ASTR180: Principles of Astronomy I
Fall 2015: August 24–December 18
MWF 11:00 AM–11:50 AM, Room: STB 118

Version 7: December 16, 2015 (subject to change)

Professor:	Kathy Cooksey, Ph.D., STB 219; kcooksey@hawaii.edu; 808-932-7195
Office Hours:	M 2–3 PM, W 10–11 AM, R 1–2 PM, and by appointment
Website:	Laulima ASTR-180-001 (HIL.14165.FA15)
Textbook:	*The Cosmic Perspective, 7th Ed.* by Bennett, Donahue, Schneider, & Voit (no `MasteringAstronomy` required; textbook also used for ASTR181)

Course Description:

A survey of modern solar system astronomy, with emphasis on the underlying physical principles. Topics discussed include the celestial sphere and aspects of the night sky, the structure and evolution of the Sun's planetary system, comparative planetology, and theories of the formation of planetary systems. Intended for science majors and prospective science teachers. (CRN: 14165, Section: 001)

Pre-requisites:

None. The student should have a good operational familiarity with high-school algebra.

Learning Objectives:

- Broad course goals:
  1. Understand how astronomers know what they know about the universe by identifying the observations on which fundamental principles of astronomy are based.
  2. Form a conceptual framework of the content, structure, and evolution of the solar system as evidenced by the ability to connect topics in astronomy in multiple, meaningful ways.
  3. Practice and improve problem-solving skills, especially in how an approach is motivated, how a solution is formatted, and how the answer is verified to be reasonable.
  4. Learn/practice "reading" equations and figures for information so that even unfamiliar equations or figures can be assessed for their meaning.
- Specific content goals:
  1. Physical quantities have units that are used units to understand the physical quantities, solve problems, and support intuition about the relative scales of physical quantities.
  2. Dimensional analysis is a way of solving problems and "reverse engineering" equations.
  3. All astronomers have is light to study so the properties of light (e.g., blackbody radiation, flux-luminosity relation, magnitude system) are exceedingly important to understand
  4. Gravitational force is the mover and shaker of the universe, so it and related concepts (e.g., orbital motions, etc.) are also exceedingly important to understand.
  5. To understand how astronomers know what they know, students should understand modern astronomical observing (e.g., types of telescopes, importance of wavelengths, etc.)
  6. There is an interplay between the motion of an object and its signature in astronomical observations (i.e., Doppler shifts).
  7. Students should understand positional astrometry (e.g., astronomical coordinate systems, night-sky motions and effects on astronomical observing, etc.)

Email, Textbook, and Website:

- UHH considers email and Laulima an official form of communication; students are responsible for receiving and returning information in a timely manner.
- The professor will email students at their `hawaii.edu` accounts only.
- The required textbook is *The Cosmic Perspective, 7th Ed.* by Bennett, Donahue, Schneider, and Voit, which is also used for ASTR181.
- The Laulima course website is listed under ASTR-180-001 (HIL.14165.FA15). This site will be the hub for all course information.

Class Rules:

- Students are responsible for their own learning, which includes preparing for class, submitting work, asking questions, and seeking additional help.
- Students must respect and support their peers' learning, which means helping each other with difficult concepts but not just giving the answer.
- Students need to convey (either in person, by email, through an intermediary, or somehow) to the professor questions, comments, and concerns about the course.
- The professor will be receptive to and respectful of the students' needs and interests and must generally follow the class rules as detailed for the students (also see next section).
- Group work is encouraged in class and for homework assignments. However, all submitted work must be the original work of the student with reference to any homework partners.
- All references (e.g., websites, books other than the official course textbook, etc.) used to complete assignments must be cited, including numbers, techniques, facts, etc.
- Students need to sign the attendance sheet each class.
- An ABCD voting card is expected in every class. Replacements can be found by searching the internet for "ABCD_VotingCard.pdf" or going to Laulima and printing another one.
- A non-smart-phone calculator is required for every class. Students should practice with the calculator they will use for quizzes and the final exam.

