Binoculars

Under “good seeing” conditions the *naked eye* can see stars up to 6th magnitude, the constellations, most of the planets, and the Sun, the Moon, and their eclipses. With a modest pair of binoculars you can gather more light and magnify objects, allowing you to see details on the surface of the Moon and planets and to view comets, and some deep-sky objects like nebulae and supernovae.

Binoculars use prisms to “bend” light as it passes from the objective lens, which collects light, directing it through a series of lenses to the eyepiece. The lenses allow binoculars to be more compact and correct the orientation of the image in the eyepiece. Binoculars are made in “power-by-aperture” sizes, where power is the magnification of the image (e.g. 7x) and aperture is the diameter of the objective lens (e.g. 50mm). A good starting size is 7x50 and using a tripod or monopod mount is also helpful for stabilization.

Telescopes

Telescopes gather far more light, have much greater magnification, and mounts that are useful for finding and tracking objects as the Earth rotates. Optical telescopes are designed to collect as much light as possible and focus it on a lens for image correction and magnification. In general, the greater the aperture, the more light you can gather, and the greater the focal length, the greater the magnification.

Telescope	Function	Features
Refractor (Galileo, Kepler)	Objective lens bends light to focus directly into eyepiece.	Can be simple and portable, but lenses are expensive and cannot collect much light. Convenient for altazimuth pointing.
Reflector (Newtonian)	Large, parabolic primary mirror focuses image onto flat secondary reflecting into eyepiece.	Huge light bucket for deep seeing, but less portable. Dobsonian mount for easy altazimuth pointing, or equatorial mount for constant tracking.
Compound (Schmidt, or Maksutov)	Long focal lengths folded into compact design with image correction.	More portable than reflector with lots of light collecting, but complex and expensive.

Be wary of inexpensive telescopes as they can lead to a very frustrating experience. Telescope prices vary widely as there are many types to consider. Consult an amateur astronomer or visit a local astronomy club gathering to learn more about telescopes.

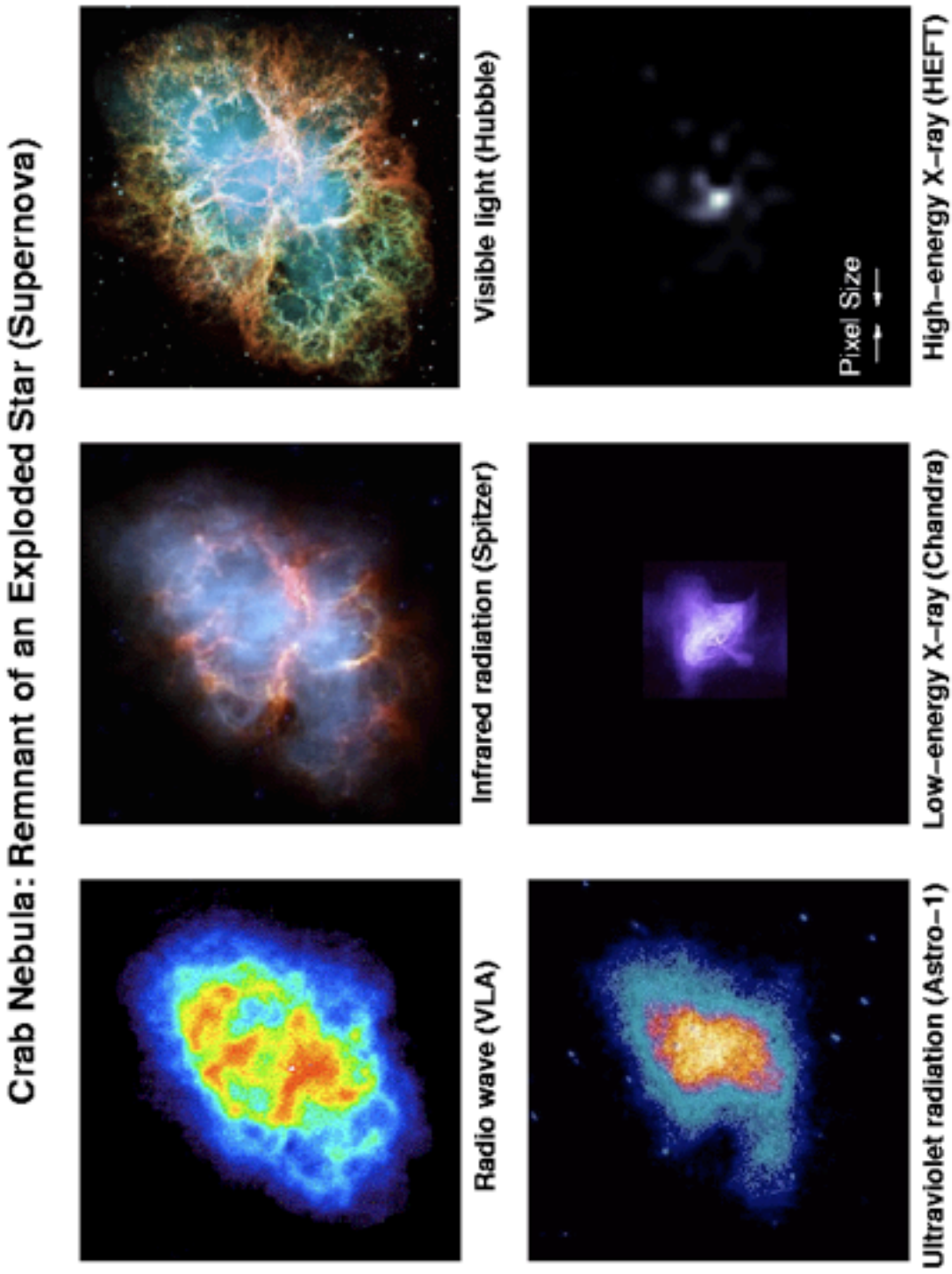
See also attached illustration of telescope schematic and light path.

