Night Lab 2

The Problem

Ever since Galileo first pointed his small telescope to the sky in 1610, the basic tool of astronomers has been the telescope. The purpose of a telescope is not just "to bring objects closer" (to use the popular expression), but it is also to collect more light from stars and galaxies so that we can observe fainter objects than one can see with the unaided eye. Modern astronomers also make telescopes to operate at wavelengths of light which the eye cannot see at all - in the radio, infrared, ultraviolet and x-ray parts of the spectrum. In the observatory, you will see just how much more one can learn about the sky by using even a small telescope.

Introduction

Even a small telescope provides an enormous gain over simple naked-eye observations, and modern telescopes equipped with sensitive light detectors are capable of measuring incredibly faint and distant objects. Unfortunately, many people who have seen beautiful color photographs in the textbooks will expect to see similar views when they look through a telescope. However, visual observations, even through a large telescope at a good location, simply cannot match what can be done photographically. For that reason, few astronomical measurements are made visually, but are recorded photographically or digitally for later analysis. Nevertheless, one can gain some insight into the way astronomy is done with simple visual observations using a small telescope.

The heart of any telescope is the **objective**, the primary lens or mirror that gathers and focuses the light into an image. Other optical elements may include an **eyepiece** for making visual observations, or a camera, a spectrograph or other instrument for making measurements. In addition, all astronomical telescopes must be mounted so that they can be pointed to any part of the sky and so that they can follow stars as the Earth rotates.

The most common type of telescope mounting is the **equatorial mount** shown in Figure 1.

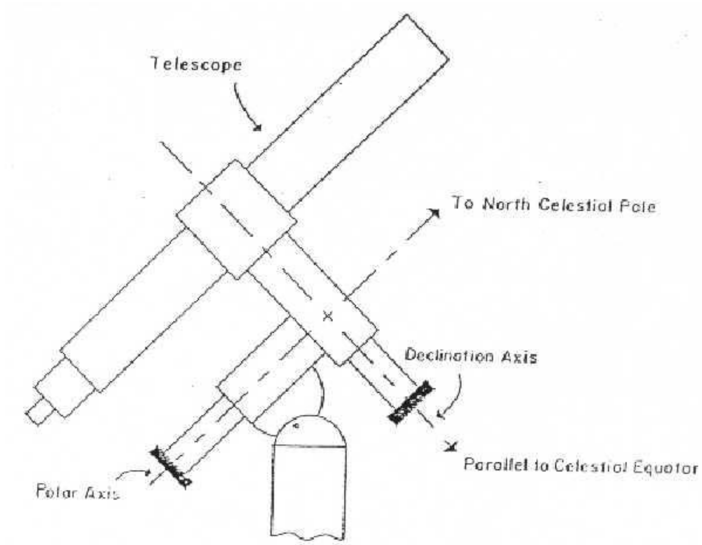

Figure 1 -- An Equatorial Telescope Mount

The **polar axis** is parallel to the axis of rotation of the Earth; as the Earth turns, the polar axis turns in the opposite direction, thus compensating for the rotation of the Earth and keeping a star in view. In order to observe stars at different declinations, the **declination axis** permits the telescope to move in the perpendicular direction.

Many people believe that the most important characteristic of a telescope is its **magnification;** that is, how large the image appears to be when one looks through the telescope. Actually, the most fundamental properties of a telescope are its **aperture** (the diameter of its objective) and its **focal ratio**, the ratio of its **focal length** to its aperture. If two telescopes have the same focal ratio, they will be able to photograph objects that are the same brightness in the same length of time. However, the telescope with the larger aperture will have a larger image.

The magnification is a secondary characteristic of a telescope, of relevance *only* when making visual observations. One can change the magnification of any telescope simply by switching eyepieces, and most small telescopes are equipped with several eyepieces. The magnification of any telescope/eyepiece combination is determined by the ratio of the focal length of the objective divided by the focal length of the eyepiece. That is:

$$magnification = focal\ length_{objective}/focal\ length_{eyepiece}$$

As you will see, it is not always desirable to use the highest magnification possible. As the magnification is increased, both the **field of view** and the **brightness** of the image decrease. Thus for observing a faint nebula, one would generally want a relatively low power eyepiece, but for some bright object such as the Moon, a much higher power will often be useful.

To get some idea of the possibilities and problems of observing with small telescopes, you will be observing a variety of objects. The emphasis of this project is to learn how telescopes work, and how they can be used to measure the universe. The objects that you can observe on any given evening will depend on weather conditions and on which ones are actually visible at this time of the year. Your instructor will select the objects to be observed and set the telescopes. Among the possible types of objects you might observe are:

1. The Moon – The easiest and brightest of all nighttime objects is visible in the evening for two weeks each month.

2. Planets – There may be one or more planets visible at any given time.

3. Binary Stars – Observations of binary stars can help demonstrate the capabilities (and the limitations) of moderate aperture telescopes.

4. Star Clusters – Several star clusters may be visible, but they are more difficult to locate in the city.

5. Nebulae and Galaxies – The city lights make it almost impossible to locate even rather bright galaxies and nebulae. Only a few of them can be seen at all in the city.

Available equipment

1. Telescopes

2. Binoculars

Experimental Procedure:

1. Telescope Components

Your lab instructor will help you to identify the various parts of telescope and demonstrate its use. You should be able to identify the main components of a reflecting and refracting telescope.

Sketch the Celestron 8 inch telescope. Label the declination and right ascension axes, the polar axis, the objective mirror, the finderscope, the eyepiece, and the brakes.

Which telescope, the 6.5" refractor or the 8" Schmidt-Cassegrain, has a longer focal length?

2. Telescopic Observations

Make telescopic observations of as many of the following objects as are visible. Be sure to include the constellation in which the object is present, the eyepiece focal length, the objective focal length, and the magnification.

i) The Moon - Compare the view near the lunar **terminator** (the day/night boundary of the Moon) with that near the **limb** (the edge of the Moon). Examine the view with different magnifications by looking through the telescope's finderscope also and/or binoculars.

ii) Planetary Observations – Describe in detail what you see of the planet. Include in your description any surface detail visible, any moons (their positions and brightness and size relative to one another), and a sketch of the planet.

iii) Binary stars – Describe their appearance, including color and relative brightness of the two stars to each other. Using the colors of the stars, determine which star is hotter.

iv) Star Clusters – Describe the cluster: include an estimate of the number of stars in the cluster, the colors of the stars, and the shape of the cluster. What can you determine from a star cluster that has many white dwarfs and few massive stars (stars with more than eight solar masses)?

v) Nebulae, Galaxies - Describe the shape and colors of the object.

vi) Other objects - From time to time there may be other objects of interest to view - comets, asteroids, novae are all may be visible. If there are any such serendipitous objects, be sure to observe them and record what you see.

3. Binocular Observations -
i) There will be several pairs of binoculars available for observing the Moon and planets.
With the help of the instructor, try to locate at least two such objects.

Analysis and Discussion

This introductory exercise is intended to give you a basic knowledge of telescopes and to introduce you to telescopic viewing. Your report should primarily be a narrative of what you actually did, based on the notes and sketches that you made. Discuss the use of magnification in telescopic observing, including instances when low magnification is the most useful and also when high magnification is the most useful. Discuss how the sky conditions affected your observations. If appropriate, discuss some of the things you could not see that should have been visible.

Data Pages

Attach your original data pages, including the following:

Description of the sky conditions

Unusual events if any

Notes on objects viewed through the telescopes

Sketches