Syllabus

Astronomy 18: Planets and Planetary Systems

Spring Quarter 2007, UC Santa Cruz

Instructor: Professor Claire Max
Office: Center for Adaptive Optics, room 213
(The small building just downhill from Nat Sci 2)
Phone: 459-2049
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Office Hrs: Thursdays 1-2 pm
Other meeting times can be arranged by phone, e-mail, or in person

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Office hrs: Tuesdays 11 am - noon

Sections: Interdisciplinary Science Bldg 165
Mon 12:30-1:30 pm, Wed 5-6 pm, Thurs 6-7 pm
One section will be a review of homework and other assignments. Optional.
The other two will contain lab exercises. You must attend at one of these 2 times.

Class Days: Tuesdays and Thursdays
Class Times: 2 – 3:45 pm with a short break halfway
Location: Natural Sciences Annex room 102

Class Web Sites:
1) The main class web site is http://www.ucolick.org/~max/AY18.2007
2) The class will also have a website on WebCT, https://webct.ic.ucsc.edu:4443/
3) There is a website associated with our main textbook *The Cosmic Perspective*: http://www.astronomyplace.com. When you purchase the book, you will find instructions inside the front cover for how to log in to this web site .

Course Description, from UCSC Catalogue: Overview of our solar system and those recently discovered around nearby stars. Topics include formation of planets, structure of planets, moons and rings, asteroids and comets, ground-based and space-based observations, and physical processes. A course in high school physics is recommended; course intended for science majors. Offered in alternate academic years. (General Education Code(s): IN, Q.)

Goals of Course:
1) Understand the unifying physical concepts underlying planetary formation and evolution
2) Become familiar with the Solar System -- it's our home in the Universe!

3) Other solar systems besides our own: Join in the excitement of discovery!
4) Gain an appreciation of how science works
5) Improve your skills in quantitative reasoning

Course Description, Longer Version:
Exploration of our own Solar System by spacecraft and by astronauts has yielded a dramatic new understanding of our immediate neighborhood in the universe. And since 1995, more than 200 planets have been discovered around *other* nearby stars, giving us the new perspective that solar systems are common phenomena in our galaxy. We will learn about planets, their moons, planetary rings, comets, asteroids, meteoroids, and life in our solar system and others. However, we will not treat these topics as a list of facts to be memorized. Rather, we will employ elegant and simple physical concepts – gravity, energy, and light – to understand the processes that lead to solar systems and form planets. All the necessary physical concepts will be presented and discussed in class and in reading material. We will be using math tools that will be reviewed in sections: exponential notation, logarithms, algebra, basic geometry, and, for those who have seen it before, basic introductory calculus. By using scientific techniques to study the solar system, we will gain an appreciation of how science works not only in astronomy but in other fields as well.

Main Text: *"The Solar System: The Cosmic Perspective*, 4th Edition with Media Update", by Bennett, Donahue, Schneider, and Voit. There is also a somewhat longer version of this text that includes *The Solar System* as well as the rest of astronomy; this is called simply "*The Cosmic Perspective*, 4th Edition with Media Update." *The Solar System: The Cosmic Perspective*is supposed to be in stock at the Bay Tree Bookstore.

Handouts: There will be handouts of reading material, available in class and on the UCSC WebCT website, https://webct.ic.ucsc.edu:4443/
You can find out the password for the Astro 18 site by coming to class.

The enterprise of science:

The legendary Berkeley chemist Joel Hildebrand wrote the following in 1957:

"I distinguish two aspects of science: content and enterprise; one is classified knowledge, the other is the way in which scientists work and think. The one way in which we write up our results, in papers and books, in the passive voice, gives the impression that we start with precise measurements and proceed by strict logical steps to incontrovertible conclusions. The way we *really* do it – starting with hunches, making guesses, making many mistakes, going off on blind roads before hitting on one that seems to be going in the right direction – that is science in the making."

This course will involve both of the approaches described by Hildebrand:

Reading and lectures will address what Hildebrand called "content" – what we know about our Solar System and others, and the scientific tools used to discover this knowledge. Homeworks and Lab Exercises will help build proficiency in using the tools of discovery and understanding.

