ASTR 211 SYLLABUS

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1. Preliminaries: On the Nature of Observational Sciences

This course is a survey of present knowledge in the astronomical sciences and is not focused upon the historical development of the field. It is nevertheless useful to understand what is meant by a natural science, and particularly how scientific models and laws are developed & tested in an observational science such as astronomy.

Scientific conclusions are often thought to be the result of a clear application of the "scientific method", consisting of a flowchart of steps like:

1. Define a problem
2. Gather relevant data (physical facts)
3. Form a testable hypothesis for a rule which can explain the data
4. Test the hypothesis, ordinarily by setting up experiment(s) that will give different results for the cases of a true or false hypothesis.
5. Conclude by accepting or rejecting the hypothesis (possibly modifying it and repeating [4]).

This listing does not really describe how science is done. To begin, [4] is difficult or impossible for most astrophysical questions (just try to build your own star to test a hypothesis). It may be impossible to set up direct experimental tests of any physical processes which operate slowly and last for long periods of time. Moreover, the study of real problems is much more complicated. There are often competing hypotheses, with several able to explain a new experiment or observation.

A better starting point would be a statement something like this: ***There are rules which govern the natural world, and natural science determines these rules and draws conclusions about the world around us using only physical data and our reasoning*.**

Contained within this statement is the concept that a scientific conclusion must be compatible with the observations (physical data), and therefore can be tested. The test is in explaining all physical data, using the connections between these facts. The testing will not always give a clear accept/ reject dichotomy from one clear-cut piece of evidence. It is often the result of a mountain of less-significant data which collectively can only be reasonably explained by a particular hypothesis.

Checking the full range of implications is the usual form of "testing by experiment" for an observational science. A hypothesis developed from one set of data will have results reflected in a different set of data. The "physical data" for testing may include laboratory experiments (an example would be determining the properties of gases under astronomically-important temperatures and pressures). But it is largely "what we see", with images and spectra from radio to gamma-ray energies, coming from throughout the universe. Therefore, testing astrophysical theories is often indirect, and the *entire set of information from across the Universe* becomes important.

No piece of information can be taken in isolation. Stars, planets, gas clouds, etc, in many different locations and stages of development show the signatures that they follow the same set of physical laws. If the physical laws were different, there would be very noticeable changes in what we see. A model or theory must therefore be able to explain the objects overall, at all their developmental stages.

This explains how conclusions can be reached about long-duration processes such as star formation. A scientific answer to what is happening in one gas cloud will take differences between clouds into account, but cannot be divorced from what occurs in other gas clouds. We don't see a single gas cloud

fully condensing into a star, but we see gas clouds at various points during the star formation process. By examining the full set and applying the physical laws, we can understand how quickly star-forming gas clouds evolve into stellar cores, and then stars.

1.1 Failing to Make the Scientific Grade

Many ideas purporting to explain astronomical topics are not acceptable scientific theories. There are several reasons for this:

- No "rules" / not even theoretically testable (not even a scientific theory)
- A testable idea, which could explain data known when it was proposed, but which fails to explain further data / observations (failed/discredited scientific theory)
- A testable idea which explains one piece of evidence but is incompatible with a mountain of other evidence. The other evidence is ignored (pseudo-science, also called "quack" science, especially when conspiracies are invoked to explain why the idea is not accepted).

This class will NOT discuss ideas which fail to make the grade as an acceptable scientific theory, except in the limited context of examples to elucidate 'scientific theory vs. nonscientific idea' or 'how scientific theories fail'.

