Astr 3090 *Observational Astronomy* Fall 2012

Instructor: Dr. Andy Layden
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Class: 184 Overman Hall (often moving to the PSLB roof), MW 8:30-9:45 pm
Textbook: *Pathways to Astronomy* by Schneider & Arny (any edition, **optional**)
Website: http://physics.bgsu.edu/~layden/a309.htm
Office Hours: MW 3:30–4:20 pm, TR 12–1 pm, F 2:30-3:20, or by appointment.

Overview: In this course, you will learn the principles and methods of astronomical observing through hands-on activities with the BGSU Observatory telescopes. We will practice the techniques of good science: systematic and well-planned observations, careful recording of observations and data, and reflection on your findings in the context of what is known about astronomy. The level and scope are appropriate to give you a solid background for a lifetime of amateur astronomy, or as a starting point for a professional career in astronomy.

Topics: The following topics will be covered, though the exact order will depend on the weather during class nights. The number in parentheses indicates the approximate number of classes dedicated to that topic.

Constellations and Naked Eye Astron. (2)
Catalogs and Finder Charts (1)
Magnitudes and Colors (1)
Telescope Theory (2)
Project Fair (1)
Celestial Coordinates and Time (2)
Visual Observing with the Telescopes (4)
CCD Observing (2-6)
Astrophotography (0-4 optional extra time)

Learning Outcomes: Students completing this course successfully will be able to:

1) Locate, name and describe bright stars and constellations in the Fall evening sky.
2) Understand the motions of the sky over a night and over the seasons so that you can teach yourself to locate, name and describe bright stars and constellations at other seasons and times.
3) Refer to key features of the night sky and observing equipment using proper terminology.
4) Safely use a small, manual telescope to find bright stars and planets, and selected fainter objects.
5) Safely use a computer-controlled telescope to find any object in the night sky.
6) Keep a quality log of observations with key observing facts and careful illustrations.
7) Take digital images using an astronomical CCD camera, and process them to produce attractive pictures; also make photometric and astrometric measurements from the images.
8) *[Optional]* Take photographic images of the sky using a camera or telescope, and perhaps even to develop the film and print paper copies in our darkroom.

Note: This course does *not* fulfill your University BG Perspective (general education) requirement.

Requirements and Grading:

1) Nighttime observing after sunset on class nights and independently on other nights will often be required. You will have access to the Observatory via keys signed out through the BGSU Key Office and/or from the Physics Dept. Office (104 Overman Hall, open 8:30am–5pm MTWRF).

2) Class attendance is essential. Most of what you will learn is techniques that must be experienced and practiced firsthand. **Observing Activities** will be done during many classes, collected, and graded -- the goal is to try, practice, and master good observing techniques. Practical exams will be taken to test your proficiency in observing with (i) the naked-eye, (ii) the manual 8-inch telescopes, and (iii) the automated 20-inch telescope. In consultation with Andy, you will select 2 of the 3 exams to take. Each exam will be done individually and take 5-10 min during class time. **Each of the practical exams is worth 100 points (10% of your course grade), for a total of 300 pts (30%).**

3) Weekly **homework** will help you become familiar with the material presented in class. Some will involve observing, some will involve basic geometry and/or algebra, and some will be done online using NAAP Simulation Labs. The compiled grades from your **Homework and Activities are worth 380 points (about 40% of your course grade)**.

4) Students have a variety of reasons for taking this course, and a variety of backgrounds. Rather than take a "one size fits all" course, you will select one of two "tracks" early in the term in consultation with Andy. The **Hobbyist track (or track-A)** will put more emphasis on star and constellation finding, motions of the sky, and planet/moon motions. It is appropriate for people who plan to be K-12 teachers, as these are highlighted in the Ohio state standards (especially for grades ~3-8). The **Professional track (or track-B)** will put more emphasis on scientific measurement including CCD imaging, photometric measurement, and interpretation (variable star light curves and a Hertzprung-Russell diagram). It is appropriate for people seeking a post-graduate career in Astronomy or Astrophysics (via a Masters or Ph.D. degree).

