Group Activities for AST205

In general, we expect that the groups will be independent, creative, and will "figure out" things on their own. You can receive some assistance from the Teaching Assistants (TAs) and Observing Assistants (Oas) and the professor, and we will provide brief on-line documentation for the equipment you can use, or explain it when you borrow them. Star-parties are also helpful training exercises (while they are not compulsory, and they do not directly contribute to your grade).

You can *meet at any time with your group*. There are no pre-set times for group observations. The system is very flexible. Since the groups only consist of a few people (5 at most), please contact your group members, and coordinate the activities and the best times. Due to the changing weather conditions, chances are that you will need to re-schedule your group activities, depending on the weather. For example, you borrow a small telescope, and plan telescopic observations for Monday night, but the weather is poor, then try re-scheduling it with your fellow group members. While it is preferred, it is not required that all group members are present at an observing session; sometimes it is hard to schedule a time that suits everyone. We ask, however, that all group members participate in the observations over the semester.

Please ***log your group activities on the blackboard journal***. We (the TAs/OAs and Prof. Bakos) will use the blackboard journal to a) communicate with you and b) to evaluate your group performance. Basic rubric is provided for these group activities.

We expect that your group will perform *at least one (and preferably more) visual observing session with a telescope,* ***and*** *at least one photographic project (preferably more)* during this semester.

We will *not* distinguish between the contribution of the individual group members. In other words, all members of a given group will get the same percentage counting towards their final grade.

You will find a number of possible projects below. This is by no means a complete list. With some creativity and Internet browsing, you can do tons of other interesting things. We will scale new ideas (that are not in the list of suggested activities) in terms of their skill level. Make sure to report ideas,

observations (*including failures!*) on your blackboard group journal.

Visual Observing

Naked eye observations – introductory exercises

These are exercises/projects that will help you perform the telescopic observations. The following exercises you can do with or without your group. Please 'blog' on your group's journal, even if you carried out the naked eye observations alone. Note the time, place, observing conditions, as if you were writing an observing log. Of course, working in a group will help you figuring out things! The skill level on a scale of 1 (simple) → 5 (harder) is indicated in parentheses.

1. (1) Figure out what time is dusk and dawn (using the Internet, or a relevant application on your smartphone). Do a reality check a couple of times a month.
2. (3) Start using a small starmap. Go out in the evening, and **identify the brightest stars, and the constellations**. Try doing all this without using your iphone/android. Use dim lights to illuminate your star chart. Try to find a place with no direct street-light hitting your eyes. Examples are: find Vega, Deneb, Altair (the great summer triangle), Albireo, Polaris, Kochab, Mizar. Report on your success on finding these stars, and their apparent colors. Find the Big Dipper (= Ursa Major), the Small Dipper (Ursa Minor), Cassiopeia, Cepheus, Draco, Pegasus, Andromeda.
3. (2) Choose a favorite star (or stars), and do research on what its name means, and how did other civilizations call that star.
4. (3) Track the Moon. Download a starmap from the Internet (e.g. http://www.skymaps.com/), and mark the apparent position of the Moon, and its phase, every evening. Describe what you see.
5. (3) Stay up “late” (rather, wake up early), and find Jupiter. Figure out what time does Jupiter rise (google). Is it going to be very different in December? Mark the position with respect to the stars every week. Which way does it move?
6. (4) Find Mars. Report on its color and position. Mark the position with respect to the stars every week. Which way does it move?
7. (3) Find Venus. If visible, should be glaring bright (as you know, since we even saw it during the daytime).
8. (3) Which planets are visible during the night? You can figure this out by some browsing on the Internet. Keywords are ephemeris, visibility, planet, etc. Where are these planets with respect to the Earth and the Sun? (imagine viewing the Solar System “from the top”, i.e. face-on, and marking the orbits of each planet, and plotting each planet at its current position). Make such a figure, and explain why and which planets you see during the night at the present time. Check out the same thing for December of 2013. Are we loosing visibility of some of the planets? Is the visibility improving for any of the planets?
9. (4) Find the Pleiades (star cluster). Count the number of stars in this cluster with your

