AST 305: Observational Astronomy

Fall 2018

7-9pm, Tuesdays and Thursdays, Science Center 1313 & Observatory

Instructor:

Dipankar Maitra
Room: Science Center 1330
Phone: x5696
Email: maitra_dipankar@wheatoncollege.edu
Office hours: Tu+Th 5-7pm, or come in when door is open, or email
(I am on parental leave this semester, so I will not be on campus a whole lot, but I will be checking emails and can set up meeting appointments over email/google hangouts/skype etc.)

Teching Assistant: **Johnathan "JP" Prideaux**

Course Goals and Student Objectives

- Learn various techniques used in astronomy to study a wide range of celestial objects and celestial phenomenon, over a wide wavelength range.
- Learning how to analyze multiwavelength data, visualize and interpret results, and present conclusions in the form of scientific reports.

By the end of this semester, you should be able to:

- Analyze data from a wide range of astronomical detectors, and know the right observational approach for a given astronomical problem.
- Select the right tool from your problem-solving toolbox to interpret, visualize, and present the data in the simplest, statistically sound, and most straightforward way.

Textbook: None in particular as we will be covering a very wide range of topics. I will post on the onCourse website various research papers as well as observing manuals for various instruments that are needed for different projects.

Daily class/lab structure: None. You will work individually or in groups of two to observe, analyze observed or archival data as required by the project, and prepare your reports. **Since the universe does not care about our class times, be prepared to do your observations at odd hours.** I will get you keys to the astronomy lab (SC 1344) and the observatory where you can come to work 24/7. I will obviously be around during the class hours (Tu and Th, 7-9pm) to help you with your projects, but you have to plan on working predominantly outside these hours.

Getting started with Linux: Astronomers use the Linux operating system for most of their work. Linux is free, fun, and efficient! While we need Windows (unfortunately) to do some stuff, we will be using Linux predominantly in the class.

In order to get a basic idea of linux and how to work in a linux environment, we will do an intense crash course during the first week and half, and earn a badge (that you can mention in your resume later on while applying for job … an official recognition that you have basic linux familiarity!). Earning the badge will add 5% to your final grade.

Collaboration: You will work in groups of one or two (for the larger projects). The groups will be fluid and you should change partners for every new big project. This was you are not stuck with someone for the whole semester, you get to make friends with more people, and learn to work collaboratively with a wide range of people.

Report submission: Reports are expected to be in a format similar to peer-reviewed journals like *The Astrophysical Journal*, *Science*, or *Nature*. I encourage either using LaTex or a shared google document to prepare the report. Especially, users of LaTex formatting will receive an extra credit point for every report made in LaTex. Sample report and LaTex templates are on onCourse. **Final report must be in PDF format.**

Guest lectures: We will have quite a few guest speakers come and present their work.

Sep 18 (Tu) or 20	Bingchen Liu, Johnathan "JP" Prideaux, Dylan Schmitt
Sep 27	Saku Vrtilek (Harvard)
Oct 04	Hugh Crowl (Bennington College)
Oct 11	Herman Marshall (MIT)
Oct 18	Jack Steiner (MIT)
Oct 25	Stella Kafka (AAVSO)
Nov 01	James Synge (PANOPTES/Google)
Nov 08	Dheeraj "DJ" Pasham (MIT)

Bingchen, JP and Dylan's talks will be from 7pm. Other talks are from 5-6pm. Depending on the speaker's availability we will also try to schedule a "meet the speaker" hour earlier that afternoon when you are encouraged to go and talk to the speaker about anything you like. After the talks by the external speakers we will head over for dinner, preferably in one of the college dining halls so that you can join us and continue the discussion. You'd also need to submit a one page summary of each talk, within a week of the talk.

Grading

Your final grade will be figured by summing up the grades you've received while doing various projects during the semester. 10% of the course grade will be based on your reports of the talks by the guest speakers and that of the field trip.

	total %
Earning the linux badge	05
Various projects	70
Summary of guest lectures	10
HWs	15

Additionally, I may throw in some extra-credit challenges from time to time.

Final Exam: None! You're done as soon as you have finished your projects, submitted their reports, and also the summary reports of the guest talks.

Grading Scale

You will not be graded on a curve. This absolute scale is designed, in part, to encourage you to work together. Please help one another inside and outside of class!

