Remote Telescope Requests

Remote Telescope Use

Today's computer technology, modern optics, and electronics offer an opportunity to provide you with access to research quality telescopes in both the northern and southern hemispheres. The University of Louisville and the University of Southern Queensland operate remotely controlled telescopes at Moore Observatory near Brownsboro, Kentucky, and at Mount Kent Observatory near Toowoomba, Australia. We are developing the capability to allow students to control these telescopes from home, taking advantage of the fact that it is nighttime at one site when it is daytime at another.

This semester one telescope at Moore Observatory in Kentucky is available with full remote control, and others are operating robotically under the supervision of a professional astronomer acquiring images to meet your requests. This is actually the way that most research astronomy is done today: astronomers pose a problem they want to solve, identify new data that would help them understand the issues, request time on a telescope and specify how that time would be used, get the data back from the telescope, analyze their results, and come to conclusions about the problem they had set out to study. Our goal in this experiment is to offer you an experience like this, and to help you work through the steps to learn by “discovery”

Available Resources

The observatories are described on our website at

http://sharedskies.org

and you are encouraged to explore it to see about the observatories and their telescopes. The content is currently under development, and may change during the semester.

The facilities you have access to include:

- Moore Observatory in the northern hemisphere near Brownsboro, Kentucky
- Mt. Kent Observatory in the southern hemisphere near Toowoomba, Australia

At both observatories we have identical 0.5 meter (20 inch) diameter "CDK20" research telescopes operating with a CCD camera and a selection of filters. These are the primary telescopes for this program. We offer other instruments too

- A 0.32 meter (12.5 inch) "CDK125" - the Shared Skies Live telescope at Moore Observatory you can operate in a web browser to take full color images
- Wide field color cameras for imaging the entire sky, constellations, or comets that may span many degrees
- A 0.6 meter (24 inch) "RC24" research telescope at Moore Observatory used primarily to study planets around other stars

We also have a growing archive of images acquired over the past few years that we provide if a request for a current image cannot be accomodated or we have something already done that we can offer quickly.

What the Telescopes Can Show

Except the color cameras, the CCD cameras on the telescopes return scientific images as digital files in “FITS” format. These images may be viewed with ImageJ, Aladin, or other software you load on your own computer. The JPG images color pictures are the same type as you would usually have from your own digital camera. They may be useful if you are interested in seeing form or structure, watching craters or shadows on the Moon, following the rotation of Jupiter or Mars, or looking for the colors of stars.

Also except for the special wide field cameras, these telescopes cover a field about half a degree across, the apparent size of the Moon. Each pixel resolves about 0.5 arcsecond (there are 3600 arcseconds in a degree), and measures how much light arrived at that spot in the image for the duration of the exposure. By comparing one pixel with another, you can tell how much brighter or fainter one feature of the image is compared to another. The image that you see, while visually exciting, is also a tool to measure how much light there is and where it is.

Some images may be returned to you with a calibration for the position in the sky, and as you explore them you can measure the celestial coordinates of any point in the image. In this way, you can identify individual stars, clusters, nebulae, and galaxies in the images. You can follow the changing positions of asteroids and satellites of planets. You can spot a new supernova, watch variable stars, measure the separation of double stars, measure the diameter of a distant galaxy, or identify a new comet. However, most images are returned without calibrated positions, and you will have to compare them to web-based resources to understand what you have recorded.

With the scientific cameras on the CDK20 telescopes each image is taken through a filter that isolates a narrow band of the spectrum. If you looked through one of them, you would see a blue, green, or red scene. Here’s how we designate the filters that are currently available:

- Blue-Green: g' (400 to 530 nm)
- Yellow-Red: r'(530 to 700 nm)
- Hydrogen: H-alpha (656 nm)
- Red-Near Infrared: i' (700 to 825 nm)
- Infrared: z' (825 1100 nm)

The numbers are the wavelength of light in the spectrum, from blue light at 450 nanometers (nm) to red light at 650 nm (nm). Infrared has a longer wavelenth than red, and ultraviolet has a shorter wavelength than blue. Our telescopes respond well to "near" infrared light, out to 1100 nm, but not well to ultraviolet light.

A measurement with different filters allows us to determine the “color” of a star, or we can put images from blue, green, and red together to make a color image that will resemble what you would see if your eyes could detect this faint light. Images through a filter that isolates light emitted by hydrogen gas would show few stars, and if you could "see" through this filter the scene would look dark red and show only the gas.

The special "live" CDK125 telescope uses a very high quality color camera and provides images immediately in full color, much as you would do with your own digital camera or cell-phone camera. This color camera is not as accurate for measuring the amount of light from stars, but it is excellent for comparing light in different filter bands. Short exposures with this camera show hints of color on the Moon, and fine detail in the atmosphere of Jupiter.

The faintest stars you will find are about 18th magnitude. These stars are more than 10,000,000 times fainter that the brightest stars in the night sky. If the air is steady, the smallest detail you will see is about 1 arcsecond across. For comparison, Jupiter appears about 40 arcseconds across in our sky, and the Andromeda galaxy extends thousands of arcseconds. Due to a limitation on the shortest exposure we can take, stars brighter than about 3rd or 4th magnitude are too bright to record except with the full color camera on the CDK125 telescope.

