

Syllabus

ASTR 1020

Introductory Astronomy II: Stars & Galaxies

Spring 2009

Location: Class: Tu, Th 2:00 -- 3:15 PM : *G1B20 Duane Physics*

Recitations: Mondays & Wednesdays: *SBO (class room & Cosmos Lab)*

Instructor: *John Bally* John.Bally@colorado.edu Duane 323A, 303 492 5786

Office Hours: Tuesdays: 11:00 AM – 12:30 PM; Wednesday, 3:30 – 4:00 PM, or by appointment

TA: *Jared Workman* jared.workman@colorado.edu

Office Hours: Mondays 3:00 PM – 4:00 PM; Tuesdays after class, or by appointment

Learning Assistants (LAs):

Craig Hoeltgen hoeltgen@colorado.edu Mon 2 PM (sect 13); Mon 3 PM (sect 15)

Charlie Maier charles.maier@colorado.edu Mon 1 PM (sect 11); Wed 1 PM (sect 17)

Elin Leiserson deebj@colorado.edu Mon 2 PM (sect 14); Wed 1 PM (sect 18)

Catherine Moran morancr@colorado.edu Mon 1 PM (sect 12); Mon 3 PM (sect 16)

Course Description:

The purpose of ASTR1020 is to introduce students to astronomy. In this course, the emphasis will be on stars, galaxies, the properties and physics of the Universe and its contents. We live in a remarkable era of discovery that is un-precedented in human history. We are part of the generation that is mapping the structure of the Universe and discovering its operating principles. Astronomers and physicists are doing for astronomy something similar to what the great voyages in the era of Columbus did for terrestrial geography. This revolution has been enabled by two factors: First, the rise of the electronics industry that has generated sensors enabling us to “see” essentially all wavelengths of the electromagnetic spectrum. Second, access to space so that we can sense this radiation without the impediment of the Earth’s atmosphere.

I will present an overview of the amazing discoveries about matter, energy, and the Universe that has emerged from the application of the modern tools of science to the study of Nature. Familiarity with basic algebra, geometry, and the use of scientific notation is assumed. Students will be expected to exercise critical thinking and quantitative reasoning skills. During the semester, we will explore the nature of stars and galaxies, the structure of matter and energy, and the forces that operate in the Universe on scales ranging from the sub-atomic to the cosmic. My primary goal is to show you the “beauty and romance” of astronomy.

Pre-requisites:

ASTR 1010 or ASTR 1110. This course is offered as a two semester sequence intended to satisfy the arts and sciences core curriculum in natural science. The math required will be algebra and some basic trigonometry and geometry. To review basic math go to <http://lasp.colorado.edu/~bagenal/MATH/main.html>.

Required Materials:

- The Cosmic Perspective, 5th Edition ("TCP") by Bennett, Donahue, Schneider, & Voit. The cover must say "5th edition" but it's not critical that it say "Media Update" on the cover. A small number of copies will be placed on reserve in the Lester Library (upstairs from the lecture hall).
- An account at MasteringAstronomy.com. Each new textbook includes an 'Access Kit' inside the front cover. If you buy a used book, you will have to purchase access at the website for \$30 (without the e-book; \$50 with e-book). You can also buy the access kit for \$35 at the bookstore. As part of registering, you must 'join a class' and use our class code of "ASTR1020Bally".
- An I-clicker available at the CU bookstore. bring to every lecture and to Fiske Planetarium. Register it via CUConnect: <http://www.colorado.edu/its/cuclickers/students/register.html>

Grading:

- 10% Clicker questions
- 10% Written homework (lowest score dropped)
- 10% Online (MasteringAstronomy) homework (lowest score dropped)
- 30% *Two* in-class midterm exams (15% each)
- 25% Comprehensive final exam

This class will be graded on a sliding curve (although not a rigorous bell curve). Approximate letter grades will be given throughout the semester.

- 10% Class participation (lecture and recitation)
- 5% Participation in SBO observing sessions

The grade will be based on problems sets (20%), midterms (30%), participation in clicker questions, recitation sections, and Sommers-Bausch observing (25%), and a final (25%). To encourage questions and discussions in class, I will hand out cards to students asking questions or volunteering answers in class. Write your name on these and hand them in to me or the TA at the end of class to get "participation points". Class and recitation session attendance is mandatory. Your participation in class will be monitored by your clicker responses.

Homework will be assigned on a weekly basis starting on Thursday, 15 January. Most homework will be done electronically using the “Mastering Astronomy” package. However, I will hand-out paper-based homework before each midterm that will have a format similar to that of the midterms and final. In general, homework will be assigned on Thursdays and due at class time on the following Thursday. Electronic assignments will be graded automatically. All paper assignments must be handed in to me or the TA by the end of class on Thursdays, otherwise they will be considered late. Late assignments will not be given credit.

There will be two in-class midterms. I will throw-out the worst of the three grades, so only you two best scores will count for your grade.

