Night Lab 1

The Problem

With even the simplest of equipment it is possible to measure one's position on the Earth and to mark the passage of time. Indeed, these were the first chores of early astronomers.
The movement of celestial objects across the sky defines our concept of time: the Sun rises in the East in the morning and sets in the West in the evening. The sky is just a giant clock, marking the passage of days and the progression of the seasons. All of us know that the stars appear to move across the sky as the Earth rotates, but few people actually have watched this happen. One purpose of this exercise is to use simple measurements of the nighttime sky to deduce your location on the Earth and to see the celestial sphere move overhead.

Introduction

The first thing you will find when you visit the observatory is that the middle of Boston is almost the worst place in the world for astronomy; nevertheless, with a little patience, you will be able to learn a great deal about the sky, even four blocks from Fenway Park.

Ancient astronomers believed that the Earth was at the center of an enormous Celestial Sphere, to which the stars, Sun, Moon and planets were fixed. For purposes of finding one's way around the sky, this simple model for the universe is still quite satisfactory, and most modern astronomical coordinate systems are based on this ancient concept.

While it is not a physically meaningful model, that is what the sky looks like through your eyes. Thus, celestial globes, the planetarium and the “celestial pipes” in our observatory are all convenient spherical representations of the sky as seen from the Earth.

Many of these concepts can be demonstrated using the celestial pipes located on the deck next to the observatory. If you stand under the celestial pipes, you should first identify the small cross-bar on the North-to-South pipe representing the celestial meridian. This cross-bar locates the north celestial pole, and Polaris should be very close to it. Looking in the opposite direction you should be able to identify the pipe representing the celestial equator. Note that every 10° of declination is marked on the meridian pipe and every hour of hour angle on the celestial equator pipe. With this simple arrangement, it is possible to estimate the approximate positions of stars and planets. 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.

The goals of this exercise will be to learn how to find your way around the summer sky by:

1. Identifying some of the major constellations that are visible at this time;

2. Sketching the stars in a constellation, identifying the brighter stars, and noting any colors you see;

3. Observing the passage of time using the "celestial pipes" as the sky turns overhead;

Available equipment:

1. "Celestial Pipes"

2. Quadrants

3. Binoculars

4. Telescopes

5. Star charts

Suggested Experimental Procedure:

1. *The Celestial Sphere –*

With help from your instructor or the celestial pipes, locate the North Star (Polaris). Compare your star chart with your view of the northern sky. Using a simple quadrant made with some string and a protractor on a stick, measure the altitude of Polaris above the horizon. Record the sky conditions, the directions of major landmarks and other relevant information in your notes. Be sure to take note of any unusual events that occurred, such as meteors, satellites or other phenomena.

2. *Constellations –*

Your instructor will lead you in a tour of the celestial sphere, pointing out the more prominent constellations and brighter stars visible. Compare what you can see in the sky with what is shown on your star charts. In your notes, record a brief description of each – comments such as "the basic pattern of the constellation was clearly visible," or "only one or two stars visible," etc. are enough.

Do an in-depth study of one of the more obvious constellations. Draw a careful sketch of the stars you can see (a pair of binoculars will be helpful here). Identify the stars in your sketch in the approximate order of their brightness as they appear to you. Take note of any color you can see in any of the stars.

If the Moon and any planets are visible make note in what constellations they appear.

3. *Time –*

The "celestial pipes" in the observatory can be used as a clock to record sidereal time (time as measured by the daily movement of the stars rather than the Sun). Choose a star or planet close to the celestial equator. Record its hour angle and declination at the beginning of the class and near the end of the class. Be sure to record the standard time (as measured on your watch) as well. Estimate how well you can record the star's hour angle. Also record the position of the Moon and any other planets that are visible, be sure to record the time the measurements are taken. Make a sketch of the Earth, Moon and Sun orbital positions relative to each other during your particular observing session.

Analysis and Discussion

This introductory exercise is intended to give you a feeling for the night sky and to help you understand how astronomical observations are made. Your report should primarily be a narrative of what you actually did, based on the notes and sketches that you made. Discuss how the sky conditions affected your observations. If appropriate, discuss some of the things you could not see that should have been visible. Compare your time and latitude measurements with the expected values.

Data Pages

Attach your original data pages, including the following:

Your description of the observing conditions: time, sky conditions, moon phase and moon's constellation;

Altitude of Polaris measurements;

Unusual events, if any;

Constellation notes and sketch;

Constellation in-depth study;

Constellations in which the Moon and any planets are located;

Hour angle measurements;

Location of the Moon and any planets made using the celestial pipes.

Sketches of Earth, Moon, and Sun orbital positions;

Notes on telescopic observations, including any sketches.