Good-to-Know about the Professor:

- She enjoys teaching and wants to be better at it, and she really cares about helping students be better. These aspects combined mean she is on the students' side; trust in that and knowledge that she is receptive to feedback will smooth over rough patches.
- She chooses teaching techniques based on physics-education research to support student learning as best as possible. This means she has one or more reasons for nearly every component of and action in a course. She'll gladly motivate these choices whenever necessary or asked.
- Her primary goal is to help students improve *how* they learn with the logic that if students learn how to learn, they can master any content. The related goal is to focus on transferrable skills so that time and effort spent for the class yield benefits beyond the course and semester.
- Generally, she does not answer questions directly. A student making connections and constructing a solution her- or himself will ingrain the answer more effectively, and the professor facilitates the process by asking leading questions. Since the motivation is to help the students, they should embrace and engage with this process. (It is also a transferrable skill to discuss ideas and answer questions on the fly.)
- She designs quizzes and exams so that no one gets 100% and no one gets 0% because either score would not be useful in assessing what the students understand and how to help. The rule-of-thumb is to score above the median (see Grading below). She has no interest in failing students who make good-faith effort in the class (e.g., good attendance, submit completed work, ask questions in and out of class).

- She thinks no single resource is comprehensive, so the expectation is that the student will have to work with the professor, her materials, the textbook, and the wealth of material available on the internet.
- The expectation is that a course requires 2–3 hr outside-of-class time per credit per week.. Hence a 15-cr semester equals 30–45 hr per week (i.e., a full-time job).

General Course Outline[1]

Reading-for-class (RfC) assignments, which include Mathematical Insights (MI), are assigned before the class in which they will be reviewed. Lectures complement (not substitute) the reading. The reading assignments are from various parts of the book; the students are expected to read any supporting sections, Mathematical Insights, etc. to understand the assigned reading.

Group problem solving will be in-class, every Wednesday. The groups will be assigned and changed after each quiz. Groups should make a habit of sitting together each class for other, irregular activities.

Homeworks will be due every two weeks, on Wednesdays, at class time. The homeworks will be all quantitative (e.g., problems, figures, etc.) and come in two parts: one "homework" posted to Laulima:Resources and one "in-class" problem set. One problem will be graded in detail, the rest will be graded for completeness. The problem graded in detail will be worth half of the total homework points. This grading scheme rewards effort and works to ensuring at least a C in the homework grade (see Grading below).

Quizzes will be every third week starting W 23 September, and all content from one week before and earlier are fair game, including problems. All quizzes will have a group component of one problem, worth 25% of the quiz grade; the expectation is that groups will score well and raise the overall quiz grades. Groups decide whether a member who missed the previous non-quiz in-class group problem-solving session will be allowed to participate in the group quiz problem and, hence, have a chance for the 25% of the quiz grade.

[1] Subject to change.

Logical progression:[1] Content organized by rough topic, with assigned readings (sections, §, and Mathematical Insights, MI) in **bold**.

L2. Solar system I: intro to solar system, setting big picture and jargon

- **§1.1** The Scale of the Universe
- **§1.2** The History of the Universe

L3. Problem Solving I: problem solving basics, dimensional analysis, scale models, common units in physics & astronomy

- **MI 1.1** How Far Is a Light-Year?
- **MI 1.2** The Scale of Space and Time
- **MI 1.3** Order of Magnitude Estimation
- **MI 4.1** Units of Force, Mass, and Weight

L4. Problem Solving II: develop intuition, tie to dimensional analysis

- **§7.1** Studying the Solar System
- **§7.2** Patterns in the Solar System
- **MI 9.1** The Surface Area-to-Volume Ratio
- **MI 13.3** Finding Sizes of Extrasolar Planets

L5. Solar System II: Sun's structure, nucleosynthesis

- **§4.3** Conservation Laws in Astronomy
- **§14.1** A Closer Look at the Sun
- **MI 14.1** Mass-Energy Conservation in Hydrogen Fusion

L6. Properties of Light I: electromagnetic spectrum, wavelength/color, frequency, energy

- **§5.1** Light in Everyday Life
- **§5.2** Properties of Light
- **MI 5.1** Wavelength, Frequency, and Energy

L7. Properties of Light II: types of spectra, blackbody radiation

- **§5.3** Properties of Matter
- **§5.4** Learning from Light
- **MI 5.2** Laws of Thermal Radiation
- **§10.1** Atmospheric Basics

