OPTICS AND TELESCOPES

Chapter 6

INTRODUCTION

The telescope is the astronomer's window into the cosmos. The laws of optics govern how a telescope focuses incoming light to a focal plane. Smaller telescopes may be refracting or reflecting telescopes. A refracting telescope uses only lenses (refractive elements) to bring light to a focus while a reflecting telescope uses curved mirrors to bring light to a focus. Catadioptric telescopes use both lenses and mirrors. Refractors are more expensive and heavier than comparably sized reflecting telescopes. All professional observatory-sized telescopes are reflecting telescopes. Assuming that any telescope suitable for astronomical viewing is going to possess excellent optical components, the fundamental criteria for judging the quality of a telescope is its light-gathering power (LGP), which is determined by the aperture of the primary objective. Ultimately, regardless of aperture, the quality of the "seeing" will determine quality of the image produced by the telescope. Even the largest telescopes will produce blurred images if the atmosphere is not steady and clear. Adaptive optics, which are being used in most modern observatories, minimize or can even eliminate the effects of slow-moving atmospheric distortions in the telescopic image. Telescopes are not limited to viewing only visible light. High-altitude and orbiting observatories have been equipped with γ-ray, x-ray, UV, and IR telescopes. The high altitudes eliminate the absorption of the light due to the atmosphere. Ground-based telescopes may be optical or radio. Radio telescopes don't suffer as much from the atmosphere since radiowaves are only minimally affected by atmospheric conditions. However, the resolving power of a telescope is dependent on the observed wavelengths so radio telescopes must be very large (or combined as part of a long-baseline array) to achieve resolutions similar to optical telescopes.

GOALS

- ✓ It is important to know the different basic telescope designs and the different components which bring light to a focus.
- ✓ Lab investigations showed how different optical components responded to light and how to measure the focal length of a lens. In lab, it was also demonstrated how to make a simple refracting telescope and calculate its magnifying power.
- ✓ A basic knowledge of the different basic telescope mounts is useful when comparing different observatories.
- ✓ It is important to know the characteristics of telescopes which observe electromagnetic radiation other than visible light. Knowing the optimum location of the observatory (ground-based or space-based) and the reasons for the location the observatory are very important.
- ✓ As a complete understanding of the advantages and limitations of different telescopes, the concepts of aperture, light-gathering power (LGP), angular resolution, focal length, and Dawes Limit should be understood.
- ✓ With the improved data-handling and analysis capabilities of the late-20th and 21st centuries, long-baseline radio interferometry and long-baseline optical arrays are becoming more common. The advantages of constructing such arrayed telescopes should be understood.

DEFINITIONS

You should have a working knowledge of at least these terms and any others used in lecture and lab. Many of. these terms will be found In the glossary at the class website.

adaptive optics	chromatic aberration	diffraction
angular resolution	spherical aberration	diffraction grating
baseline	coma	eyepiece
Cassegrain geometry	Cassegrain focus	field
Catadioptric design	coudé focus	apparent field
charge-coupled device (CCD)	Newtonian focus	true field
	prime focus	focal length

focal plane
focal point
focus (as in a lens or mirror)
grating
imaging
interferometry
light-gathering power
light pollution
magnification
magnifying power
Newtonian reflector
Cassegrain reflector
Schmidt-Cassegrain
Maksutov-Cassegrain
objective
objective lens
objective mirror
primary mirror
secondary mirror
optical telescope
γ-ray telescope
x-ray telescope
UV telescope
IR telescope
radio telescope
photometry
radio window
reflecting telescope
reflector
refracting telescope
refractor
reflection
refraction
seeing
spectrograph
spectroscope
spectroscopy
very-long-baseline interferometry