Class Projects will address what Hildebrand called "enterprise" -- the way scientific discovery *really* works, including deciding what questions to ask, developing hunches and guesses, gathering data, and the process of making sense of what seems at first like a confusing mass of data and facts. Projects will be collaborative, involving groups of students, and will last for the entire quarter. Near the end of the quarter, each group of students will present their Project to the class.

Homeworks: Homework assignments (problem sets) will be given every week, and will be due at the start of class on Thursdays. Because you will also be doing class projects (see below), problem sets will be shorter than the norm in most introductory physics and astronomy courses. Homeworks will constitute 30% of the final grade.

Projects: Projects will be an important part of the course (30% of the final grade), and will give crucial experience in the *process* of scientific inquiry. They will be collaborative, involving groups of 2 (or more) students each. Each group will work on one project topic for the entire quarter. You should choose the topic for your project because you are *interested* in it. Topics for projects can be chosen from a list of potential projects prepared by the professor, or from ideas proposed by the students yourselves (with approval from the professor). Projects will be structured so that there are clear weekly milestones, in order to avoid getting "lost" in a topic. Project teams will meet with the professor and TA several times during the quarter. Instead of a second mid-term exam, each group of students will present their Project to the class and will hand in a short paper describing their work.

Exams: There will be one mid-term exam and one final exam. Exams will not be graded on a curve: if everyone does well, everyone will get high grades. No student's grade will go down because others have done better. Exams will consist of both conceptual essay questions and conventional problems. About half the questions will be conceptual, and half computational problems. Exams will constitute 30% of the final grade.

Lab Exercises: Most weeks, one of the sections will be devoted to a "lab exercise" of some sort. These will range from practice in quantitative reasoning all the way to stargazing and observing the planets with a telescope. (The second section will be devoted to reviewing homeworks and exams.) Lab exercises will constitute 10% of the final grade.

Work Load: In addition to attending class sessions, you should count on at least six to eight hours of study out of class each week, including reading, projects, and homeworks. If you have difficulty with a problem or a concept, see the professor or the Teaching Assistant. We're here to help you learn, but you must invest the time to study and complete your assignments. If you do these things, this will be a rewarding and mind-broadening course and will give you a new appreciation for the world we live in.

Class Participation and Questions: Due to the size of the class, it is especially important that you feel free to speak out if you have a question. If you do not understand material in the book or in class, it is up to you to ask questions in class, in sections, or in office hours. If you don't let

us know that you are having a problem, we won't find out until the exam, and that may be too late. Class participation will constitute 10% of the final grade.

Feedback: I welcome feedback on the class. If you wish, you can send comments or suggestions to me via e-mail. Please put "Astro 18" in the subject line of any e-mail related to the course. Again, I cannot address a problem if I'm not made aware of its existence.

Grading and Exams: Your final grade will be based on the following:

Projects:	30%
Homework:	30%
Exams:	30%
Lab exercises:	10%

Extra credit: Up to 10 percentage points of extra credit can be earned through the Reading Quizzes given at the start of each lecture.

Homework turned in one class period late will be graded with a grade reduction of 1/2. Homework more than one class period late will not be accepted. Your one lowest-graded homework assignment will not count toward your grade.

Topics Covered in Astro 18: (not necessarily in order of the lectures)

1) Overview of the course: mechanics of how the course will work; overview of the Solar System, its scale, its place within the Milky Way Galaxy and its place in the Universe at large.

2) Projects: groups of 2 or more students per topic.

3) Discovering the sky for yourself: how to distinguish planets from stars; how to find the planets; the constellations; the Zodiac; the seasons.

4) Gravity: mass and weight; Kepler's laws and Newton's laws; planetary orbits; Lagrangian points; tides and tidal heating; planetary rings.

5) Energy and matter: concepts of temperature and pressure; potential and kinetic energy; conservation of energy; equation of state; phase transitions.

6) Light: wavelength, frequency, and energy; emission and absorption of radiation; spectra; black body radiation; Doppler shift; infrared and radio waves; x-rays and gamma-rays.

7) Telescopes and spacecraft -- how we learn about the Universe by observing light: eyes, cameras, film, CCD's, telescopes, blurring of images by the Earth's atmosphere; spacecraft types and trajectories; advantages of observing from space or from the ground.

8) Origins -- Formation of the sun and the Solar System: the early solar nebula; gravitational

collapse; condensation and accretion; protoplanetary disks; formation of terrestrial and giant planets; formation of asteroids, comets, planetary moons; evidence that stars and planets are forming today elsewhere in our Galaxy.