We will use clickers in class. There will be several clicker questions during each session and your participation in answering these questions is mandatory. A right answer will be worth 1 point, but a wrong one will still be worth ½ point. Not answering will be scored 0. The participation portion of your grade will have three components: 1) Asking questions in class, 2) participation in clicker questions, and 3) participation in recitation sessions to be run by our Learning Assistants (LAs). When you ask a question in class, I will hand you an index card.

All students are expected to do their own work. Cheating, copying, or use of material without proper referencing or attribution is unacceptable.

Observing at SBO and special sessions in the Fiske Planetarium:

We have been assigned the following times on the Sommers-Bausch observing deck:

DAY	DATE	START	LUNAR PHASE	MOON UP?
Tue	Jan 20	7:00	-22%	dark
Wed	Feb 04	7:00	74%	MOON
Thu	Feb 19	7:00	-21%	dark
Mon	Mar 09	8:00	99%	MOON
Tue	Mar 31	8:30	33%	MOON
Wed	Apr 15	8:30	-63%	dark

You are required to attend at least two observing sessions. Each of you are expected to observe at least one Solar System object (Moon, a planet, or comet, etc.) , and four objects outside the Solar System (a multiple star systems, a star cluster, a nebula, and a Galaxy. You will be asked to sign-in on a sign-in when you are on the observing deck so we can verify attendance, and to provide a brief description of the objects you observed, including the name of the target, a description of the observing conditions, and a description of the objects seen.

If the above dates are cloudy, additional make-up days will be assigned during the semester. Additionally, you can make your observations during open house nights on Friday nights.

We will meet in the Fiske Planetarium instead of in G1B20 three times. The dates for these special sessions will be: **Thursday, 12 February, Thursday, 19 March; Thursday 23 April**. The three planetarium sessions will cover the following topics:

Overview of the night sky (12 Feb): Discussion of constellations, motion of the Sun, Moon, and planets, and visualization of the motions of the sky as seen from various locations on Earth (North Pole, South Pole, equator, etc.).

The Milky Way Galaxy (19 March): The distribution of gas, dust, and stars. Star and planet formation. Stellar Evolution, Stellar death and end states. Clusters, Nebulae, and the interstellar medium

Galaxies & Cosmology(23 April): Exploration of the sky beyond the Milky Way. The cosmic expansion & evolution. The evidence for a hot Big Bang. The contents of the cosmos: matter, dark matter, and dark energy.

Classroom policies:

No Laptops in Class. Laptops and computers may NOT be used in class! Cell phones must be turned off while in class as ring-tones can be highly disruptive.

Class Honor Code. All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-725-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Additional information on the Honor Code can be found at

<http://www.colorado.edu/policies/honor.html> and at

<http://www.colorado.edu/academics/honorcode/>

While everyone understands what the honor code means on quizzes and exams, there's confusion on what it means for homeworks and other assignments. Students are encouraged to work together on homeworks, but your write-ups and web submissions must be independent. Copying, whether by hand or cut-and-paste on your computer, or consulting the graded work of another student constitutes cheating. The best way to ensure you understand the assigned material is to split off from the group when writing up or submitting your answers. Use of another student's 'clicker' is also cheating.

Email Policy. CU requires you to regularly read (or forward) email at your CU-provided address. Please (1) make good use of the "Subject:" line to alert me to your problem or question and level of urgency, and (2) always send a copy to yourself on important messages. Homework should not be emailed except under extenuating circumstances.

Disability Accommodation. If you qualify for accommodations because of a disability, please submit a letter to me from Disability Services in a timely manner so that your needs may be

addressed. Disability Services determines accommodations based on documented disabilities. Contact: 303-492-8671, Willard 322, or see www.Colorado.EDU/disabilityservices and confer with the instructor in the first two weeks of the semester so that appropriate accommodations may be made.

Religious Observances. Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, you must contact the instructor in the first two weeks of class to make alternate arrangements. See policy details at http://www.colorado.edu/policies/fac_relig.html

Policy on Sexual Harassment. The University of Colorado at Boulder policy on Discrimination and Harassment (<http://www.colorado.edu/policies/discrimination.html>), the University of Colorado policy on Sexual Harassment and the University of Colorado policy on Amorous Relationships applies to all students, staff and faculty. Any student, staff or faculty member who believes s/he has been the subject of discrimination or harassment based upon race, color, national origin, sex, age, disability, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the ODH and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at <http://www.colorado.edu/odh>

Classroom Behavior. Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender, gender variance, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. See policies at <http://www.colorado.edu/policies/classbehavior.html>.

Classroom Courtesy. For the benefit of your fellow students and your instructor, you are expected to practice common courtesy with regard to all course interactions. For example:

- Show up to class on time, and be prepared to learn when class starts.
- Do not leave class early, and do not start packing up before class is dismissed, as it is very noisy and distracting to other students. I will make sure that class ends on time as long as you will give your attention to the class until the end. If you must arrive late or leave early, please inform me or the TA in advance. Please sit near a rear exit – do not use the doors in the front of the classroom.
- Do not sit in the balconies: enrollment is capped low enough for all students to sit in the main classroom for better interaction & participation. If there is any reason why the steps or seats in the classroom are difficult for you, please contact the instructor as soon as possible for help.
- Please turn off cell phones in class; texting during class is distracting and not allowed.
- Laptop computers may not be used in class.