Grade	+		-
A		>92	87 - 92
B	84 - 87	81 - 84	77 - 81
C	72 - 77	67 - 72	63 - 67
D	60 - 63	55 - 60	50 -55
F	< 50		

Policies

Data collection: Since clear weather cannot be guaranteed, I have put enough buffer-time in the projects that require collecting new data.

- Please make best use of the clear nights. If a project is for 4 weeks, say, and you haven't been able to collect any data during the first 2 weeks, either due to weather or instrument failure, come and talk to me.
- Calibration data (e.g. flats, darks, biases) taken within +/- two weeks of taking the science data will be acceptable, but any further delay will cause you to lose points (and also affect the accuracy of your science results).
- The time allocated to any project includes time for data acquisition (if any), analysis, visualizations, and report submission. Only one report per team needs to be submitted via email.

Once you have completed data collection and analysis for a project you can take on a second project while you work to finish the report for the first project. But you will not be allowed to take on a third project until the report for the first project has been turned in.

Time Commitment: As emphasized earlier, the universe does not care about our class times. So be prepared to make observations during the oddest possible hours. On the other hand, you can work on the archival data on your computer from anywhere and anytime.

Please DO NOT schedule any other activities during the Tu/Th 7-9pm class time period. While we will normally be doing individual meetings during class times, we may cancel the meeting and schedule observing sessions with less than 3 hour notice (because I do not control weather). Your attendance in these events is expected.

Safety: Projects that require using the domes at night should be done with a lab/observing partner. While astronomy is generally not a high-risk science, you do need to be careful when in the observatory premises, especially during nights. Sometime the open walkways can be slippery, especially under humid, rainy, or icy conditions. Make sure to

1. keep your cellphone with you. Wheaton emergency number is: (508) 286-3333
2. have a red flashlight with you.
3. have your lab partner standing outside when you step inside a dome.

Accommodations and Accessibility: *Wheaton is committed to ensuring equitable access to programs and services and to prohibit discrimination in the recruitment, admission, and education of students with disabilities. Individuals with disabilities requiring accommodations or information on accessibility should contact Susan Friedman or Kristine Smith, interim Accessibility Services Specialists, at the Filene Center for Academic Advising and Career Services. ~ accessibility@wheatoncollege.edu or (508) 286-8215 ~*

Athletics: College policy dictates that team practice is not a legitimate excuse for missing a class. If you foresee any regular season game conflicting with your work, let me and your project partner know as soon as possible.

Tentative Calendar:

Tuesday	Thursday	Notes
8/28 Syllabus, logistics. Our facilities. Telescopes	8/30 CCDs. Telescopes.	Start working on linux badge.
9/4 CCDs. Telescope training	9/6 CCDs. Telescope training	
9/11 CCDs. Telescope training	9/13 CCD data processing: Image processing	Linux badges to be earned by 9/14.
9/18 7pm. Guest lecture: Bingchen, JP Dylan.	9/20 CCD data processing: Photometrry.	
9/25 Meeting or Observing	9/27 5pm. Guest lecture: Saku Vrtilek (Harvard)	
10/02 Meeting or Observing	10/04 5pm. Guest lecture: Hugh Crowl (Bennington)	
10/09 October break	10/11 5pm. Guest lecture: Herman Marshall (MIT)	
10/16 Meeting or Observing	10/18 5pm. Guest lecture: Jack Steiner (MIT)	
10/23 Meeting or Observing	10/25 5pm: Guest lecture: Stella Kafka (AAVSO)	
10/30 Meeting or Observing	11/01 5pm. Guest lecture: James Synge (PANOPTES/Google)	

11/06 Meeting or Observing	11/08 5pm. Guest lecture: DJ Pasham (MIT)	
11/13 Meeting or Observing	11/15 Meeting or Observing	
11/20, 11/22 Thanksgiving break.		
11/27 Meeting or Observing	11/29 Meeting or Observing	
12/04 Meeting or Observing	12/06 Meeting or Observing	All reports must be submitted by midnight Dec 07.
Please DO NOT schedule any other activities during the Tu/Th 7-9pm class time period. While we will normally be doing individual meetings during class times, we may cancel the meeting and schedule observing sessions with less than 6 hour notice (because I do not control weather). Your attendance in these events is expected.		