These ideas include:

- all forms of astrology
- the Earth is flat
- the Earth is hollow
- the Apollo Moon landings were faked
- the Moon's craters are volcanic
- Venus was a comet disgorged from Jupiter
- there is a sculpture of a human face on Mars
- catastrophes occur when planets line up in a single line out from the Sun
- objects outside the Earth's atmosphere do not follow unchanging physical rules, or any rules at all
- plate tectonics are caused by a chemical reaction in the Earth's crust
- plate tectonics do not exist; the expanding sea floors are due to the Earth puffing up like a balloon
- the Sun's energy has nothing to do with nuclear fusion, but comes from gravitational contraction
- the Sun is an iron ball, powered by radioactive decay, with a thin layer of hydrogen on its solid surface
- the Universe has no beginning - it has always been expanding like this, going back infinitely far in time
- the Universe has a beginning, but it took place much less than billions of years ago
- the Universe is not expanding; it's an illusion because light gets "tired" over time

1.2 Course Objectives / Expectations

The course will present, through reading and lecture, our present state of knowledge of, and relevant concepts for, the astronomical sciences. The course will emphasize stellar topics.

These concepts will be applied to astronomical situations. These applications include comparisons and simple calculations to determine relative properties.

The primary assessment of whether students have understood the material will be how they apply the concepts to specific astronomical circumstances, and use the concepts to solve problems.

The course will also present observational topics, focused upon the observed motion of the sky. These topics include naked-eye observations and exercises in comparative reasoning concerning what we would expect to see under different circumstances.

2. Textbooks / Classroom Materials

You have two required textbooks:

Universe, 8th ed. (Freedman & Kaufmann)
Lecture-Tutorials for Introductory Astronomy, 2nd ed. (Prather et al.)

You also need:

a "Star and Planet Locator" (available at the bookstore)
a **bound** observing log - not a ring or spiral binder. A comp notebook is fine; it can have blank, lined, or gridded pages, as long as you are comfortable sketching and writing in it.
a calculator
a protractor
ABCD response card (class handout)

Students are expected to show up at class meetings with, at a minimum:

Lecture-Tutorials for Introductory Astronomy
ABCD response card
note-taking materials * do NOT take notes in your observing log. The log will be under examination, and thus unavailable, during the final exam period
a calculator is also very useful

Universe is your "big book of facts" textbook, providing the readings and organizing the course content. it is not, however, necessary to bring to class.

3. Office Hours

I am available after the 9:40 section, every day (1-6), from approximately 10:55-11:30, & by appointment

4. Grades

Scheme:

online assessment (first week)**	1%	full points for participation
online assessment (post-class)	1%	for < 50% : 0, 50-75% : 0.5, > 75% : 1
3 observing labs	8%	
observing project 1	4%	
observing project 2	4%	
homework	33%	
IN-CLASS POP QUIZZES	5%	
3 in-class tests***	22%	* your top 2 test grades will be used, at 11% each *
final exam	22%	

UNANNOUNCED 5-MINUTE QUIZZES WILL BE GIVEN THROUGHOUT THE SEMESTER. They are each weighted equally in the 5% quiz portion of the grade.

** The assessment is online. You will need to fill in the form at
http://www.physics.csbsju.edu/assess/ADT2.html

You must fill in and submit the form by **MONDAY, January 19 AT 9:00 AM** to get the first week participation point. The form consists of 21 multiple-choice questions, plus a few demographic survey questions. **You are NOT expected to study anything for the first week assessment.**

Tests:
In-class tests will be NON-cumulative. The final, however, will cover the ENTIRE course. Tests will cover material from the sections of *Universe* covered in class, any *Lecture-Tutorials* done in class, and may include lab-related information, such as how to use star charts.

Letter Grades:

I do not grade on a curve.

You are competing against an absolute standard of achievement, not against your classmates. I generally expect the following:

50% = pass (D)
67% = satisfactory (C)
75% = good (B)
85% = excellent (A)

Mid-letter grades are (BC, etc) are determined after the final is graded. They are usually not precisely halfway between the full letter grades.

S/U policy: You may opt to take the class S/U instead of for a letter grade. You must notify me **by e-mail**. You may make (or take back) any such decision until you take the final exam. **There are NO take-backs after the final and no conditional S/U requests.** You will be given information about test, HW and lab performance "to date" throughout the semester, but you will be responsible for determining whether a request for S/U is a wise choice.

