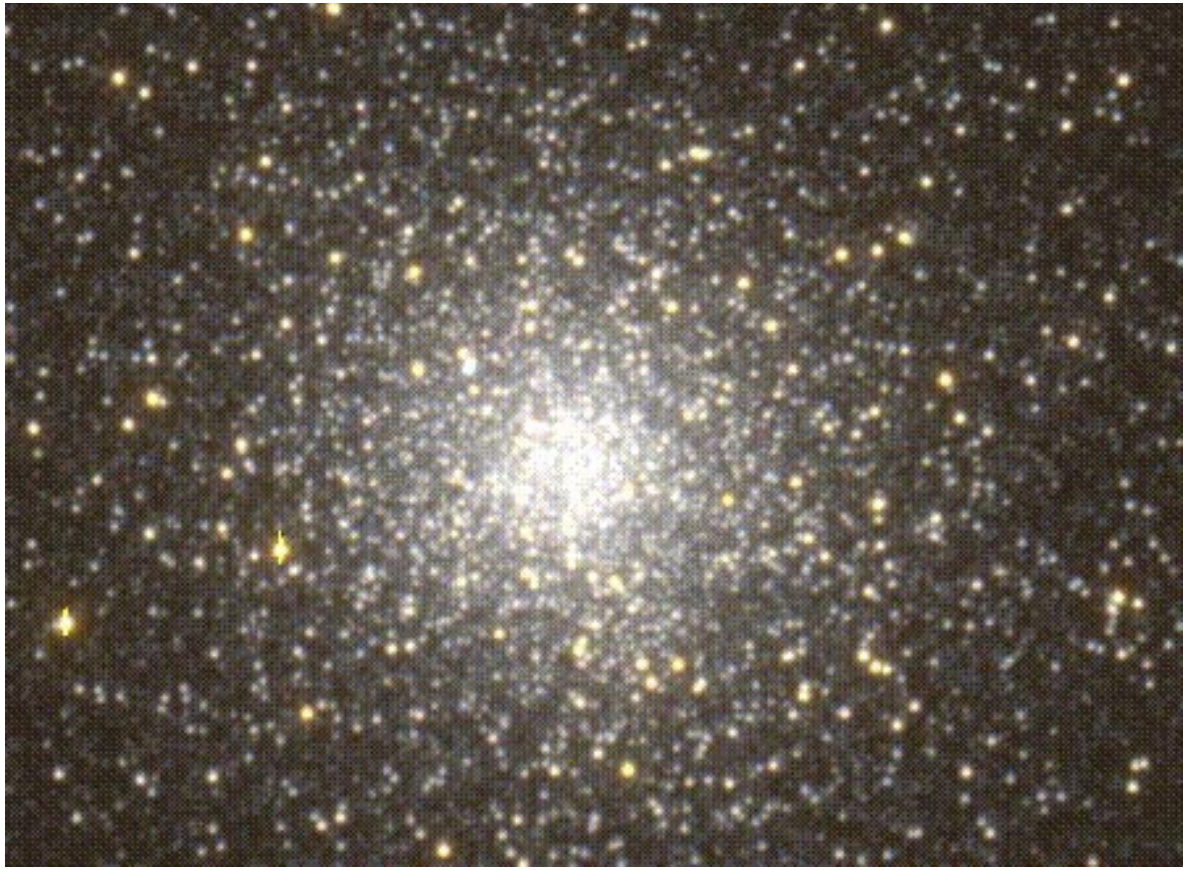
The best mirror mankind has ever made



NASA's Next Major X-Ray Observatory
The Constellation-X Mission

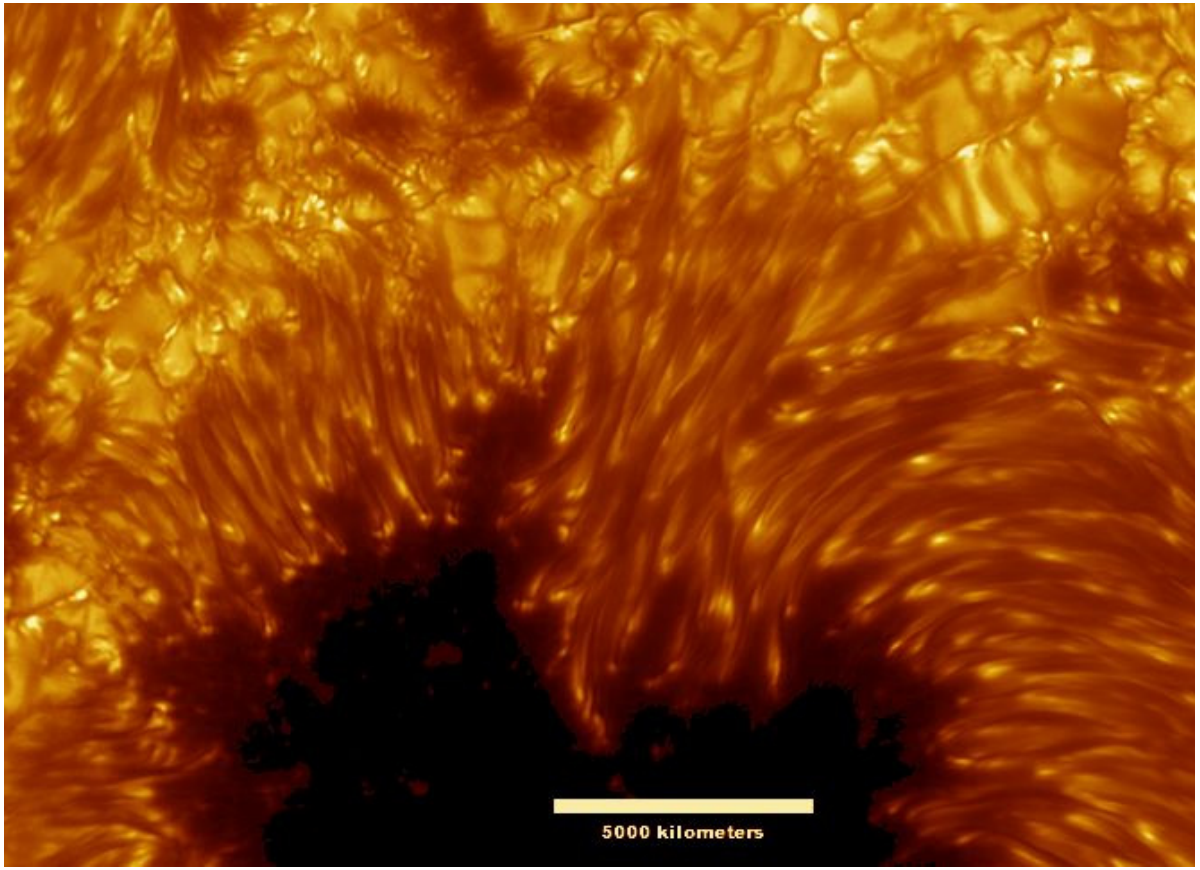


Globular Cluster 47 Tucanae



