

**AY 5: Introductory Astronomy–  
The Formation and Evolution of the Universe**

Summer Session I: June 23–July 25, 2008

MWF 10:00 AM–12:45 PM, Room: Nat. Sci. Annex 102

**Draft 2:** June 22, 2008 (subject to change)

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**Instructor:** Kathy Cooksey, ISB 111, kcooksey@ucolick.org, 459-3809

**Office Hours:** W 3:00–4:30 PM, Th 10:00–11:30 AM, and by appointment

**Website:** <http://www.ucolick.org/~kcooksey/education/AY5.html>

**Prerequisites:** None

**Course Goals:**

1. Students will engage in the scientific process to learn about astronomy and improve their scientific skills in general.
2. Students will improve their ability to understand what equations and plots mean and how to use them to answer questions.
3. Students will understand the logic and implications of the following statement: “electromagnetic radiation is all astronomers have to study the Universe.”
4. Students will develop an intuitive understanding of the content, structure, and evolution of the Universe.

**Class Rules:**

1. Each student should take responsibility for his/her own learning (*e.g.*, ask questions, seek additional help).
2. All students should be respectful and supportive of their peers’ learning (*e.g.*, help each other with difficult concepts but do not just “give the answer”).
3. Everyone should actively participate in class (*e.g.*, discussions, activities, demonstrations).
4. The students should convey (either in person, by email, through an intermediary, or somehow) to the instructor questions, comments, and concerns about the course.

5. The instructor should be receptive to and respectful of the students' needs and interests and should generally follow the class rules as detailed for the students.
6. This class will be Internet and email intensive. If you have difficulties accessing Internet and/or email, please talk to the instructor immediately.
7. The instructor opted to *not* have a textbook and to instead rely on Internet resources and resources the students find for themselves, whether online or in a library. **Most of the course readings will be distributed on the course website**, and students will be requested to use the Internet in lieu of a textbook (*e.g.*, for values of constants in equations, background material, etc).

### **Broad Course Topics:**

1. **Nature of Science:** what is science; what is a scientist; how do scientists know what they know.
2. **Properties of Light:** electromagnetic radiation; blackbody radiation; inverse-square law; continuous, emission, and absorption spectra; Doppler effect.
3. **Stars:** formation and evolution; classification; Hertzsprung-Russell Diagram; standard candles; nuclear fusion and chemical evolution.
4. **Galaxies:** formation, structure, and evolution; classification; feedback processes; mergers.
5. **Observations and Instrumentation:** charge-coupled device (CCD); filters; resolution; sensitivity; saturation; ground and space observatories; observational bias.
6. **Misc. Physics:** Newtonian gravity; special relativity; general relativity as it relates to black holes; relative strengths and spheres of influence of the four fundamental forces.
7. **Cosmology:** Big Bang; early Universe; hierarchical structure formation; large-scale structure; Universal expansion and Hubble's Law.

### **Course Outline:**

1. Overview of cosmology (June 23)
  - (a) "What is *cosmology*?" (discussion activity)

- (b) “What is science?” (discussion activity)
- (c) Introduction to astronomical observing (CCDs, filters)
- (d) Blackbody radiation (atomic structure and motion; Wien’s Law; Stefan-Boltzmann Law)
- (e) Assignment: read “The Secret to Raising Smart Kids,” C. S. Dweck, *Scientific American*, 11-28-2007 (due: W June 25)
  - If this metacognitive article is interesting, here is another good article about how stereotypes subconsciously affect human achievement in “The Threat of Stereotype,” J. Aronson, *Educational Leadership*, 63: 14–19, 2004.
- (f) Assignment: submit cosmology article to instructor for approval for final presentation (see “Final” section below for more details; due: W July 16)

## 2. Galaxy inquiry (June 25, 27)

- (a) Inquiry = learning science as science is done.
- (b) Ryan Montgomery (ISB 131, rmontgom@ucolick.org, 459.3259) will be in charge, but the facilitators Liz McGrath and David Lai will be leading the inquiry.
- (c) *Grade*: 5% of your total course grade is participating in the two days of the inquiry. (5% of your total grade is the written summary of your participation in the inquiry, described below.) You will be graded on:
  - Attending both days of the inquiry (and being on time.) You will be working in teams, and it would be very unfortunate to miss a team member during any portion of the inquiry.
  - Participating in the tasks and challenges that the facilitators lay out.
  - Sharing your questions, comments, and ideas throughout the inquiry.
  - This is a non-traditional grade, since inquiry is more about the process of learning than about right or wrong. Ryan, David, and Liz will score your participation on how engaged you are throughout, how much you push your understanding, how you interact with your peers, how you improve in your scientific process skills, etc.
- (d) Assignment: **email** written summary *in the body of the email* (no word processing or formatting necessary; due: **5 PM**, Saturday, June 28)
  - Address the following in whatever order and in however many word necessary:
    - What did you learn? How did you learn this?

- What were the key points that the facilitators wanted you to learn? Did you learn these key points? Why or why not?
- What more would you have liked to investigate and why? If nothing, why?
- Did the “The Secret to Raising Smart Kids” reading influence your inquiry experience? Why or why not?
- Any questions, comments, concerns?
- The summary is worth 5% of your grade. It will be graded on how clearly you recount your experience with—and your thoughts on—the inquiry.
- This is not an English grammar class; the summary does not have to be fancy, just informative. *But* it is expected that you will *e.g.*, clearly distinguish between fact and opinion, use complete sentences and proper capitalization, check spelling, etc.