naked eyes

10. (5) How many stars do you see inside the Pegasus square?
11. (5) Try spotting Andromeda galaxy with the naked eye.
12. (4) Locate the center of the Milky Way on a starmap (will be close to Sagittarius), and then find Sagittarius (the teapot) in the sky to locate the center of the MW (works early Fall).
13. (5) Find the Milky Way. Which constellations does it go through? For this exercise make sure the Moon is not up, and you will have to move outside Princeton to a darker area.
14. (3) Look up the visibility of the International Space Station (ISS). Go out at the given time and observe it!
15. (5) Find the assumed peak activity of the next significant meteor shower. Go out on the given night and spot shooting stars. Establish their membership from their direction and appearance.
16. (3) Look up the visibility of Iridium satellites. Find out what they are and what makes them special. Go out and spot one of them in the dusk/dawn sky.

These activities will contribute to the overall grade for the visual observations, but only if telescopic observations were also performed by the end of the course.

Small binocular observations

Some ideas that require the small binoculars are below. These binos are 10 x 50, meaning the magnification is 10x, and the diameter is 50mm (how much more light do they gather than your eyes, assuming 8mm pupil diameter?). You can borrow these as a group, or as an individual. Return within approximately one week, to let other groups & students also use them. See basic instructions on how to use the small binoculars. Also, it is highly recommended that you also borrow one of the higher resolution starcharts (Wil Trion Bright Star Atlas, hereafter BSA). **Extra marks if you draw** what you see at the telescope. Be sure to upload the drawings with your journals. The skill level on a scale of 1 (simple) → 5 (harder) is indicated in parentheses.

1. (1) Look at the Moon with the small binos. Can you see craters? What other features do you see? Make a sketch on a piece of paper. Draw a circle first (say 4 inch in diameter), preferably during the day. Then use this to mark details during the night (or daytime, if you prefer daytime lunar observations, and if the Moon is visible!). You will get a feeling of visual observations. When your sketch is complete, compare this with a moon atlas (find on-line). Mark features on your sketch with numbers, and in a separate file (along the sketch), identify each feature.
2. (2) Find Alcor and Mizar with the small binos. Try to measure their separation. You can use the Moon as a visual comparison (which is about 0.5 degrees). Do you see other stars very close to Alcor and Mizar?
3. (3) Find Albireo. Note the colors, separation.
4. (2) If you have the small binos at new moon (check moon-phases for the next couple of months), look inside the Milky Way. Do you indeed see many more stars than e.g.

pointing the binoculars to Ursa Major (which is far from the MW)?

5. (3) Find Andromeda Galaxy with the small binos. Perhaps you even see it with the naked eye? You will need BSA for this.
6. (4) Find χ and h Perseii, which is a pair of open clusters in Perseus, in between Cassiopeia and Perseus. A little internet research will show where to find this. Also, BSA is useful.
7. (5) Find M33, the Triangulum spiral with the small binos (extra prize for this!). As you recall from our news on Sep 25, this smaller galaxy will also collide with our galaxy and Andromeda, a little over 4 billions years from now.
8. (3) Turn the small binos on Jupiter. Do you see the moons of Jupiter? If yes, make a sketch, showing how many moons you see, and on which side of Jupiter. Also note the time! Repeat your observations a day (and couple of days) later.
9. (5) Find the Hercules globular cluster.
10. (5) Measure the brightness variation of a bright and large ampltitude variable star with respect to comparison stars. Examples are; Mira, Algol. (Use wiki to look up the necessary details!).

Small telescope observations

This section refers to the small telescopes that come with a tripod, so you can aim the telescope at a location and share the view with others. You can change eyepieces, tweak the position to track the motion of the celestial objects. **Extra marks if you draw what you see at the telescope. Be sure to upload the drawings with your journals.** The skill level on a scale of 1 (simple) → 5 (harder) is indicated in parentheses.