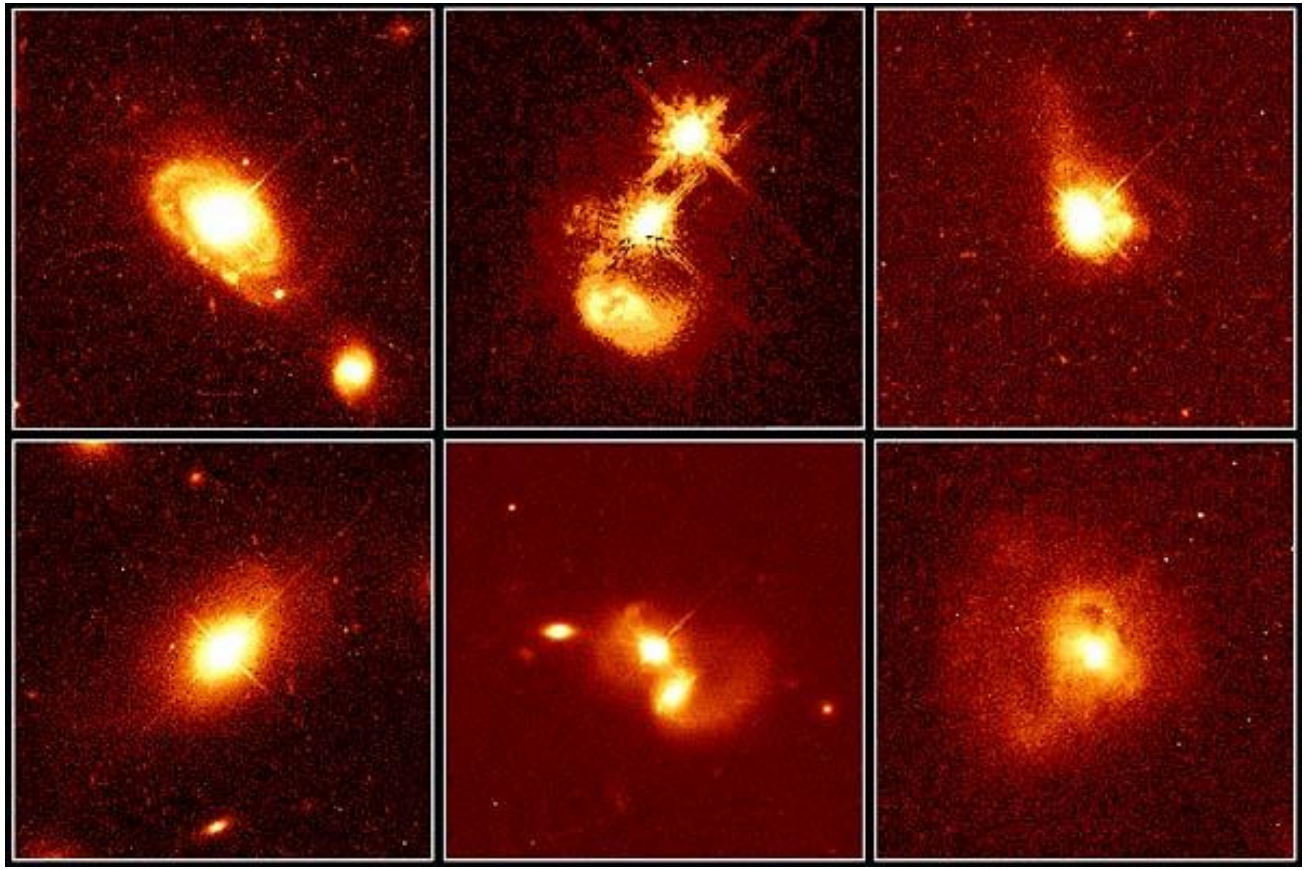
The Sharpest View of the Sun

Credit: SST, Royal Swedish Academy of Sciences



A Quasar Portrait Gallery

Credit: J. Bahcall (IAS, Princeton),
M. Disney (Univ. Wales), NASA