9) Comparative geology of the terrestrial planets; planetary interiors; shaping planetary surfarces (cratering, volcanism, tectonics, and erosion); comparison of the terrestrial planets.

10) Atmospheres of the terrestrial planets: atmospheric structure, planetary magnetospheres; weather; climate; atmospheric origins and evolution; history of atmospheres on the terrestrial planets.

11) The Giant Planets -- Jupiter, Saturn, Uranus, Neptune: the Voyager, Galileo, and Cassini space missions; giant planet interiors; giant planet atmospheres.

12) Moons and Rings of the Giant Planets: three categories of moons; the four largest moons of Jupiter; Titan; medium-sized and small moons; Triton, Neptune's backward moon; rings of the giant planets.

13) Asteroids, Comets, and Pluto-Charon: the difference between comets and asteroids; origin and evolution of the asteroid belt; how we learn about asteroid characteristics; what can we learn from asteroids about the origin of the Solar System; comets; Pluto and its moon Charon.

14) Meteorites, and the age of the Solar System: where do meteorites come from? what do they look like? what can they tell us about early Solar System evolution? what can they tell us about the age of the Solar System? You will be able to hold (small bits of) meteorites in your hands.

15) Cosmic Collisions: Comet Shoemaker-Levy 9; impacts and mass extinctions on Earth; frequent impact events in the early Solar System; what does cratering tell us about the histories of the terrestrial planets and moons? are asteroids a threat to Earth?

16) Planet Earth: unique geological processes; our unique atmosphere; water and oxygen; the early history of the Earth; greenhouse gases and global climate change; life on Earth; life elsewhere?

17) Extrasolar Planets: how are they being discovered? why do other solar systems seem so different from our own? implications for theories of solar system formation.

18) Is there life beyond Earth? the new science of astrobiology.

Academic Honesty:

Academic dishonesty undermines the efforts of honest students, the value of a UC Santa Cruz degree, and the integrity of the university as an institution. If cheating occurs, there will be consequences within the context of this course. In addition, *every* case of academic dishonesty is referred to the student's college Provost, who then sets the disciplinary process in motion. Cheating in any part of the course may lead to failing the course and suspension or dismissal from the university.

What is cheating? In short, it is presenting someone else's work as your own. Examples would include copying another student's written homework assignment, or allowing your own work to be copied. Although you are encouraged to discuss the course with fellow students, your collaboration must be at the level of ideas and concepts only. Your homework, project reports, etc. must be written *in your own words*. Legitimate collaboration ends when you "lend", "borrow", or "trade" written solutions to problems, or in any way share in the act of writing your answers. If you collaborate (legitimately) or if you receive substantial help (legitimately) from anyone, you must credit them by placing their name(s) at the top of your paper.

The following is from the Fall 1999 Schedule of classes under General Information:

Academic Integrity

All members of the UCSC academic community have an explicit responsibility to present as their original work only that which is truly their own. Cheating, plagiarism, and other forms of academic dishonesty are contrary to the ideals and purposes of a university and will not be tolerated. Note that plagiarism includes the deliberate misrepresentation of someone else's words and ideas as your own, as well as paraphrasing without footnoting the source. Students and faculty are jointly responsible for assuring that the integrity of scholarship is valued and preserved.

Due Process

Students charged with academic dishonesty have the right to due process through established policies and regulations concerning student conduct and discipline. Copies of these policies and regulations can be found in the Rule Book (http://www2.ucsc.edu/judicial/) which is available at the offices of each college provost, the dean of graduate studies, and the Vice Chancellor of Student Affairs.

The official UCSC policy concerning academic integrity, including disciplinary procedures and student rights and responsibilities, can be found at
http://www.ucsc.edu/academics/academic_integrity

Classroom Etiquette: *Conversation, reading newspapers, talking on cell phones, sending or reading email or text messages, eating snacks, and other disturbances will not be tolerated.* If you must leave class early, clear it with the Professor prior to class and find a seat near an exit. We have a lot to learn, so each class meeting is important. A 1 hour and 45 minute class may be difficult at first. I will do my best to break up every class into discrete parts and keep the presentation and discussion lively and interesting. In return, I expect your attention and, when called for, participation. This will make your learning experience (not to mention your grade) a better one!