List of projects (more may be added with time)

One-line Project description (Meet DM for details on each)	Maximum project duration	Points
Spectrum of Sun using our USB spectrometer and identify the elements creating major absorption lines. [Can be done on any day, clear or cloudy!]	1 wk	5
Spectrum of a sunspot using our USB spectrometer and identify differences between regular solar spectrum and sunspot spectrum. [Only try after you have used the USB spectrometer for the 'Spectrum of Sun' project, and once you've verified that there is at least one large sunspot on the Sun.]	1 wk	5
Spectra of different regions of the Moon using our USB spectrometer and identify differences. [Only try within +/- 7 days of the Full Moon.]	1 wk	5
Spectrum of a bright star using a grating placed in front of our DSLR camera, and identify major absorption lines.	1 wk	5
Find the spectral response of some of our astronomical filters using the USB spectrometer. [Can be done anytime in our lab.]	1 wk	5
Contribute to real science: https://www.aavso.org/aavso-alert-notice-645 or https://www.aavso.org/aavso-alert-notice-641 [Good project for iTelescope.net]	2 wk	10
Image a bit of the "dark side" of the Moon (see S&T, 2018, Sep, 52) using our astro-webcams (or some other equipment), and identify the features.	1 wk	5
Determine the characteristics of one of our CCDs. This implies determining (a) the bias level, (b) finding the hot pixels, (c) studying how the dark current changes with temperature and time, (d) studying the linearity of the CCD, (e) studying the response of each pixel by illuminating it with uniform light. [Can be done anytime in our lab.]	3 wk	15
A deep narrowband image of a planetary nebula or a supernova remnant (preferably an object from Messier catalog) using Wheaton's telescopes. Choose a suitable object and consult with DM before starting. The total exposure time must be at least 2 hours. [Needs a clear, moonless night.]	1 wk	5
Observing Abell Planetaries in OIII --- S&T, 2017, July, 34. Choose a suitable object and consult with DM before starting. The total exposure time must be at least 2 hours using Wheaton's telescopes. [Needs a clear, moonless night.]	1 wk	5
Observe Ancient Photons from AGNs --- S&T, 2018, March, 57. Choose a suitable object and consult with DM before starting. The total exposure time must be at least an hour using Wheaton's telescopes. [Needs a clear, moonless night.]	1 wk	5
A deep RGB color image of a galaxy. Preferably one from Messier or Caldwell catalog; or a galaxy in collision (S&T, 2017, May, 28); or Observing Starburst Galaxies (S&T, 2018, March, 28). Choose a suitable object and consult with DM	2 wk	10

before proceeding. Exposure in each filter must be at least an hour. [Needs a clear, moonless night.]		
CCD photometry of the exoplanet WASP-80b using archival data (and optionally modeling the light curve you obtained).	2 wk (+1 wk)	10 (+5)
Observing an exoplanet transit and obtaining the light curve (and optionally modeling the light curve you obtained).	3 wk (+1 wk)	15 (+5)
Polarization studies of astronomical objects.	3 wk	15
CCD Photometry of a bright variable star and finding its period. [Typically needs a few observations every night for a about 3 weeks.]	4 wk	20
CCD Photometry of a black hole or neutron star X-ray binary in two wavelengths and study its evolution using archival data.	4 wk	20
Orbital period of an X-ray binary using archival X-ray data.	2 wk	10
CCD astrometry of an asteroid, or Pluto, using archival or new data (and orbit determination)	1 wk (+1 wk)	5 (+5)
Astrometry of Proxima Centauri to detect proper motion, using archival data	2 wk	10
Photometry of stars in a globular cluster to create a HR diagram and look for the main sequence turnoff	3 wk	15
A project of your own: Bring your ideas to the table. Consult with DM for possibilities and feasibilities	3 wk max.	15 points max

Note: While, there is no upper limit on the length of you project reports,

- All 1-week project reports should be at least 2 pages in length, including figures, tables, graphs, and references.
- All 2-week project reports should be at least 3 pages in length, including figures, tables, graphs, and references.
- All 3-week project reports should be at least 4 pages in length, including figures, tables, graphs, and references.
- All 4- or 5-week project reports should be at least 6 pages in length, including figures, tables, graphs, and references.