1. Repeat any of the items (or all) that is listed under small binocular observations! Same difficulty levels apply.
2. (3) Observe the moons of Jupiter every (clear) night for a couple of nights. Make a sketch. You will see them moving. Can you figure out their motion (which moon is which, what is the direction they are orbiting, etc)? This is not an easy task, but extremely rewarding.
3. (4) Can you see any surface detail on Jupiter?
4. (4) Find Uranus. It is visible in the first half of the night. This requires figuring out its position (Internet research), and marking it in the BSA, and then star-hopping at this position. Some patience is required, but extremely rewarding.
5. (5) Find Neptune. Visible in the first half of the night. See comments for Uranus.
6. (2) Find the Pleiades. Make a drawing of it. Do you see any nebulosity around the stars? Make sure it is not nebulosity due to dew on the eyepiece or lens (and if there is dew condensation on the lens, do NOT try to wipe it off! Try creating an airflow with your hands to get rid of it, but never touch the glass.)
7. (4) Find the Orion Nebula. How many stars do you see in it? What is the colour of the nebula, if any? Ask a TA/OA to show to show you the same nebula on one of the larger telescopes. Does it look different? Do you see any colour now?

8. (5) Find the Ring Nebula (or any other planetary nebula). What is the colour of the nebula, if any? Ask a TA to show to show you the same nebula on one of the larger telescopes. Does it look different? Do you see any colour now?
9. (3) Observe the moon every few nights. Identify some features on the moon (mountains, craters, valleys). Find (and draw) features near the terminator. Do these features look the same next night? Why, why not?

Astrophotography

We have seven cameras: 7 pieces of Canon 60D, 1 Canon Rebel XT, and a Canon Rebel XSI. At the very least, you need the camera-bag, the camera, a lens attached to the camera, the exposure control cord, and a tripod. You can attach the camera to any photo tripod to take night exposures. You are also welcome to use your own equipment for this project, in case you have a good digital camera that permits long exposures. Minimum requirement: the exposure should show a celestial object other than the Sun. Brief instructions on how to use the camera are provided. After you took the exposures, you can download the images onto your laptop for further processing. *Never delete the images from the camera!*

You can also borrow one of our tracking mounts: 7 pieces of “ioptron” skytracker, and 2 pieces of Fornax F10 telescope mount. These attach on a photographic tripod, onto which you can attach the camera. This allows you to take longer exposures (up to minutes), while tracking at the stars. This way you can produce nice images with many stars. The skill level on a scale of 1 (simple) → 5 (harder) is indicated in parentheses.

Some ideas are listed below, but – as with photography – be creative!

1. (2) Take images of Princeton during the night (note: at least one celestial object should be visible on the frame!). For example, take photos of your college with the Moon in the background, or stars behind it.
2. (2) Try a long exposure at low sensitivity to see trailing stars. Can you detect the stars moving on a long enough exposure? Note: for very long exposures, the sky background will saturate the image, and you won't see anything!
3. (2) Take photos of Peyton hall with stars behind. This is challenging due to the near-by street-lights, but not impossible.
4. (4) Go to a 'dark' place, like the graduate college and the golf-course (beware the sprinklers, which last time started at 11pm!). Take photos of nice scenery. Another location is the D&R Canal park. Please go in groups.
5. (4) Take a photo of Carnegie lake with certain celestial objects reflected on it! (See my AST205 google maps for possible locations).
6. (5) With the tracking mount you have plenty of other possibilities. Of course, you need to (roughly) align the mount's axis with the celestial pole, i.e. aim it towards Polaris. Take 1 minute exposures of Andromeda Galaxy. (You can even stack these with various software, e.g. StarStaX).
7. (5) Take exposures of the Pleiades while the telescope mount is tracking (and zoom in the lens).

8. (5) Take photos of Princeton night scenery with the tracking mount. Stars will be way more apparent on the images, and the buildings/trees will be a little more diffuse.

Light pollution / Sky background measurements

Performing at least two of these counts towards your astrophotography points.

