ASTR180: Principles of Astronomy I
Fall 2014: August 25–December 17
MWF 11:00 AM–11:50 AM, Room: STB 226

Version 1: August 25, 2014 (subject to change)

Professor:	Kathy Cooksey, Ph.D., STB 219; kcooksey@hawaii.edu; 808-932-7195
Office Hours:	M 1–2 PM, T 12–1 PM, W 10–11 AM, and by appointment
Website:	Laulima ASTR-180-001 (HIL.13305.FA14)
Textbook:	*The Cosmic Perspective, 7th Ed.* by Bennett, Donahue, Schneider, & Voit (no `MasteringAstronomy` required)

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: 13305, 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 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 student must ensure that the professor has her/his correct email address.
- The required textbook is *The Cosmic Perspective, 7th Ed.* by Bennett, Donahue, Schneider, and Voit.
- The Laulima course website is listed under ASTR-180-001 (HIL.13305.FA14). This site will be the hub for all course information.

Class Rules:

1. Students are responsible for their own learning, which includes preparing for class, submitting work, asking questions, and seeking additional help.
2. Students should be respectful and supportive of their peers' learning, which means helping each other with difficult concepts but not just giving the answer.
3. Students should convey (either in person, by email, through an intermediary, or somehow) to the professor questions, comments, and concerns about the course.
4. The professor should be receptive to and respectful of the students' needs and interests and should generally follow the class rules as detailed for the students.
5. Sign in each class on the attendance sheet.
6. Bring an ABCD voting card to every class. Replacements can be found by searching the internet for "ABCD_VotingCard.pdf" or going to Laulima and printing another one.
7. 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.

General Course Outline[1]

Reading assignments are assigned before the class in which they will be reviewed. Students are expected to come to class with questions about the assigned reading, which include sections and Mathematical Insights. The reading assignments are from various parts of the book; the students are expected to reading 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 will change after quizzes. 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; the other problems will be worth 5 points.

Quizzes will be every third week starting 1 October and will cover all preceding content, but only problem types from the noted homework(s) and in-class problem set(s) will be tested. All quizzes will have a group component of one problem, worth 25% of the quiz grade. Groups get to 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.

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[1]Subject to change.

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

1. Solar system I: intro to solar system, setting big picture and jargon [2 lectures; HW #2]

   §1.1 The Scale of the Universe
   §1.2 The History of the Universe
   §7.1 Studying the Solar System
   §7.2 Patterns in the Solar System

2. Problem Solving I: problem solving basics, dimensional analysis, common units in physics & astronomy [1 lecture; IC A; HW #1]

   MI 1.1 How Far Is a Light-Year?
   MI 1.3 Order of Magnitude Estimation
   MI 4.1 Units of Force, Mass, and Weight
   MI 9.1 The Surface Area-to-Volume Ratio
   MI 13.3 Finding Sizes of Extrasolar Planets

3. Problem Solving II: scale models, develop intuition, tie to dimensional analysis [1 lecture; IC B; HW #1]

   MI 1.2 The Scale of Space and Time
   §4.3 Conservation Laws in Astronomy
   MI 14.1 Mass-Energy Conservation in Hydrogen Fusion

4. Properties of Light I: electromagnetic spectrum, wavelength/color, frequency, energy [1 lecture; IC C]

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

5. Solar System II: formation, Sun, solar wind, magnetosphere, heliopause, aurora, solar flares [2 lectures; HW #2]

   §8.1 The Search for Origins
   §8.2 Explaining the Major Features of the Solar System
   §14.1 A Closer Look at the Sun

6. Orbital Mechanics I: gravity basics, orbits basics [2 lectures; IC D; HW #3]

   §4.1 Describing Motion: Examples from Daily Life
   §4.2 Newton's Laws of Motion
   MI 1.4 Speeds of Rotation and Orbit
   §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

7. Properties of Light II: light travels in straight lines, refraction and reflection [1 lecture; HW #4]

   §6.1 Eyes and Cameras: Everyday Light Sensors
   §6.3 Telescopes and the Atmosphere
   §10.1 Atmospheric Basics

8. Astronomical Observing I: telescopes (refractors and reflectors); trace light path [2 lecture; IC E]

   §6.2 Telescopes: Giant Eyes
   §S1.2 Celestial Coordinates and Motion in the Sky

9. Properties of Light III: flux-luminosity relation, blackbody radiation (Wien's Law and Stefan-Boltzmann Law) [3 lectures; IC F; HW #5]

   MI 15.1 Inverse Square Law for Light
   §5.3 Properties of Matter
   §5.4 Learning from Light
   MI 5.2 Laws of Thermal Radiation

10. Astronomical Observing II: magnitudes [1 lectures; IC G]

    MI 15.3 The Modern Magnitude Scale

11. Solar System III: properties of terrestrial planets, magnetic fields, satellites [2 lectures; IC H]

    §9.1 Connecting Planetary Interiors and Surfaces
    §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

12. Orbital Mechanics II: seasons, phases, eclipses [1 lecture; HW #6]

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

13. Astronomical Observing III: instruments (CCDs, imagers, spectrographs, satellites), filters, spectroscopy [1 lectures; HW #6]

    §6.4 Telescopes and Technology
    MI 6.2 The Diffraction Limit
    §13.1 Detecting Planets Around Other Stars

14. Astronomical Observing IV: resolution and sensitivity; uncertainties [2 lectures; IC I]

    MI 6.1 Angular Resolution
    MI 5.3 The Doppler Shift
    MI 13.2 Finding Masses of Extrasolar Planets

