PH2900 Observatory Practical #1

1 Introduction

In your first observatory practical you will learn the basics of how to use the telescope and one of our CCD cameras.

For most of the steps below the demonstrator will show you how to proceed. Please be very careful with all of the equipment. Much of it is delicate and a bit fiddly, so if something doesn't work on the first go, do not force it. Ask for help. Do not overtighten any of the set screws, and most importantly be careful and don't rush.

2 Procedure

First we will point the telescope at the star Vega 'the hard way', i.e., we will set the declination and hour angle of the telescope using the setting circles. In practice we will usually do this with the telescope's computer, but for this one time we will do it the old fashioned way as an exercise.

2.1 Initial set-up

The telescope is a Meade LX200 GPS. Start up the telescope with the switch on the left of the telescope's console box. The telescope's computer will take several minutes to set the local latitude, longitude and time using its GPS receiver, after which it will beep and say "Align – One star".

The hand-paddle has a nested set of menus. The top line on the hand paddle shows you what menu you're in, and the bottom line shows one of several submenus into which you can enter. You can scroll through the remaining submenus with the up and down arrow keys at the bottom of the hand-paddle (not to be confused with the up, down, left and right keys in the middle of the paddle).

To enter into a submenu, press enter; to go back, press mode. In particular you do *not* want to go into the "One star" submenu of "Align". When the scope starts up the first thing to do is to press mode twice, which will put you at the top of the system of menus, called "Select item". More information on the menus can be found from the course website (including the online manual for the LX200).

Your demonstrator will show you how to mount the flip-mirror assembly and insert a low-power eyepiece and the LPI CCD camera.

2.2 Finding Vega

Start the program Starry Night and find the star Vega. Go to the info window box and get the star's right ascension and declination. Also record its Hipparcos catalogue number.

To move the telescope we will only use the four arrow keys in the middle of the hand-paddle. The up and down keys move the telescope north and south; the left and right keys move it east and west.

In your write-up, make a sketch of the region near the north celestial pole as seen from the inside of the celestial sphere and show for at least two locations what is meant by moving the telescope north, south, east and west.

Using the north and south keys, set the declination to the desired value as accurately as possible by looking at the telescope's setting circles. Make a rough estimate of how accurately you think you have it set.

Next, we need the hour angle of Vega, which is related to its right ascension by

$$h = \mathrm{LST} - \alpha \ , \tag{1}$$

where LST is the local sidereal time. To find this, go to the website `tycho.usno.navy.mil/sidereal.html` or find a another sidereal clock on the web. For our longitude use $\lambda = -34'$ (recall we measure longitude increasing to the east).

The hour angle setting circle of this telescope wasn't well designed for this sort of operation. You will have to hold one part of the setting circle in place and aligned on zero as you slew the scope east and west. Think carefully about which direction from zero you need to move the telescope. By the time you finish setting the hour angle, refresh the website showing LST and make a final adjustment using the updated value.

You should be able to observe Vega in the finder scope, although you will be lucky if you are accurate enough to see it in the eyepiece without a little tweaking. Using the north-south-east-west keys, centre Vega in the eyepiece.

Providing the telescope was powered off correctly, it should know what direction it is pointing in when it is powered back on. Nevertheless we can now set the telescope's current direction to the direction of Vega with the following steps:

1. Press the "star" key.
2. Get "named" using the arrow keys (bottom of hand-paddle) and press enter.
3. Using again the arrow keys find the star you're pointing at and select it with "enter".
4. Now press and hold enter, when you release it will prompt you to press enter again to synchronise. When this is done the computer will beep.
5. Press the mode key to go back to the main menu level.

Every time you get an accurately alignment on a known object, it is useful to repeat this procedure so that the telescope retains the best possible knowledge of what direction it's pointing.

2.3 Focusing

The telescope has two focusing adjustments: a manual coarse adjustment and an electric fine adjustment. Start with the coarse adjustment by first unlocking the primary mirror and try to get as good of a focus as possible by hand. **The primary mirror must be unlocked before you try to focus manually. Failure to do so can cause severe damage to the telescope.** When you are done focusing, relock the mirror.

To use the electric focuser, press the "focus" key on the hand-paddle. This will put you in a special mode where the east and west keys now control the focus. This focuser actually moves the eyepiece (or camera) in and out of the rear cell of the telescope – it does not move the primary mirror. You can change the rate of focusing using the up and down arrows at the bottom of the paddle. When you are done focusing, pressing the "mode" key to exit from the focusing mode.

2.4 Finding a star using the telescope's computer

Once the telescope's coordinates have been synchronised using a known star, you can use the telescope's computer to point the telescope in different directions. One way to do this is with the "go to" key on the hand-paddle. To practice this, first slew the telescope somewhat away from Vega using the arrow keys.

To use the "go to" key, you first need to go tell the telescope what object you want to go to. From the top of the menu tree (Select item) enter into "Object", and then "Star". There are several ways to specify which star you want. One way is to enter the "named" submenu, which gives you a list of named stars. Scroll through this list until you find Vega and select it by pressing "enter". The hand-paddle should read "Vega – Alp Lyr" (Alpha Lyrae).

Another way to select a star is by specifying its Hipparcos catalogue number. The Hipparcos catalogue includes 118 218 stars whose coordinates were measured by the Hipparcos mission in the 1990s. You can get the Hipparcos number for any star from Starry Night by placing the cursor over the star, right-clicking, and selecting "info window". The Hipparcos (HIP) number is in the upper left. Go back to the hand paddle, select "Object", "Star", "Hipparcos number", enter the number and press enter.

With whatever method you choose, get the telescope's paddle to read "Vega – Alp Lyr". Now when you press the "go to" key the telescope will move there, but before you do this, make sure you can get at the power switch to turn it off quickly in case it starts to move in a direction you do not expect. This is particularly important if you have a large CCD camera mounted on the telescope. If it were to try to slew too far north, it could cause the camera to collide with the fork. After pressing "go to" wait for the telescope to slew to the desired direction. It will beep when it's there.

Another important way to go to a star is to set the RA and dec manually. To do this, hold down the "mode" key for two seconds and release (this can be very fiddly – you may have to try several times). The paddle will then read the RA and dec values. You an then use the north-south-east-west keys to move to any desired values of the coordinates.

Use both of these methods to practice moving to several stars.

2.5 CCD camera

Your demonstrator will show you how to set up the LPI (Lunar and Planetary Imager) CCD camera and start the LPI program. Practice centring several stars in the CCD's field of view (make sure you've set the flip mirror so that light is hitting the CCD and that you've selected the 'live' view).

Practice recording images of several stars and store them in a folder that indicates the date, e.g., 12oct07. You can copy this folder to the Y or W drives of whomever is logged in and later the data can be shared with the other members of the group.

You will learn more about using the CCD camera in the next practical.

3 Report

In your report you should include a brief description of the procedure followed, observations, analysis, and results, following all of the guidelines that you learned in the first-year laboratory course. Include at least one image of each target observed and in addition you should provide some (brief) background information on all of the targets. Discuss briefly the pointing accuracy that you were able to achieve using both the telescope's computer and pointing by hand. In addition you should answer any questions in the script. The entire report should consist of around 3 pages of text not including images, tables, etc.

G. Cowan
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