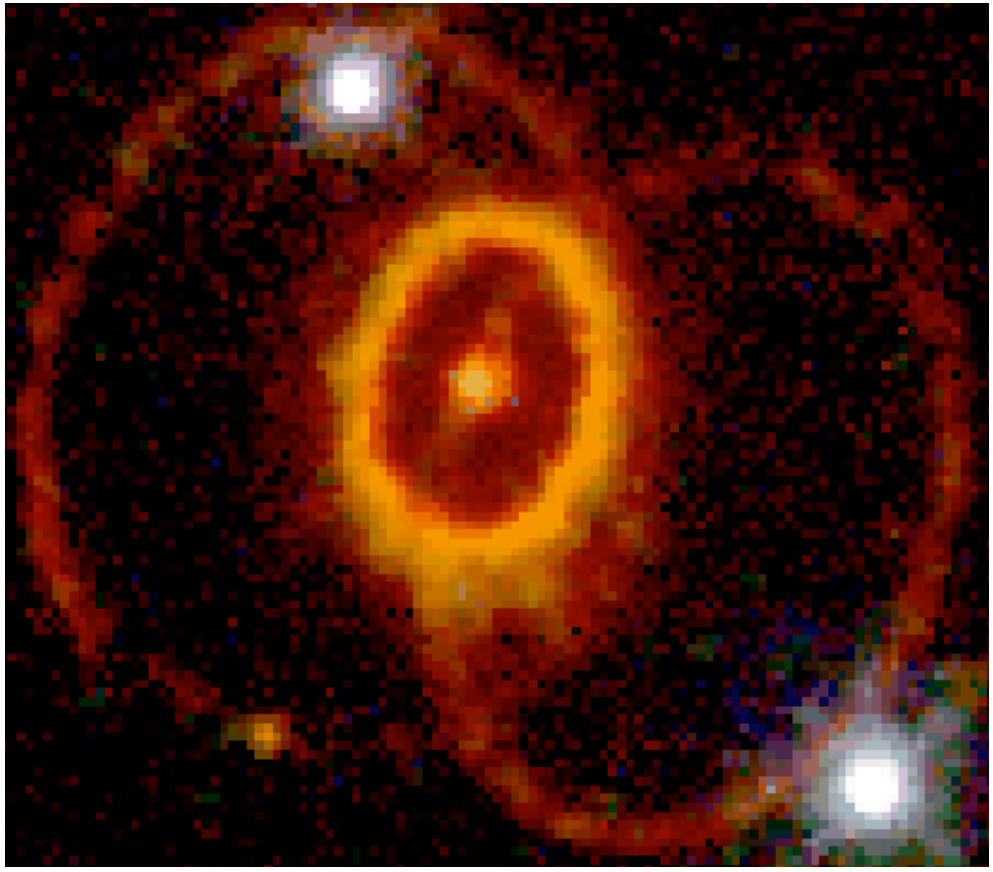


The Crab Nebula from VLT

Credit: FORS Team, 8.2-meter VLT, ESO

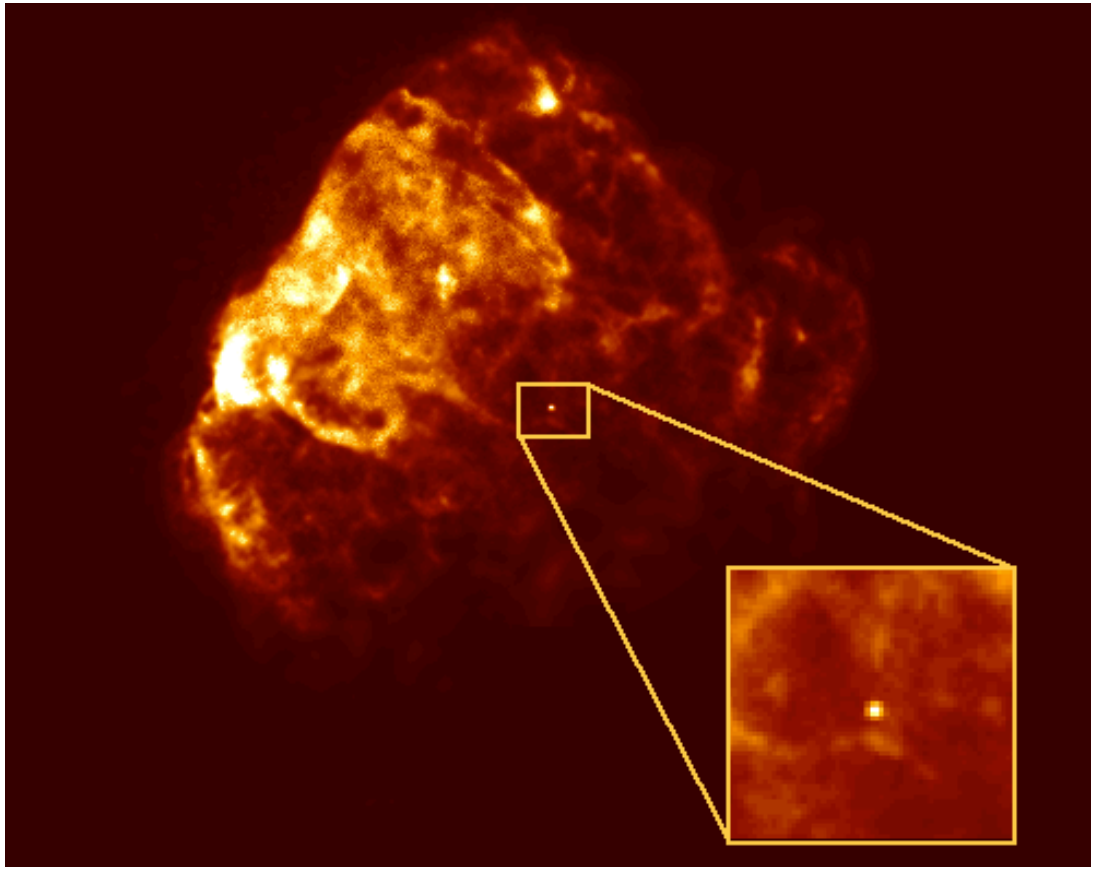
The Mysterious Rings of Supernova 1987a

Credit: C. Burrows (ESA/ STScI), HST, NASA



Supernova Remnant and Neutron Star

Credit: S. Snowden, R. Petre (LHEA/GSFC), C. Becker (MIT) et al., ROSAT Project, NASA



The Coma Cluster of Galaxies

Credit & Copyright: O. Lopez-Cruz (INAOEP) **et al.,** AURA, NOAO, NSF