L8. Astronomical Observing I: flux-luminosity relation, magnitudes

- **MI 5.3** The Doppler Shift
- **MI 15.1** Inverse Square Law for Light
- **MI 15.3** The Modern Magnitude Scale

L11. Orbital Mechanics I: force and motion

- **§S1.2** Celestial Coordinates and Motion in the Sky
- **§4.1** Describing Motion: Examples from Daily Life
- **§4.2** Newton's Laws of Motion
- **MI 1.4** Speeds of Rotation and Orbit

L12–13. Orbital Mechanics II: gravity and orbits

- **§4.4** The Universal Law of Gravitation
- **§4.5** Orbits, Tides, and the Acceleration of Gravity
- **MI 4.4** Escape Velocity
- **MI 4.5** The Acceleration of Gravity

L14, 17. Orbital Mechanics III: seasons, phases, eclipses

- **§2.2** The Reason for Seasons
- **§2.3** The Moon, Our Constant Companion
- **MI 3.1** Eccentricity and Planetary Orbits

L18. Solar System III: formation, taxonomy

- **§8.1** The Search for Origins
- **§8.2** Explaining the Major Features of the Solar System
- **§9.1** Connecting Planetary Interiors and Surfaces
- **MI 13.2** Finding Masses of Extrasolar Planets

L19. Solar System IV: properties of terrestrial planets

- **§9.3** Geology of the Moon and Mercury
- **§10.3** Atmospheres of the Moon and Mercury
- **§9.4** Geology of Mars
- **§10.4** The Atmospheric History of Mars
- **§9.5** Geology of Venus
- **§10.5** The Atmospheric History of Venus

L20. Astronomical Observing II: telescopes and instruments; resolution

- **§6.2** Telescopes: Giant Eyes
- **§6.3** Telescopes and the Atmosphere
- **MI 6.1** Angular Resolution
- **MI 6.2** The Diffraction Limit

L23. Astronomical Observing III: angular sizes

- **MI 2.1** Angular Size, Physical Size, and Distance
- **MI 15.2** The Parallax Formula

L24. Orbital Mechanics IV: Kepler's Laws

- **MI 3.2** Kepler's Third Law
- **MI 4.3** Newton's Version of Kepler's Third Law
- **MI 13.1** Finding Orbital Distances for Extrasolar Planets

L25. Solar System V: properties of Jovian planets, magnetic fields, satellites, rings

- **§11.1** A Different Kind of Planet
- **§11.2** A Wealth of Worlds: Satellites of Ice and Rock
- **§11.3** Jovian Planet Rings

L26. Solar System VI: properties of other solar system objects

- **§12.1** Asteroids and Meteorites
- **§12.2** Comets
- **§12.3** Pluto: Lone Dog No More

Detailed schedule:[1] acronyms: HW = homework; IC = in-class problem solving; LS = Laulima survey; MI = Mathematical Insight; RfC = read for (next) class.