### 3. Light: properties and information (June 30)

- (a) Electromagnetic radiation (energy; type of spectra)
- (b) Blackbody radiation (revisited)
- (c) Chemical composition
- (d) Astronomical observing (nature of telescopes; ground and space-based observatories)
- (e) Assignment: read “Misconceptions about the Big Bang,” C. H. Lineweaver and T. M. Davis, *Scientific American*, 02-21-2005 (due: W July 2)
- (f) Assignment: “Scale Models in Astronomy” problem set (due: M July 7)

### 4. History of the Universe (July 2, 7)

- (a) Big Bang
- (b) First second
- (c) Cosmic microwave background
- (d) First stars and reionization
- (e) Assignment: read “The Lives of Stars: From Birth to Death and Beyond (Part I),” I. Iben Jr. and A. V. Tutukov, *Sky & Telescope*, Dec. 1997 (due: W July 9)
- (f) Assignment: “Energy History of the Universe” problem set (due: W July 16)

5. Objects in the Universe I: Stars (July 9, 11)
  - (a) Environments
  - (b) Formation and evolution (Newtonian gravity and general relativity)
  - (c) Classification
  - (d) Life-cycle of gas and dust
  - (e) Assignment: read “The Life Cycle of Galaxies,” G. Kauffmann and F. van den Bosch, *Scientific American*, 12-31-2002 (due: M July 14)
  
6. Objects in the Universe II: Galaxies (July 14, 16)
  - (a) Large-scale structure
  - (b) Formation and evolution
  - (c) Classification and morphology
  - (d) Life-cycle of gas and dust
  - (e) Assignment: read “Dark Energy & the Preposterous Universe,” S. Carroll, *Sky & Telescope*, Mar. 2005 (due: F July 18)
  - (f) Assignment: “Measuring the Universe” problem set (due: W July 23)
  
7. Future of the Universe (July 18, 21)
  - (a) Dynamics and expansion (dark matter, dark energy)
  - (b) Doppler shift (special relativity)
  - (c) Cosmological redshift
  - (d) Hubble’s Law (standard candles)
  - (e) Assignment: “Course reflection and alternate syllabus” writing assignment (due: F July 25)
    - Address the following for the “course reflection” in whatever order and in however many words necessary:
      - What will you remember best/longest from this course? Why do you believe this to be so?
      - On what topic(s) should we have spent more time? Less?
      - Were the “Course goals” met? Why or why not?
      - What one aspect of the course should *not* be changed? What one *should* be changed? Why (for each)?

- For the “alternate syllabus,” please enumerate and *explain* any changes you would make to the syllabus (*e.g.*, order and/or time spent on certain sections, use or types of readings and/or demonstrations, etc).
  - This writing assignment is worth 5% of your grade. It will be graded on how clearly you express your opinions on the content, structure, etc of this course.
  - Again, this is not an English grammar class; the summary does not have to be fancy, just informative. *But* it is expected that you will *e.g.*, clearly distinguish between fact and opinion, use complete sentences and proper capitalization, check spelling, etc.
- (f) Assignment: submit three short-answer questions and your answer key about the material you will cover in your final presentation (due: M July 21)

8. Final July 23, 25

- (a) In lieu of a final exam, each student will give a presentation on a recent *popular science* article about cosmology from a published periodical, *e.g.*, *Sky & Telescope*, *Astronomy*, *Scientific American* (15% of grade).
- (b) Articles must be approved by the instructor by Wednesday, July 16. Most likely, students will need to review supplementary material to understand and present the science of their chosen article; these sources need not be approved but must be cited during the presentation.
- (c) Presentations can be Power Point, transparencies, or simply spoken but not read word for word. The instructor is available to help students construct their presentations.
- (d) The grade will be based on:
- Clearly summarizing the thesis and main supporting evidence of the science.
  - Describing the current state of the specific science relating to the article’s content and how the latter describes or contributes new science.
  - Relating the content to the course material.
  - Being professional during the presentation and question session. This includes *staying within the given time limit*, which will be announced after the class enrollment is settled.
  - Submitting three good short-answer questions (due M July 21) and providing the answers clearly in your presentation.

- (e) Quiz(zes): At the end of each presentation day, there will be a short-answer quiz with questions drawn from the questions each student submitted about his/her presentation.

**Grade Policy:**

1. Your grade depends on the following items: three or four problem sets (40%); final presentation (15%); in-class participation (10%); inquiry participation and written summary (10%); in-class quizzes (10%); instructor discretion (10%); reflection writing assignment (5%).
2. Group work is encouraged in class and for homework assignments. However, all submitted work must be in your own words and in your own writing with reference to whom your partners were.
3. All references (*e.g.*, websites, textbooks, etc.) used to complete assignments must be cited, including numbers, techniques, facts, etc.
4. Extra credit may be awarded as the instructor sees fit.

**Important Dates:**

“The Secret to Raising Smart Kids” reading due ..... W June 25  
 Galaxy Inquiry ..... WF June 25, 27  
**Final day to drop class** ..... F June 27  
 Inquiry written (email) summary due ..... 5PM Sat. June 28  
 “Misconceptions about the Big Bang” reading due ..... W July 2  
**No class** ..... F July 4  
 “Scale Models in Astronomy” problem set due ..... M July 7  
 “The Lives of Stars” reading due ..... W July 9  
 “The Life Cycle of Galaxies” reading due ..... M July 14  
 “Energy History of the Universe” homework due ..... W July 16  
 Submit final presentation articles for approval ..... W July 16  
 “Dark Energy & the Preposterous Universe” reading due .. F July 18  
 “Measuring the Universe” homework due ..... W July 23  
 Final presentations ..... WF July 23, 25  
 “Course reflection and alternate syllabus” due ..... F July 25