15. Orbital Mechanics III: parallax, Kepler's Laws [2 lecture; IC J; HW #7]

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

16. Solar System IV: properties of Jovian planets, magnetic fields, satellites, rings [1 lecture]

    §11.1 A Different Kind of Planet (in Ch 11 Jovian Planet Systems]
    §11.2 A Wealth of Worlds: Satellites of Ice and Rock
    §11.3 Jovian Planet Rings

17. Solar System V: properties of other solar system objects (asteroids, Oort cloud, gas and dust (Zodiacal light)) [1 lecture]

    §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 25 Aug	ASTR180		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 27 Aug	Solar System I		RfC: MI 1.1, 1.3, 4.1, 9.1, 13.3 Recommended reading: Appendix C: A Few Mathematical Skills	LS #1
F 29 Aug	Problem Solving I			
M 1 Sep	Labor Day (no class)			
W 3 Sep		IC A: Problem Solving I	RfC: MI 1.2, §4.3, MI 14.1 HW #1: Problem Solving	
F 5 Sep	Problem Solving II		RfC: §§7.1–7.2	
M 8 Sep	Solar System I (cont'd)			
W 10 Sep		IC B: Problem Solving II	RfC: §§5.1–5.2, MI 5.1	
F 12 Sep	Properties of Light I		RfC: §§8.1–8.2	
M 15 Sep	Solar System II			
W 17 Sep		IC C: Properties of Light I	RfC: §14.1 HW #2: Solar System I & II	HW #1+IC B
F 19 Sep	Solar System II (cont'd)		RfC: §§4.1–4.2, MI 1.4	
M 22 Sep	Orbital Mechanics I			
W 24 Sep		IC D: Orbital Mechanics I	RfC: §§4.4–4.5, MI 4.4–4.5	
F 26 Sep	Orbital Mechanics I (cont'd)			
M 29 Sep	Review for Quiz #1			
W 1 Oct		Quiz #1 [HW #1, IC A–C]	RfC: §6.1, §6.3, §10.1 HW #3: Orbital Mechanics I	HW #2+IC D
F 3 Oct	Properties of Light II		RfC: §6.2	
M 6 Oct	Astronomical Observing I			
W 8 Oct		IC E: Astronomical Observing I	RfC: §S1.2	
F 10 Oct	Astronomical Observing I (cont'd)		RfC: MI 15.1	
M 13 Oct	Properties of Light III			
W 15 Oct		IC F: Properties of Light III	RfC: §5.3 LS #2: Mid-term course evals. HW #4: Properties of Light II	HW #3+IC E
F 17 Oct	Properties of Light III (cont'd)			LS #2
M 20 Oct	Review for Quiz #2			
W 22 Oct		Quiz #2 [HW #2–3, IC D–E]	RfC: §5.4, MI 5.2	
F 24 Oct	Properties of Light III (cont'd)		RfC: MI 15.3	
M 27 Oct	Astronomical Observing II			
W 29 Oct		IC G: Astronomical Observing II	RfC: §9.1, §9.3, §10.3 HW #5: Properties of Light III	HW #4+IC F
F 31 Oct	Solar System III		RfC: §9.4, §10.4, §9.5, §10.5	
M 3 Nov	Solar System III (cont'd)			
W 5 Nov		IC H: Solar System III	RfC: §§2.2–2.3, MI 3.1	
F 7 Nov	Orbital Mechanics II		RfC: §6.4, MI 6.2, §13.1	
M 10 Nov	Astronomical Observing III			
W 12 Nov		Quiz #3 [HW #4, IC F–G]:	RfC: MI 6.1 HW #6: Orbital Mechanics II & Astronomical Observing III	HW #5+IC H
F 14 Nov	Astronomical Observing IV		RfC: MI 5.3, 13.2	
M 17 Nov	Astronomical Observing IV (cont'd)			
W 19 Nov		IC I: Astronomical Observing IV	RfC: MI 2.1, 15.2	
F 21 Nov	Orbital Mechanics III		RfC: MI 3.2, 4.3, 13.1	
M 24 Nov	Orbital Mechanics III (cont'd)			
W 26 Nov		IC J: Orbital Mechanics III	RfC: §§11.1–11.3 HW #7: Orbital Mechanics III	HW #6+IC I
F 28 Nov	Thanksgiving break (no class)			
M 1 Dec	Solar System IV			
W 3 Dec		Quiz #4 [HW #5–6, IC H–I]	RfC: §§12.1–12.3	
F 5 Dec	Solar System V		RfC: §13.4: The Future of Extrasolar Planetary Science	
M 8 Dec	Course Synthesis			
W 10 Dec	Course Synthesis (cont'd)	Course evals.		HW #7+IC J
W 17 Dec	Final Exam	9:40 AM–11:40 AM, STB226		

Grading:

- The grade depends on the following items: homework assignments (45%); 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.
- 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.
- 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.
- The letter grade will be given based on the chart below:

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.

Grade	% Required
A	≥ 93
A$-$	$[90, 93)$
B$+$	$[87, 90)$
B	$[83, 87)$
B$-$	$[80, 83)$
C$+$	$[77, 80)$
C	$[73, 77)$
C$-$	$[70, 73)$
D	$[60, 70)$
F	< 60

where e.g., $[90, 93)$ means $\geq$ 90% and < 93%.

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.