ASTR4610 Introduction to Astrophysics
SYLLABUS- FALL 2018 Section 01 (vers 0.0 2019 Aug xx)

Time: MWF 9:00-9:50  Location: PS227
Instructor: Prof. Chip Kobulnicky  Office: 225 Physical Sciences
Phone: none  E-mail: chipk@uwyo.edu
Office hours: Monday & Wednesday 10:00 – 11:30, or by appointment
Class Web Page: http://physics.uwyo.edu/~chip/Classes/ASTR4610

Pre-requisites: Physics IV or consent of instructor
Credits: 3

NOTE ON COMMUNICATIONS: I will use your UWYO email address to communicate. If you don't check this email, please forward it to your phone or an email account that you do check!

Required Materials:
Required Text: Astrophysical Concepts by Martin Harwitt (3rd edition preferred)
Supplemental Text: An Introduction to Modern Astrophysics by Caroll & Ostlie
Data Reduction and Error Analysis for the Physical Sciences by Bevington

Course Content
In this astrophysics class we’ll take your knowledge of astronomy and physics from the first few years of college and integrate them to understand how astronomers decipher the universe. We’ll focus mainly on concepts related to gravity and the production and transmission of radiation. After all, everything we know about the universe is gleaned from clues contained in the light that comes to us from astrophysical sources. Our approach will be partly theoretical, and partly practical (i.e., laboratory-like). Because this course is two semesters at many universities, I’m going to selectively teach the topics that I think you’ll find most useful for a career in astronomy or science of some related kind.

Our approach will be data-driven. That is, I’m going to give you real data (as much as possible) from real telescopes to analyze using a combination of observational tools and astrophysics theory. As much as possible, we’ll emulate the approach of working astronomers. Unlike your previous astronomy course where the topics were organized by type of object or size scale, (i.e., you worked your way up to the universe starting from the solar system), the progression in this class will be by physical concept. That is, we may talk about galaxy clusters and star clusters all in one sentence dealing with gravity, since gravity is the common force that shapes both types of objects.

Just as real astronomers form collaborations, I want you to collaborate with your class peers to complete homeworks and class assignments. That said, be sure to do your own work, because I’ll expect you to show individual proficiency on the exams. On homeworks and exams, you should do just what real scientists do: show all of your work and assumptions.

The most important things I want you to gain from this course are:
• An ability to think physically to apply your already-vast knowledge of physics to astronomy
• Experience in making scientific models plots using a programming language (IDL or Python)
• Confidence solving ill-posed problems where you must begin to make intelligent assumptions for values not explicitly given.

Grading: (Subject to revision):

homework assignments (~weekly; HW is due at the start of class on the assigned day; credit declines at 10% per hour to a minimum of 20% ) 30%
one mid-semester exam Friday, March 27th 30%
final exam (Monday, May 17, 8:00 a.m.) 40%
Grading:

>90% - A  
80% - 90% - B  
70% - 80% - C  
60% - 70% - D  
<60% - F

A note about grades: Your grade in this course reflects only your performance over a 14 week period on a small subset of science. Your grade does not reflect your worth as a person or what I think of you. Your grade does not reflect the full range of your abilities in oral communication, writing, enthusiasm, logic, creativity, perseverance, etc, or a host of other qualities necessary for a happy life and productive career. In short, do not cause yourself undue anxiety by making your grade out to be more than it really is. Furthermore, view your classmates as collaborators not competitors. Think of them as training partners to help you prepare for the day when you will have to compete with students from other universities for jobs or spots in graduate school. When you leave UW, your reputation will be somewhat tied to the reputation of UW and its students. Work to make each other the best you can be in order to help all of you be successful.

Attendance: You are expected to attend class every day. Missing class will inevitably result in missing key class materials, for which there are no make-ups.

**Course Goals**

Here is a list of things that practicing astronomers need in their tool bag. These are things things we’ll make sure you know by the end of the semester.

- How to measure distances to astronomical objects
- How to convert between linear and angular distances
- How to convert between various flux units used in astronomy
- How to measure masses
- How to measure temperatures of astronomical objects
- How to measure chemical compositions
- How to write scientific programs and make scientific plots
- How to do a numerical integration to make a simulation
- How to identify and compute the energy generated from the main sources of radiation (blackbody, thermal bremsstrahlung, and synchrotron radiation)
- How to make an analytical model of an object and compare it to real data
- How to treat uncertainties in measurement
- How to use a standard astronomical analysis software package (IRAF)
- How to use a unix operating system

And you’ll practice using these tools to answer some fundamental questions in astronomy:

- What sorts of objects exist?
- How far away are things?
- How large are they?
- What are their motions?
- What are their luminosities?
- What are their temperatures?
- What are they made of?
- What are their masses?
- What powers them?
- What are their magnetic and electric fields?
- What are their excitation and ionization states?
- What are their ages?

These things, in turn, help astronomers answer the really fundamental questions?