Date	Topic	In-class	Assignment	Due
M 24 Aug	L1. ASTR180	Pre-quiz	RfC: §§1.1–1.2 Read "Secret to Raising Smart Kids" (Dweck, *Scientific American*, 28 Nov 2007) and complete LS #1 (under Tasks, Tests and Surveys)	
W 26 Aug	L2. Solar System I		RfC: MI 1.1–1.3, 4.1 Recommended reading: Appendix C	LS #1
F 28 Aug	L3. Problem Solving I		RfC: §§7.1–7.2, MI 9.1, 13.3	
M 31 Aug	L4. Problem Solving II			
W 2 Sep		IC A: Problem Solving I	RfC: §4.3, §14.1, MI 14.1 HW #1: Problem Solving (incl. IC B)	
F 4 Sep	L5. Solar System II			
M 7 Sep	Labor Day (no class)			
W 9 Sep		IC B: Problem Solving II	RfC: §§5.1–5.2, MI 5.1	
F 11 Sep	L6. Properties of Light I		RfC: §§5.3–5.4, MI 5.2, §10.1	
M 14 Sep	L7. Properties of Light II			
W 16 Sep		IC C: Properties of Light I	RfC: MI 5.3, 15.1, 15.3 HW #2: Properties of Light (incl. IC C)	HW #1 (incl. IC B)
F 17 Sep	L8. Astronomical Observing I			
M 21 Sep	L9. Review for Quiz #1			
W 23 Sep		Quiz #1 [HW #1, IC A–B]		
F 25 Sep	L10. Post-Quiz #1 Review		RfC: §S1.2, §§4.1–4.2, MI 1.4	
M 28 Sep	L11. Orbital Mechanics I			
W 30 Sep		IC D: Properties of Light II	RfC: §§4.4–4.5, MI 4.5–4.5 HW #3 is IC D & E	HW #2 (incl. IC C)
F 2 Oct	L12. Orbital Mechanics II			
M 5 Oct	L13. Orbital Mechanics II (cont'd)			
W 7 Oct		IC E: Orbital Mechanics I	RfC: §§2.2–2.3, MI 3.1	
F 9 Oct	L14. Orbital Mechanics III			
M 12 Oct	L15. Review for Quiz #2			
W 14 Oct		Quiz #2 [HW #2, IC C]	HW #4: Solar System I (incl. IC F)	HW #3 (IC D & E)
F 16 Oct	L16. Post-Quiz #2 Review			
M 19 Oct	L17. Orbital Mechanics III (cont'd)		LS #2: Mid-term course evals	
W 21 Oct		IC F: Orbital Mechanics II	RfC: §§8.1–8.2, 9.1, MI 13.2	
F 23 Oct	L18. Solar System III		RfC: §§9.3–9.5, §§10.3–10.5	LS #2
M 26 Oct	L19. Solar System IV			
W 28 Oct		IC G: Solar System	RfC: §§6.2–6.3, MI 6.1–6.2 HW #5: Orbital Mechanics (incl. IC G)	HW #4 (incl. IC F)
F 30 Oct	~~L20. Astronomical Observing II~~ L21. Review for Quiz #3			
M 2 Nov	~~L21. Review for Quiz #3~~ No Class			
W 4 Nov		Quiz #3 [HW #3–4, IC D–F]		
F 6 Nov	L22. ~~Post-Quiz #3 Review~~ Astronomical Observing II (was L20)		RfC: MI 2.1, 15.2	
M 9 Nov	L23. Astronomical Observing III			
W 11 Nov	Veteran's Day (no class)		RfC: MI 3.2, 4.3, 13.1 HW #6: Astronomical Observing (incl. IC H)	~~HW #5 (incl. IC G)~~
R 11 Nov				**HW #5 (incl. IC G) by 11 AM, box outside office (STB219)**
F 13 Nov	L24. Orbital Mechanics IV		RfC: §§11.1–11.3	[HW #5 late deadline]
M 16 Nov	L25. Solar System V			
W 18 Nov		IC H: Orbital Mechanics III	RfC: §§12.1–12.3	
F 20 Nov	L26. Solar System VI			
M 23 Nov	L27. Course Synthesis			
W 25 Nov		IC I: Orbital Mechanics IV	HW #7: Solar System II (incl. IC I)	HW #6 (incl. IC H)
F 27 Nov	Thanksgiving break (no class)			
M 30 Nov	L28. Review for Quiz #4			
W 2 Dec		**Quiz #4 [HW #5–6, IC G–H]**		
F 4 Dec	L29. Post-Quiz #4 Review			
M 7 Dec	L30. Course Synthesis (cont'd)			
W 9 Dec		Post-quiz & course evals.		HW #7 (incl. IC I)
W 16 Dec	Final Exam	9:40 AM–11:40 AM, STB118		

Grading:

- The grade depends on the following items: homework assignments (40%); completing pre- and post-quizzes (5%); quizzes (40%); and the final exam (15%). The lowest homework and quiz grades will be dropped.
- There will be no make-up work other than the final exam.
  - If a student were excused, the graded work will not be included in her/his final grade.
  - If a student must miss a class for a reasonable reason, s/he must email the professor before the start of class time.
  - If a student were unable to email in advance due to extreme circumstances, s/he should contact the professor as soon as possible. Such instances will be judged on a case-by-case basis.
  - If a student were excused from all points in a given category, the percentage of the other categories will be increased to fill the void.
- Homework assignments are never excused since their due dates are known in advance. It is the student's responsibility to turn in the homework somehow, either by giving it to another student to submit or by scanning and emailing it to the professor.
- Late homework is accepted within 24 hours of the deadline for 75% credit.
- Cheating is not tolerated. Any question of cheating will be tested with an oral exam, to see whether the student(s) involved understand the material. Cheating will result in a zero for the item in question and a report to the University. It may result in immediate failure of the course.
- The final letter grade will be given based on the class statistics (e.g., the 25^{th}, 50^{th}/median, 75^{th} percentiles). The goal is to score higher than the median on all graded work. The expectation is that final grades higher than the median will pass with at least a C and that the 25^{th} to 50^{th} percentiles will likely earn something in the C range.

Disability Support: Any student with a documented disability who would like to request accommodation should contact the University Disability Services Office at 932-7623 (V) or 932-7002 (TTY), as early in the semester as possible.

Advising: Advising is a very important resource designed to help students complete the requirements of the University and their individual majors. Students should consult with their advisor at least once a semester to decide on courses, check progress towards graduation, and discuss career options and other educational opportunities provided by UH Hilo. Advising is a shared responsibility, but students have final responsibility for meeting degree requirements.

Kilohana Academic Success Center: The KASC provides academic support opportunities for all UH Hilo students that foster their development into independent, self-motivated learners. Students who visit Kilohana have access to subject-specific and academic skills tutoring from UHH students selected for their academic achievement and dedication to helping others succeed. Kilohana is located on the lower level of the Mookini Library and on the web at `http://hilo.hawaii.edu/kilohana/`.

Human Rights: The University of Hawai'i at Hilo prohibits discrimination in its education programs based on race, national origin, color, creed, religion, sex, age, disability, veteran status, sexual orientation, gender identity or associational preference. If at any time during class you feel uncomfortable about what is being talked about, or feel that your human rights have been violated, please feel free to leave the room. However, the professor asks that you confer with her as soon as possible about what happened so that appropriate action can be taken if necessary to avoid future problems. If you are uncomfortable speaking with the professor about your concern, please contact Kalei Rapoza (`kaleihii@hawaii.edu`), Interim EEO/AA Director, at 932-7641.

UH Hilo Sexual Assault Policy: UH Hilo provides confidential assistance for victims of sexual assault. Counseling Services on-campus and the YWCA Sexual Support Services off-campus offer guidance regarding

medical assistance and emotional help and can discuss options for reporting sexual assaults to law enforcement. All conversations are private and confidential. The UH Hilo Sexual Assault Policy can be found at: `http://hilo.hawaii.edu/uhh/vcsa/documents/UHHSexualAssaultPolicy.pdf` For assistance during the day, contact UH Hilo Counseling Services at (808) 932-7465; or, after hours and on weekends, contact the YWCA Sexual Assault Support Services at (808) 935-0677.

Student Conduct: Students are expected to follow the University of Hawai'i at Hilo Student Code of Conduct available at the following URL:
`http://www.uhh.hawaii.edu/catalog/student-conduct-code.html`.

Student's Name
Group Members' Names

ASTR180 Question X: Problem-Solving Steps

1. **Recognize the problem:** What's going on? What do I want?
   - Draw a picture of the situation.
   - Define useful quantities: identify what you know and don't know.
   - State the question in terms of something you can calculate.

2. **Describe the problem in terms of the field:** What does this have to do with...?
   - State general principles that might be useful to approach this problem.
   - Give any constraints imposed by the situation.
   - State any approximations that might be useful.
   - Draw any diagrams that might be useful.
   - Translate the general principles into equations specific to the situation.

3. **Plan a solution:** How do I get what I want?
   - Identify your target quantity.
   - Construct a chain of equations linking your target to known quantities.
   - Check to see if you have sufficient equations.

4. **Execute the plan:** Let's get an answer.
   - Math goes here.
   - Follow your plan to calculate an answer.
   - Check your units.

5. **Evaluate the solution:** Can this be true?
   - Did you answer the question?
   - Justify that your answer is reasonable.