5. In-class Quizzes / Tests / Exam Dates

Quizzes are unannounced. **There are no opportunities to make up lost credit**, but a missed quiz may be EXCUSED for serious, DOCUMENTED reasons.

In-class tests will take up the class meeting period on the following three dates:

Feb. 4 **Feb. 26** **Apr 2**

The Final will be at the time prescribed by the registrar. You are expected to be available during the entire exam period, and are responsible for checking the time against any personal conflicts.

Test Material:
Tests and the final will be closed-book, closed-notes. They will require a calculator.

The in-class tests will be non-cumulative, covering the new material from the previous test date. However, related concepts and methods that have previously been used may still be applied to new material on the next test.

In-class tests are set for a 70-minute period. Students may continue during the between-classes break, but must stop by the start of the next class period.

Only the best 2 of the 3 in-class tests will count toward your grade. Their % scores will be averaged for the in-class test portion.

The final exam will be cumulative. It will be set for a 2 hour block, with some leeway allowed after the 2 hour block ends.

6. Homework

This course has very frequent HW sets. **You should expect 2 or 3 each cycle**.

You may drop off homework in the trays (marked by section time) outside my office.

These will be very short HW sets, with only a few (1-4) questions. **Not all homework questions will be graded.** All questions will have solutions given in the solution sets, but each HW set will have HALF the questions graded. These questions will be selected randomly (by dice or computer program); they will not be "representative" or "best" questions.

You are encouraged to work with other students, but the submitted answers must be your own.

Regardless of difficulty, **each corrected HW problem will be given the same weight**. If points values are given in a question, it is only to indicate the relative value of multiple parts in the problem.

There is a very fast turnaround, and students are expected to be considerate by properly identifying themselves, and properly attaching all piece(s) required.

Therefore, a 10% penalty for the HW question(s) will be assessed on HW with either/both of the following:
- lack of a name
- fails the "shake test" (paperclipped sheets or rolled-up corners are unacceptable, you must staple sheets together)

Late Homework Policy:
Homework will not be accepted late. Homework will be due by 5 PM and the solution set may be released as early as the following morning. Solutions should be available at the next classroom meeting.

Homework will be **excused** for serious, unavoidable, documented reasons. Under those circumstances, the missed HW will not be counted, and the HW portion of the grade will be averaged over all the other HW sets. Serious reasons include (but are not necessarily limited to) injury, illness, National Guard duties, and family emergencies.

Each student has **ONE** "no questions asked" HW excuse throughout the semester. You will need to request that I use yours for a particular HW set, via e-mail. It will not be automatically applied if you miss a HW set. It will also not be applied to a HW set you did hand in.

7. Laboratory Exercises

You have registered for an evening lab section in order to take the course. There are only 3 formal outdoor labs throughout the semester.

Students are only permitted to change a lab section if they find a student to swap with. You may not just show up at a different lab section.

You must use a bound observing log. Reports using notepads, spiral-rings, etc, will be penalized

Your lab time, as registered, is in CENTRAL STANDARD TIME. This may not be the time on the clock; the clock will read one hour later than your registered time in the early fall / late spring. This is so that the "early" lab can start after dark.

You will do your lab on your day's first night in February, March, and April, IF IT IS CLEAR. If it is cloudy, you will do the lab on your day's second night. If the second night is cloudy, you will do a cloudy night observing substitute. A bulk e-mail at 5 PM on a lab day, with the message "GO" or "NO GO", will inform you of whether the night is clear. Further details will be given in class.

The dates will be:

Mondays:	Feb. 2 OR 9	March 9 OR 16	Apr 6 OR 20
Tuesdays:	Feb. 3 OR 10	March 10 OR 17	Apr 7 OR 14

Lab notebooks will be collected at the end of the lab period. The lab exercise will be photocopied the following day, and the notebook returned. The corrected exercise will be returned after all lab sections have had their work reviewed.

