Telescopes: (Chapter 6)

Human eyes only see visible light. Eyes can't make a permanent record of what they see, can't see dim objects, and are blinded by bright objects. Astronomers need something better - cameras.

Eyes have three main parts: pupil, lens, and retina. The pupil controls how much light enters the eye, the lens bends the incoming lightrays together to a focus, and the retina is where the light is absorbed and detected. Cameras need the same three parts - something to control how much light comes in, something to bend the light to a focus, and something to detect the light.

Light emitted from a point source spreads out in all directions. Every point on the surface of a lens is illuminated by a light-ray from this point source. The special property of a lens is that it bends these light rays as they pass through the lens such that all the light-rays converge at a single point (the focal point) on the other side of the lens.

Telescopes help collect light that is then observed by a camera or an eye. Good telescopes have a large light-collecting area, so that dim objects appear brighter, and good angular resolution, so that the image has sharp edges. The angular resolution of a telescope is limited by atmospheric turbulence and by the diffraction limit of light.

Refracting telescopes use a lens to gather light. The entire lens must be perfect and the lens is mounted at the top end of the telescope, which is unstable. Reflecting telescopes use a mirror. Only the surface of the mirror must be perfect and the mirror can be mounted at the base of the telescope, which is more stable. Most astronomical telescopes today are reflectors.

The eye can detect red, green, and blue light separately. Black-and-white images appear the same to each type of colour detectors in the eye. Astronomers often show three black-and-white images together, one printed in red ink, one in green ink, and one in blue ink, to form a composite colour image. The viewer can interpret such a composite image more easily than three separate black-and-white images.

Sometimes astronomers take spectra instead of an image. A spectrum measures the brightness of an object at different wavelengths, revealing the chemical fingerprints of different elements in the object.

Since the atmosphere prevents many wavelengths of light (UV and X-ray) from reaching the ground, telescopes in space can see things that telescopes on the ground cannot. They are also above atmospheric turbulence, so have better angular resolution.

Light can be observed at many wavelengths, from gamma rays to radio waves, using telescopes and cameras designed for those wavelengths.