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Lab 3 - Observation Planning

September 20, 2017

This lab is a bit different from the other labs that we'll be doing this semester in that we won't be using Python. Goals are:

1) You will be introduced to the observational planning software iObserve
2) You will learn how to use the Astronomical Database Simbad to find out more about objects and find references to them.
3) You will use iObserve to select a target for your final project and will write a brief observing proposal.

Intro to iObserve

1. Open iObserve and click on "New Observatory"
2. Look up the latitude, longitude and altitude of Smith College and enter it in the iObserve fields and on your lab worksheet. *You may need to convert fractions of a degree to hours and minutes. You will also have to be careful about "East" and "West" longitude. The Longitude input for iObserve assumes positive numbers are East.*
    a. Latitude: _______deg ______ min ______ sec
    b. Longitude: _______deg ______ min ______ sec
    c. Altitude: _____________________ meters
3. When you think you've found all the right answers, check them with two neighboring groups and resolve any disputes.
4. You don't need to send an e-mail to the creator of iObserve about the Smith Observatory, so when you're done and that screen comes up, click "cancel".
5. Now click on "New Object" in the upper menu bar.
6. In the field marked "Object Name", type "M22" and then "Add New Object". What appears will be the standard iObserve interface, with an orange curve labeled "M22". **Note:** *Make sure that the observatory selected is Smith Observatory, by selecting from the drop-down list of observatories in the lower right by the dome icon.*
7. Do the same for the object "M13". Both should now appear in the lefthand iObserve menu marked "OBJECTS". When you click on each one, the curve for that object will show, but if you click on one and then command⌘ + click on the other, both curves will show at once.
8. Play around with the interface for a while and answer the following questions:
    a. What are the axes on the main iObserve plot (note that there are two x and two y axes)? Define each term in your own words
    b. Click on the label "Local Mean Sidereal Time" at the top of the plot and "Universal Time" at the bottom of the plot several times to see all of the options (there should be three). Which two do you think will be most useful to you when you're conducting observations and why? Set the axes to these.
    c. Play with the two sliding bars at the bottom right and left of the plot until you understand what they do and then write an explanation.

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d. The three shades of blue on the plot mark civil, nautical and astronomical twilight, respectively. How long does each phase of twilight last? How long between sunset (the start of civil twilight) and the end of astronomical twilight?
e. At the very bottom center of a plot is a slider with "today" marked and two arrows on either side. Drag the slider forward, and many things will change. What are they?
f. Use your answer to e to record on your lab worksheet to record at what times of year M22 can be observed. Do the same for M13.
g. Click forward twice until you see the date in the form MM/DD/YYYY. Click on DD and toggle the date between yesterday and today until you see a black vertical line appear on the iObserve plot. This is the current time (*iObserve is a little buggy for this one thing, which is why we have to do this)*.
h. Drag your cursor into the iObserve window and you'll see a red cross. (You may need to click the "Curve Tracking" checkbox in the lower right.) Two types of boxes appear near the object curves when you do this. The most relevant quantities in these boxes are hour angle (HA), airmass (AM) and the UT/LST time of the cursor. Define in your own words the hour angle and airmass quantities.

9. Another useful feature of iObserve is the ability to get so-called "finding charts". Select M22 and then click on the tab at the top labeled "Charts". Then click "Download all Charts". This will pull images centered at the appropriate RA and Dec from a bunch of all-sky surveys. "DSS" charts are from the optical wavelength Digital Sky Survey and the "2MASS" charts are from an infrared wavelength all sky survey called the 2 Micron All Sky Survey, which was a collaboration between UMass and JPL/Caltech.
    a. If you click and drag inside any of these images, you'll create a triangle with the angular distance along each side labeled. Do this in one of the DSS images and use it to get the field of view of the image. How big is it?
    b. Check that you got it right by clicking on the menu at top that says "All Charts" and selecting the one you were looking at. The FOV will be printed as a label.
10. Going back to our airmass charts, why are neither M13 nor M22 good targets for us to observe this semester? Which cluster would be difficult to observe any time of year from the Smith Observatory, and why?
11. Write down the "ideal" RA range of targets that we can observe this time of year.
12. Write down the "ideal" Dec range of targets that we can observe from Smith.
13. Using the list of globular and open clusters from your homework or, probably more efficiently, using Google to find the best Northern hemisphere candidates, add a number of globular and open clusters to iObserve as targets. We suggest creating folders - one for open clusters and one for globular - and adding at least 5-10 potential targets for each one. If you mouse over the OBJECTS label at the top left, there will be a little folder icon. Clicking it will create a new folder that you can then name.

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Instructions for the "Observing Proposal" component of Next Week's Homework (#3)

We will be doing our observing at Smith in the first part of the night (~9pm-midnight) over the course of the next month or so, and each group of 2-3 students will need to pick one cluster and one backup cluster to observe. The following information about the Smith telescope and camera will be relevant in choosing your targets:

Camera FOV = 15' x 24'
Magnitude limit = ~14-15th magnitude for clear filter in 60sec
Pixel scale = 0.5"/pixel
Typical FWHM of target stars = 6 pixels

And some things to consider in choosing your two clusters:

a. They should transit at different times in the early evening in case there are clouds
b. At least 50 individual stars within the cluster should be bright enough to detect with the Smith telescope
c. These bright stars should also be far enough apart to avoid them falling onto the same pixel on the Smith camera
d. These stars should fit within the field of view of the Smith telescope

To get this information, you should use a combination of iObserve and the Vizier database that you used last week. Once you select a couple of targets that you think look good, enter their names into Vizier and select "optical" from the wavelength menu and "Photometry: wide-band" from the astronomy menu, then you'll get a list of digital data for that cluster. Look for a table with lots of entries/individual stars from that cluster. You can use this (and python) to be more quantitative about your magnitude limit, field of view, and separation criteria.

Note that the Smith telescope and camera parameters make globular clusters particularly hard to observe. You should only choose a globular cluster as your primary or secondary target if you're confident that you will be able to isolate at least 50 stars at a range of magnitudes (and not just the brightest stars in the cluster).

Your observing proposal should include the following sections, and as many calculations, screen shots from iObserve, etc. as you need to justify your arguments.

1. Introduction
   a. Explain what an H-R diagram is and how it can be used to determine the age of a cluster.
   b. Explain the basic difference between color-magnitude and H-R diagrams.
   c. Explain what an open and/or globular (depending on the targets your chose) cluster is and what you expect a cluster's color-magnitude diagram to look like. What are the main features?
   d. Explain why a cluster's color magnitude diagram can use apparent (rather than absolute) magnitude on the Y-axis. What is special about the stars in a cluster that allows for this?

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2. Targets
    a. List the name, RA, Dec, transit time (in local time), angular size, and range of magnitudes for your clusters in tabular form
3. Observing Plan.
    For all questions in this section, you should use screen shots from iObserve, calculations done in a Jupyter notebook from Vizier data, etc. liberally.
    a. Justify your choice of targets by discussing why you think their location in the sky, distance, angular size, range of magnitudes, etc. makes them good targets for this project
    b. Predict roughly how many stars you expect to be able to resolve in each cluster by tying data on the cluster to the properties of the Smith telescope and detector