Observatories

Astronomical observatories are land or space-based facilities used by amateurs and professionals for a wide range of astronomical research. There are hundreds of professional ground-based observatories ranging from a single dome to hundreds of miles in aperture, and hundreds more public and private small and large amateur observatories throughout the world.

Telescope	Wavelength	Targets	Base
Radio	> 1mm	Cosmic background radiation, pulsars, quasars, radio galaxies, and supernova remnants.	Ground (Arecibo, VLA)
Sub-millimeter	0.1mm - 1mm	Stars, molecular clouds.	Ground (Mauna Kea, ALMA), Space (SWAS, Herschel)
Infrared	700nm - 1mm	Infrared radiation from visible sources.	Ground (Mauna Kea), Space (Spitzer, Herschel)
Visible	400nm - 700nm	Normal visible light sources.	Ground (LBT), Space (Hubble)
Ultraviolet	10nm - 400nm	Optical sources and others.	Space (Hubble, FUSE)
X-ray	0.01nm - 10nm	Galaxy clusters, neutron stars or black holes, Active Galactic Nebulae, and some solar system bodies.	Space (Chandra)
Gamma-ray	< 0.01nm	Emissions from highly energetic celestial events, e.g. supernova, radioactive decay.	Space (Compton Gamma Ray Observatory)

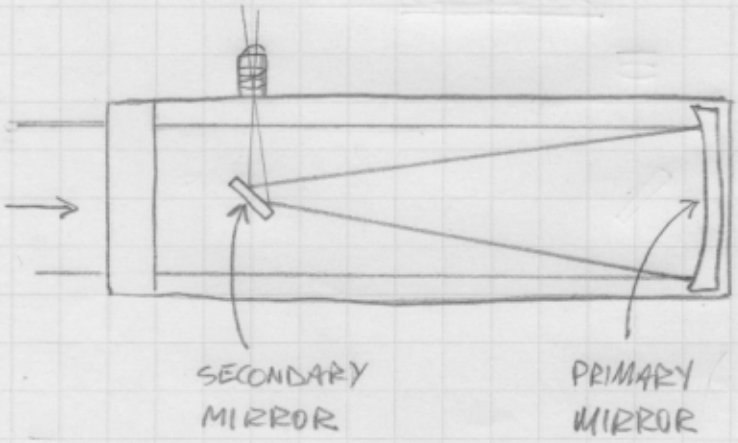
Further Reading: Amateur telescope making, Binoculars, Great Observatories satellites, List of Astronomical Observatories, Robotic telescope, Skymaps.com (reverse), Telescope.


Crab Nebula: Remnant of an Exploded Star (Supernova)
Visible light (Hubble)
Infrared radiation (Spitzer)
Radio wave (VLA)
Pixel Size
High–energy X–ray (HEFT)
*** 15 min exposure ***
Low–energy X–ray (Chandra)
Ultraviolet radiation (Astro–1)

REFRACTOR

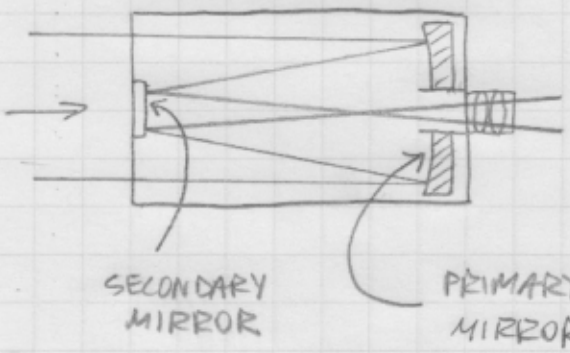
+ PORTABLE
+ SIMPLE
− CHROMATIC ABERRATION
− EXPENSIVE
− LOWER MAGNIFICATION

REFLECTOR



+ BIG LIGHT BUCKET
+ NO CHROMATIC ABERRATION
+ LEAST EXPENSIVE
− MORE LIGHT LOSS
− DIFFRACTION POSSIBLE (SECONDARY)
+ WELL-SUITED TO DOBSONIAN MOUNTING
+ SIMPLE, MAKE YOUR OWN!

COMPOUND



+ COMPACT, LIGHT-FOLDING
+ MINIMIZE ABERRATIONS
− MOST EXPENSIVE
− GREATEST LIGHT LOSS
− LONG COOLING TIME (SEALED)