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 (1 cm = 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
Typical Space Telescope Design
X-Ray Telescope

Focus

Primary Mirror

Secondary Mirror
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

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