5) A **final exam** (part multiple choice, part written, and part mathematical calculation) **is worth 320 points (about 30% of your final course grade)**. The exam is tentatively scheduled for **Mon Dec 10, 8:15-10:15 pm** (let me know if you have a conflict well in advance).

6) People in the Hobbyist track will plan and complete one observing project (see HW16), involving either photography and/or the electronic CCD camera. I will provide a list of possible topics, though you are encouraged to devise your own. Either way, your project must be approved before you begin. You will present the results of your project in class on the last class of the term (**Wed Dec 5**) as part of our Project Fair; your presentation will be a short, formal speech to the class, using powerpoint or other means of presenting images.

7) Grading is the standard: >90% = A, 80-89% = B, 70-79% = C, 60-69% = D, <60% = F. I round up in cases where effort is evident.

Privileges: After the successful completion of Astr 3090 (a final score of 80% or better), you will be able to use the BGSU Observatory without supervision any time it is available. You will have the experience needed to become a member of the Stargaze staff, or to contribute to the astronomical research conducted at BGSU.

Supplies: Bring your calculator (square roots and scientific notation are required -- the Union Bookstore has *TI-30XA* for $12). We have clunky flashlights at the observatory, but you may want to get yourself a small one, preferably with a red light -- LED ones are excellent!

Practical Exam Study Questions

I. Naked-Eye Observing: (target date, first week of Sep)

1) Locate (point out) and name 5 bright stars of your choice (include proper name and Bayer designation).

2) Locate, name and describe at least 5 bright constellations from the list below, and at least 2 other ones not on that list (you choose). The description should include pointing out which stars are in the constellation, what the constellation represents, and a very brief description of the legend behind the constellation (if there is one):

Aquila, Bootes, Cassiopeia, Cygnus, Pegasus, Sagittarius, Scorpius, Ursa Major

3) Point out key features of the sky, including the horizon, zenith, meridian, celestial pole, celestial equator, and NSEW cardinal points. Measure the altitude and azimuth of an object Andy selects.

4) Describe how the sky moves over the course of 24 hours, including pointing out the paths stars take if they start out on the horizon (i) in the SE, (ii) due East, (iii) in the NE, and (iv) near the celestial pole.

5) Describe how the view of the sky will change as time and the seasons change. For example, how will the sky look in two hours? In two months? *{Hint: experiment with a planisphere or NAAP simulator to help you answer this question}.*

II. Observing with the 8-inch Telescopes: (target date, 3rd week of Sep)

1) Take your 8-inch telescope from the observing room and mount it for observing.

2) Answer the following questions, pointing and describing as needed:
   (a) Change the eyepiece and adjust the star diagonal to a comfortable observing position.
   (b) Where is the finder telescope and how do you use it?
   (c) How do you focus the main telescope?
   (d) Show how to move the telescope in RA (or HA); include use of lock and slow-motion knob.
   (e) Show how to move the telescope in Dec; include use of lock and slow-motion knob.
   (f) Plug the clock drive power cord into your telescope. What does it do and why?
   (g) Explain the purpose of the "wedge" that tilts the telescope "backwards" (how is the telescope oriented?)
   (h) Explain how you would "star-hop" to the star marked on a finder chart.
   (i) Which eyepiece would you use to "star-hop" and why?

3) Use the telescope to point at one of the following objects (you choose). Adjust it for the best view and show Andy. Describe what you are looking at.

Vega (α Lyr), Deneb (α Cyg), or Altair (α Aql), Alberio (β Cyg) or a planet.

4) Use the telescope to point at one of the following objects (Andy will choose, be prepared for all of them!) adjust it for the best view and show Andy. Describe what you are looking at.

ε Lyr, M57 (Ring Nebula), M31 (Andromeda Galaxy), h & χ Persei (Double Cluster)

III. Observing with the 20-inch Telescope: (target date, 2nd week of Oct)

1) Set up and/or shut down the 0.5m telescope using the Procedure Sheet (Andy will choose whether you set up on shut down).
   (a) Explain what you are doing and why you are doing it along the way.
   (b) Include the following, along with verbal explanations:
      * Choose a star for zero-pointing the coordinates and slew to it.
      * Center the object in the main telescope, focus it, and zero-point the coordinates.
      * Set the display epoch to the year 2000.