8. Individual Observing Projects

Your projects will be graded during the final exam period. **Your lab notebooks will be due at that time, and not available during that period.**

You may go out and do observations with other students. However, each student must indicate all the people who are working with them on the logbook entry for a night's observations.

Further details about the projects will be given in class and in separate handouts.

FURTHER NOTES ABOUT THE COURSE

Lecture-Tutorials
The course includes a substantial peer tutorial / group exercise component. Students are required to participate in their group's work. Students who do not participate will have to leave that class meeting.

The test and homework questions will require similar reasoning to many of the peer exercises. However, they will never be the same questions.

Note-taking
The only materials from class which I will make available are the in-class multiple-choice questions where students use their response cards. These will be posted on the course website and have the correct answer indicated. Do not waste time writing these down; use the time given to think about your answer.

You are welcome to take a look at the overhead sheets at the end of class, if you missed a few details.

I do not make handouts outlining my overheads or notes. Students are expected to determine what they need to write down in order to remind themselves of the topic or concept covered. My lecture is intended to help organize the topic covered and as preparation for doing exercises in astronomy. It should help you prioritize the important aspects of a topic.

You will occasionally get handouts with the assigned reading for the next few cycles.

You are encouraged to make point-form notes from assigned reading before class, and add to them during class. You are also encouraged to reread the textbook section(s) covered after the class, recopy your notes using that information, and clear up any discrepancies.

Test Time Conflicts
If you have a serious conflict (sport team travel, etc) with any of the in-class tests, you must contact me well in advance of it. If a special testing time can be arranged within a few days of the scheduled test date, you will be able to do the test then. If not, it will be the one "dropped" test of the three.

If you have a serious conflict with the registrar's time for the final, you must discuss this with me well before the exam period. If needed, the exam can be offered during a multi-section common exam period scheduled by the registrar. A desire to finish your exams and leave campus early will not be considered a serious conflict.

Partial Credit for Homework
Partial credit on HW questions is based upon the demonstrated level of understanding. Thus, two HW sets with the same final answer can get very different partial credit. Adding incorrect information, of course, demonstrates poor understanding. Moreover, you must answer the question.

Correct but irrelevant information will not boost partial credit. If the correct but irrelevant information demonstrates that the question is not well understood or addressed, it will reduce any partial credit.

Tips for Study and Review

Effective Studying

Study time, including homework, should be free of background noise and distractions. The radio, iPods, overheard conversations, and background TV are not compatible with learning.

Test questions will never repeat a HW, *Tutorial*, or in-class multiple-choice question.

Homework, *Tutorial,* and multiple-choice questions posed to the class, will, however, demand the same type of reasoning, and the application of information, as test and exam questions. These questions are some of your best review materials.

Very few test questions will ask you to state basic facts.

Studying for tests and exams will require learning some basic facts, but that should not be your emphasis. You will need to learn how to put concepts to work. Learning how to compare objects X and Y, or object Z before and after something is done to it, will be more important than reading the chapters a dozen times.

All tests and the final exam will rely heavily on multiple-choice questions (approximately 1/4 of a test will be short-answer questions or short 'show your work' calculations). This does NOT mean that memorizing a laundry list of facts will help.

Even without calculations, the questions will ask you to identify factors or concepts in astronomical situations, not remember the names of Jupiter's moons or the nearest White Dwarf star.

Some questions will require the same types of comparisons or calculations as homework problems or Tutorial questions. Some will be quite similar to the "ranking task" questions you will frequently encounter in homework or class exercises.

When reviewing, you should be able to do homework and tutorial problems without looking at the solutions, instructions for similar problems, or the textbook.

You should be able to explain why each false answer (in a multiple-choice question) is false.

You should also be able identify which pieces of information are or are not needed to solve a question or compare two astronomical situations.