TEXT BOOK:

`` *The COSMIC Perspective*'' (5-th edition) , Bennett, Donahue, Schneider, & Voit

Course Outline:

The schedule is meant to be flexible. The field trip to ARC and the VLA will take about 5 to 6 days. I requested the last week in October for the field trip, but we will not know the exact timing until we receive the Fall schedule (expected in late September). The outline below is intended to provide a summary of the course contents.

Week 1 (Jan 13, 15) Introduction:

Intro to class and logistics. Class overview. Time- and distance scales in the Universe. Our modern view of the cosmos and our place within. The sizes and ages of the Solar System, the Galaxy, and the Universe. Read Ch 1 ("Our Place in the Universe") and Ch 4 ("Making Sense of the Universe' Understanding Motion, Energy, and Gravity").

Week 2 (Jan 20, 22). Review of Basics I: Gravity, the laws of motion. The 4 forces in Nature (gravity, electromagnetism, the weak, and the strong nuclear forces. Read Ch 5 ("Light and Matter; Reading Messages from the Cosmos") and section S4 (p 472; "Building Blocks of the Universe").

Week 3 (Jan 27, 28) Review of Basics II: Review properties of light and functions of a telescope. From eyesight to film, to modern electronic sensors. Detectors throughout the spectrum. Telescopes as "time-machines". Read Ch. 14 ("Our Star")

Week 4 (Feb 3, 5) The Sun as a star. Properties and structure of our star. Energy generation and the Sun's lifetime. Nuclear energy and Solar fusion reactions. Structure of Sun-like stars. Solar surface activity and its impact on Earth and the planets. Read Ch. 15 ("Surveying the Stars")

Week 5 & 6 (Feb 10, 12, 17, 19) Stars. Stellar properties. Masses, ages, luminosities, abundances of the elements. Spectral typing of stars. Energy generation and the mass-lifetime relation. The H-R diagram. Star clusters and nebulae. Read Ch. 16 ("Star Birth")

Midterm 1 (Thurs, 19 Feb)

Week 7 (Feb 24, 26) Star Formation. The interstellar medium. Giant molecular clouds. Turbulence, cloud cores, gravitational collapse. Protostars, outflow and jets. Ionized nebulae. Read Ch. 13 ("Other Planetary Systems; The New Science of Distant Worlds")

Week 8 (Mar 3, 5) Planet Formation and extra-Solar planets. Planet formation in the star forming environment. Clues about the birth-environment of our Solar System. The search for Other worlds. The search for life in the Universe. Read Ch. 17 ("Star Stuff")

Week 9 (Mar 10, 12) The Life of Stars; origins of the elements. Stellar evolution. Binary and multiple stars. Stellar winds and radiation. Feedback and regulation of the structure of the interstellar medium. Stellar death; collapsed stellar cores and supernova explosions. Read S2 (p 424, "Space and Time") and S3 (p 448 "Spacetime and Gravity").

Week 10 (Mar 17, 19) The Stellar Graveyard. Astronomy in extreme conditions; moving near the speed of light and the effects of very strong gravity. Review of special relativity. White dwarfs, neutron stars, and black holes. Pulsars, gamma-ray bursts, origins of cosmic rays, particle jets moving close to the speed of light. Read Ch. 19 (“Our Galaxy”)

Week 11 (Spring Break)

Week 12 (Mar 31, Apr 2) The Milky Way Galaxy. Young and old stellar populations. Globular clusters, The Galactic center. Gas, dust, interstellar medium, cosmic rays. Clusters of stars and supernovae. The “Galactic Ecology”. Read Ch. 20 (“Galaxies and the Foundations of Modern Cosmology”)

Week 13 (Apr 7, 9) Galaxies. Galaxy morphology and structure. The local group. Measuring distances and the distance ladder. Galaxy rotation. The Hubble expansion. Read Ch. 21 (“Galaxy Evolution”)

Midterm 2 (Tuesday, April 7)

Week 14 (Apr 14, 16) Looking back over cosmic time. Clusters of galaxies. Evidence for dark matter. Formation and evolution of galaxies. Active galactic nuclei and super-massive black holes. Powerful radio galaxies and jets. Read Ch. 22 (“Dark Matter, Dark Energy, and the Fate of the Universe”) and Ch. 23 (“The Beginning of Time”)

Week 15 (Apr 21, 23) Cosmology. The Hubble expansion, the cosmic microwave background, the big bang theory. Origin of matter. Current challenges in astrophysics; unifying the world of gravity and the quantum. Read Ch. 24 (“Life in the Universe”)

Week 16 (Apr 28, 30) Life in the Universe and Astrobiology. Origins and evolution of life. Speculation about the what happened in the Big Bang and what came “before”. Speculations about the future and fate of the cosmos.

Final: G1B20 Saturday, 2 May 2009, 7:30 – 10:00 PM