1. (1) Borrow our Sky Quality Meter (SQM). Perform observations of the clear night sky at new moon and full moon, but point the SQM away from the moon (at full-moon). No stray light from street-lighting should fall in the SQM. Mark the values and compare them.
2. (3) Measure the sky background from the residential colleges *at the same time*, so results can be compared. This requires a little walking around during the night.
3. (3) Measure the sky background somewhere close to the center of Princeton (again, no direct street-lights should fall on the detector, so you need a balcony, roof or garden). Following this measurement, try moving outside from Princeton, (e.g. to the D&R Canal Park), and measure the sky background again. Try doing this when the Moon is not visible during the night. Compare the values, report your findings.
4. (4) Should you commute in to NYC for an evening, take the SQM with you! Measure the sky background from there (but, this will be tricky, as you need to find a spot, where no light from the skyscrapers and no street-light falls on the detector, i.e. you are indeed measuring the light of the sky).
5. (4) Look around in Princeton, and mark areas on google maps that are “dark”, i.e. not much stray light is disturbing the observations, and yet there is a wide enough horizon to see some of the sky. Such a map will be very useful for class activities and future class events. See my google maps at: https://maps.google.com/maps/ms?msid=211596102397591105684.0004c97060af8fb228cde&msa=0 .
6. (3) Look at light fixtures with a critical eye. Note the ones that are shielded, and only lighting downwards, and note those where the light is a) too bright, b) much of it goes up. Create a “shame-list” of the worst ones you find. You can take daytime and night-time photos of these with your smartphone or any digital camera.
7. (3) Measure the sky background every clear night for a month from the same location at the same time. How does it vary? Note down the moon phase and altitude at the time of each measurement, how does the sky background relate to the moon?
8. (5) Same as 7., but try to make the measurements with the moon at the same altitude each time. You will need to find out how to predict the altitude of the moon (use the software Stellarium, for example). How do your measurements depend on the phase of the moon? What other variables may affect your observations?
9. (4) Measure the sky background after sunset, and once every few minutes until it is fully dark. How dark does the background have to be before you start seeing the first stars? How long does it take before the sky background is at its darkest?

Rubrics

These are very rough, and only for guidance, due to the large variety of possible observations and photography one can carry out.

Visual Observing rubrics

- **0%**

  Does not know bright stars, basic constellations, current visibility of planets. Not familiar with telescopes, no ability to find bright night time objects with a small telescope or binoculars.

- **25%**

  Performs and reports on naked eye observations in form of an observing log on the blackboard journal. Ability to use a small starmap (not a smartphone app) to locate bright stars and basic constellations (Ursa Major, Ursa Minor, Draco, Cassiopeia, Pegasus, Cygnus, Lyra, Orion). Familiar with bright night time objects, such as brightest stars and planets. Demonstrated the ability to use a small telescope by completing at least one project from the "small binocular observations" list.

- **50%**

  Same as for 25%, and completed at least 9 points from the "small binocular observations" list. (By this we mean the sum of the skill levels for each successfully performed task. Reminder: these are only ideas. You don't have to perform these exact tasks). Most small binocular observations can also be carried out with a small telescope.

- **75%**

  Same as for 50%, and completed at least one “small telescope” project, i.e. carried out observations with a small telescope from a tripod. Again, no need to observe with binoculars, as long as those tasks are carried out by using a small telescope.

- **100%**

  Same as for 75%, and completed at least three “small telescope” projects.

Night photography rubrics

- **0%**

  No demonstrated ability to use a DSLR camera during the night time, no photo taken with night time celestial objects visible.

- **25%**

  Ability to take wide field night-time photographs that show at least one celestial object. Complete at least one project from the "astrophotography" list. You can complete this with your own camera, including smartphone. No need to borrow our Canon cameras.

- **50%**

Ability to take wide field night-time photographs that show at least one celestial object. Complete at least 6 points from the "astrophotography" list. Ability to focus the camera, use exposure control, use a tripod, compose a photo, download the photo, post on blackboard.

- **75%**

  Same as 50%, but complete at least 10 points from the "astrophotography" list and use a skytracker. Alternatively, same as 50%, use a skytracker, and complete at least one project from the "light pollution" list.

- **100%**

  In addition to what is required to 75%, ability to align a telescopic mount to the celestial pole, take astrophotos in tracking mode, ability to use a telephoto lens, ability to find a smaller night time object (Andromeda Galaxy, Pleiades), and take photographs. In summary, complete at least one of the "5" point exercises, complete at least 15 points from the list. Alternatively, complete at least one of the "5" point exercises, complete at least 10 points from the list, and complete at least two projects from the "light pollution" list.