- How did it form?
- What will become of it?
Course Outline
(subject to revision)

Week 1-2: Chapter 2 – Distances in Astrophysics (C&O Chapter 3, 23)
A. Trigonometric Parallax
B. Spectroscopic parallax
C. Standard Candles (RR Lyrae stars, Cepheid variables, supernovae, HII regions)
D. H-R diagram fitting
E. Tully-Fisher relation
F. Redshift-Distance relation

Week 3: Introduction to IDL Programming (with applications to distances)
A. Reading data files
B. Making plots
C. Making hardcopies
D. Simple arithmetic

Week 3-6: Chapter 3 - Gravity
A. The two-body problem and Kepler’s laws
   1. Application to binary stars
   2. Application to galaxy masses
B. The Virial Theorem
   1. Application to masses of star clusters
   2. Application to clusters of galaxies
C. Tides and tidal forces
   1. Application to planet formation and destruction
D. Power from Accretion
   1. Applications to X-ray binaries
   2. Applications to Active Galaxies
E. Introduction to IRAF
F. Measuring masses of clusters with the Virial theorem and spectral data

Week 7-10: Chapter 4 - Random Processes
A. Statistical Distributions
B. Error analysis
C. Maxwell Boltzmann Distributions
D. Saha and Boltzmann Equations

Week 10-14: Radiation
A. Blackbody radiation
   1. Applications to stars
B. Bremsstrahlung Radiation
   1. Applications to HII regions
   2. Applications to Clusters of Galaxies
C. Synchrotron radiation
   1. Applications to Supernovae
   2. Applications to Active Galaxies
D. Gravitational Radiation
   1. Applications to Compact Binaries
E. Radiative Transfer, opacity
F. Information in spectral lines
G. Formation of Absorption and Emission lines
H. The Hydrogen atom and spectrum
I. Selection Rules in Atoms and Molecules

Academic Honesty
"Academic dishonesty will not be tolerated in this class. Cases of academic dishonesty will be treated in accordance with UW Regulation 2-114. The penalties for academic dishonesty can include, at my discretion, an “F” on an exam, an “F” on the class component exercise, and/or an “F” in the entire course. Academic dishonesty means anything that represents someone else’s ideas as your own without attribution. It is intellectual theft – stealing - and includes (but is not limited to) unapproved assistance on examinations, plagiarism (use of any amount of another person’s writings, blog posts, publications, and other materials without attributing that material to that person with citations), or fabrication of referenced information. Facilitation of another person’s academic dishonesty is also considered academic dishonesty and will be treated identically."

Classroom Behavior Expectations: Participate eagerly in daily problem solving and classroom discussion with your peers at your table group. Act professionally, arrive on time, pay attention, complete your work in a timely and professional manner, and treat all deadlines seriously. Be respectful towards you classmates and instructor. Spirited debate and disagreement are to be expected in any classroom and all views will be heard fully, but at all times we will behave civilly and with respect towards one another. Personal attacks, offensive language, name-calling, and dismissive gestures are not warranted in a learning atmosphere. As the instructor, I have the right to dismiss you from the classroom, study sessions, electronic forums, and other areas where disruptive behavior occurs."

Classroom Statement on Diversity: “The University of Wyoming values an educational environment that is diverse, equitable, and inclusive. The diversity that students and faculty bring to class, including age, country of origin, culture, disability, economic class, ethnicity, gender identity, immigration status, linguistic, political affiliation, race, religion, sexual orientation, veteran status, worldview, and other social and cultural diversity is valued, respected, and considered a resource for learning."

Special accommodations
“The University of Wyoming is committed to providing equitable access to learning opportunities for all students. If you have a disability, including but not limited to physical, learning, sensory or psychological disabilities, and would like to request accommodations in this course due to your disability, please register with and provide documentation of your disability as soon as possible to Disability Support Services (DSS), Room 128 Knight Hall. You may also contact DSS at (307) 766-3073 or udss@uwyo.edu. It is in the student’s best interest to request accommodations within the first week of classes, understanding that accommodations are not retroactive. Visit the DSS website for more information at: www.uwyo.edu/udss.”

Duty to Report: UW faculty are committed to supporting students and upholding the University’s non-discrimination policy. Under Title IX, discrimination based upon sex and gender is prohibited. If you experience an incident of sex- or gender-based discrimination, we encourage you to report it. While you may talk to a faculty member, understand that as a "Responsible Employee" of the University, the faculty member MUST report information you share about the incident to the university's Title IX Coordinator (you may choose whether you or anyone involved is identified by name). If you would like to speak with someone who may be able to afford you privacy or confidentiality, there are people who can meet with you. Faculty can help direct you or you may find info about UW policy and resources at http://www.uwyo.edu/reportit You do not have to go through the experience alone. Assistance and resources are available, and you are not required to make a formal complaint or participate in an investigation to access them.
Additional help and campus resources
- STEP Tutoring Center in Coe Library is open Sunday-Thursday 6-9 p.m.  www.uwyo.edu/step
- DISABILITY SUPPORT SERVICES: udss@uwyo.edu, 766-3073, 128 Knight Hall, www.uwyo.edu/udss
- COUNSELING CENTER: uccstaff@uwyo.edu, 766-2187, 766-8989 (After hours), 341 Knight Hall, www.uwyo.edu/ucc
- ACADEMIC AFFAIRS: 766-4286, 312 Old Main, www.uwyo.edu/acadaffairs
- DEAN OF STUDENTS OFFICE: dos@uwyo.edu, 766-3296, 128 Knight Hall, www.uwyo.edu/dos
- UW POLICE DEPARTMENT: uwpd@uwyo.edu, 766-5179, 1426 E Flint St, www.uwyo.edu/uwpd
- STUDENT CODE OF CONDUCT WEBSITE: www.uwyo.edu/dos/conduct