2) Use the hand-paddle to slew to a bright star, planet, or the moon (your choice). Center the object in the main telescope and focus it. Explain what you are doing and why you are doing it along the way. Why did you choose that object?

3) Select a good object to view from the "white pages." Explain why you chose that object and what makes it "good to view" (you might include intrinsic interest as well as sky position). Use the computer to slew to the object you selected and prepare it for viewing (center, focus, adjust reticles, etc.).

List of Astr 3090 Activities, Homeworks and LabSimulations

HW/Act#	Title	Points	Comments
Act 1	Measuring Angles	10	Goals: practical angular measurement
Act 2	Alt/Az & Mags	10	Goals: first-hand experience with alt/az and magnitudes
Act 3	Observing Alt/Az w/ Time	10	Goals: application of alt/az to quantify rate of sky motion
~~Act 4~~	~~Limiting Mag for Naked Eye~~	~~5~~	Goals: practical constell/star finding application, practical mag interpolation
Act 5	8-in Telescopes	15	Goals: learn how to use 8-ins, determine FOV, point at bright objects
HW 1	Celestial Names and Magnitudes	10	Goals: familiarize with naming systems and magnitude scale
HW 2	Your Constellation	10	Goals: find a constell in the sky, research info & story online
HW 3A+B	Lunar Cycle (obs/theo)	20+20 **A-only**	Goals: apply alt/az to a problem, design/conduct experiment, understand orbit/phases
HW 4	Local Coords	15	Goals: represent and measure alt/az on planisphere and celestial sphere, sky rotation *at BG*
HW 5	Equatorial Coords & Sidereal Time	15	Goals: to represent and measure these coordinates and star paths for a BG *observer*
NAAP 1	Rotating Sky	40	Goals: obtain better, interactive/moving view of celestial sphere at *any latitude* on Earth
HW 6	Intro to the 0.5-m Tel	15	Goals: become comfortable operating the telescope; reinforce HA/RA/ST//Dec & alt/az
HW 7	Observing Skills	10	Goals: practice planning an observing session, dusk/dawn, finder charts; eye function
HW 8	Visual Observing w/ 0.5-m Telescope	20	Goals: get familiar with using the telescope, and the objects visible through it; AngDia & SAF ***(requires clear weather)***
NAAP 2	Planets & Cosmol. ***OR*** Filters	40 **A / B**	Goals: see relation between orbital position and night sky /OR/ see how filters define light into a camera
HW 9	Telescopes & Eyepieces	20	Goals: understand & predict telescope properties, including large professional tells; SAF
HW11	Intro to the CCD	15	Goals: become comfortable operating the CCD camera
HW12	CCD Observing w/ 0.5-m Telescope	20	Prep: successful completion of HW11 Goals: get familiar with using the CCD camera, and the objects visible with it; AngSize & SAF
HW13	Observing an Asteroid	15 **B-only**	Goals: plan an observation of a moving object by interpolating w/in an ephemeris ***(requires clear weather)***
NAAP 3	Variable Stars	40	Goals: learn photometry & detecting var stars; period finding & phasing, characterizing LC
HW14	Variable Star Analysis	20 **B-only**	Goals: analyze time series images of a variable star taken with BGSU 0.5-m; P, A, type *[uses MSexcel]*
HW15A	Color-Magnitude Diagram #1	15 **B-only**	Goals: measure mags of 15 stars on V & I images taken w/ 0.5-m, make a CMD & interpret *[uses MSexcel]*
HW15B	Color-Magnitude Diagram #2	15 **B-only**	Goals: extend analysis to 2556 stars w/ DAOPHOT mags; excel to plot CMD, add isochrones *[uses MSexcel]*
HW16	Observing Project	25 **A-only**	Goals: to design & undertake a small research or art project

• The A/B on some point totals indicates the Hobbyist(Sky/Teaching) track vs. the Professional(Research/CCD) track. Students select track in consultation with ACL in first week of classes.