Within our solar system you could expect to see

- changing phases of the Moon, and its libration
- craters on the Moon and shadows that move during the night
- "earthshine", the light on the dark side of the Moon reflected from Earth
- Venus, Mars, Jupiter, Saturn, Uranus and Neptune moving nightly across the sky with respect to stars
- polar caps and large features on Mars
- satellites of Jupiter, Saturn, Uranus and Neptune moving nightly
- changing atmospheric features on Jupiter and Saturn
- rings of Saturn
- asteroids

- the brighter dwarf planets

Within our Milky Way galaxy you could see

- star birth nebulae
- open clusters of young stars
- active stars that erupt and change brightness
- double stars in orbit around one another (but not so fast that you would see the motion) unless you come back several years later
- planetary nebulae surrounding dying stars
- globular clusters of very old stars

Beyond our galaxy there are

- nearby companion galaxies like the Large and Small Magellanic Clouds
- clusters of galaxies like those in Virgo and Coma
- active galaxies with blackholes in their nuclei
- other fainter galaxies out to distances of over 100 million light years
- quasars out to distances of billions of light years
- the occasional new supernova in a distant galaxy

However, what is available to see depends on the time of year (where Earth is in its orbit), where the planets are in their orbits, and whether you are using a telescope in the northern or southern hemisphere.

How to Proceed

If you are in the astronomy lab on campus and working in a small group (usually 3 students), you may make a decision as a group about what to request. This is easiest for us too, since we have fewer requests to handle that way. However, if you prefer you may work on your own too.

You will have until the end of the semester to complete this exercise. However, it has two graded parts, and the first part you need to do immediately: define a problem and propose an observation. After that, we will help you to use data with our telescopes, and assist you with understanding what it has to offer.

Begin by asking yourself

What would I like to know more about that I could expect to "see" with one of these telescopes?

With that in mind satisfy your curiosity by selecting an object and the sort of data you would like to have on it. Check that the objects of interest are visible to us now, and complete the simple form at this website:

Telescope Use Request Form [1]

Answer the questions on this form as best you can. There is no correct answer, but if needed we will ask for additional information to be sure we can supply data that are interesting and useful. The form asks for a contact email, and you may supply one or more names. You do not have to submit a request for each person in the group, just for the group as a whole.

After you have done that, then each student should answer these questions in the lab and give them to the lab assistant. He may have an immediate suggestion. Remember that we need both the answers from you on the usual lab sheet, and the completed group web form while you are in class today.

Questions

1. What is the name of the object you have selected?

2. What sort of object is it? Simple answers are a planet, a dwarf planet, an asteroid, Earth's Moon, a star ...

3. How bright is it? Give its magnitude. You can find this usually on the web (Wikipedia is quite reliable for this), or in Stellarium or XEphem on the lab computers. Just to remind you, the brightest stars are 0th magnitude, the faintest you can see without a telescope is about 6th magnitude, and the faintest our telescopes can see is about 18th magnitude. The Moon and nearby planets are of course much brighter than the brightest stars.

4. How large is it in degrees, arcminutes, or arcseconds (as appropriate)? The smallest detail our telescopes can record is about 1 arcsecond, and the field of view is about 1/2 degree.

5. What is its declination (north is +, south is -) of the object?

6. Do you need a southern telescope to see it? If it is below -10 degrees we cannot do it well from our northern telescopes. The absolute limit for us is -52 degrees but that puts the object on the southern horizon for a few seconds! We have limited time this semester for new data from Mt. Kent.

7. What is its right ascension (in hours from 0 to 24, with minuts and seconds)? We cannot see objects between 14 and 20 hours this month because the Sun is in the way.

8. At what time in late October or early November will this object be will above the horizon seen from Louisville, KY?

9. What would you like to know more about that you could expect to "see" with the images from a telescope?

10. What last name and email address do you want us to use to provide you with instructions on where to find your data?

Limitations

The one necessary part of this request is that you have to select an object that is observable with our telescopes. You might use Stellarium, for example, to see what is currently visible, and Sky-Map to explore images and data on the web. You could also use Google simply to search for more information about your proposed target. If your request is inappropriate, we will work with you to help refine your selection. However, once you have data, one of the questions you will have to answer is why you made this choice, and what you expect to learn from it.

This fall we are able to observe the entire sky north of -10 degrees Declination except from Right Ascension 14 hours to 20 hours, from about October 20 through November 20. This includes Jupiter, Mars, and the Moon:

- New moon on October 26
- First quarter on November 3
- Full moon on November 10
- Last quarter on November 18

Our opporutunities in the southern sky are more limited because of technical improvements being installed on our telecope, but we may be able to provide new images of parts of the Milky Way not seen from the northern hemisphere, and the Large and Small Magellanic clouds. Once your data are available we will provide a link from which you can download images and there will be another unit posted here on Moodle for you to use in completing the work. This is the simplest process since it does not depend on coordinating your schedule with the telescope and weather. It is available for any of the telescopes we have in operation this semester.

If you would like an opportunity to operate the "live" telescope at Moore Observatory and take images of your own, please note that. We may offer this for color images of targets in the northern sky, but we have to schedule the use and coordinate with you so that you can be at your computer when it is dark and clear at the observatory. Usually we would assist you at the same time by a Skype session, email chat, or a phone call.

References

[1] https://docs.google.com/spreadsheet/viewform?formkey=dGlxdXE5WVBmMlpjUV94VEVPR3JyQ3c6MA

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