# SYLLABUS
# ASTR 460/560
# Stellar Evolution Seminar
# Spring 2018

**LECTURES:** Monday/Wednesday: 11:00 a.m. - 11:50 a.m. (2 credits)
Steward Observatory, Room 204
**(Last regular lecture May 2)**

**INSTRUCTORS:**


Dr. Nathan Smith
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**OFFICE HOURS:**
Monday 1:00 p.m. - 2:00 p.m.

Wednesday 1:00 p.m. - 2:00 p.m.

**EXAMS:** None.

**OVERVIEW:**

The current graduate astronomy curriculum includes a course called Astrophysics of Stars and Accretion (ASTR545), but this course has a focus mainly on the standard theory of stellar interiors and the physics of accretion disks. The undergraduate curriculum includes a basic introduction to astrophysics. This seminar is designed to be complementary to these core courses, and will connect the equations of stellar structure and evolution to the observed properties of a wide variety of stars, including spectral types, luminosity and temperature evolution on the Hertzsprung-Russell diagram, uncertainties in stellar evolution models, the inferred influence of composition, mass loss, binary star evolution, different types of stellar death, dependence on environment, and influence on the galactic environment (feedback). We will also explore some key observational diagnostics of stellar properties along the way. The course will examine both the historical origin of several key ideas in the field, as well as current frontier topics in the literature. The course will benefit students who intend to specialize in research on stars, but will also cover key topics relevant to interpreting observations of galaxies and the role of stars in galaxy evolution and cosmic evolution.

**GRADES:** Your final grade for the course will be determined based on the assignments and class participation in the following proportion:

| | |
|---|---|
| In-class Presentations | 40% |
| In class Participation | 40% |
| Observing proposal | 20% |

**HOMEWORK:** The weekly homework will center on reading relevant papers from the literature (see below), or in some cases excerpts from monographs, for discussion each week. Students are expected to have read the papers when not presenting, and to be intimately familiar with papers (as well as related literature and concepts) when they are presenting.

**TOPIC SCHEDULE:**

| Week | Topic |
|---|---|
| Jan 10 | (N) Overview, logistics, pre-main-sequence |
| Jan17 | (N) Stellar structure, convection, nuclear burning (no class Jan 15; MLK) |
| Jan 22/24 | (N) The HR Diagram and stellar evolution models |
| Jan 29/31 | (N) Stellar atmospheres, spectral types, observational diagnostics |
| Feb 5/7 | (D) The Sun, solar wind, low-mass main-sequence stars and brown dwarfs |
| Feb 12/14 | (D) Low-mass post-MS stars, blue stragglers, globular clusters, low metallicity |
| Feb 19/21 | (N) Low-mass late phases; AGB, carbon stars, planetary nebulae, role of binaries |
| Feb 26/28 | (D) Low-mass binary endpoints, white dwarfs, Type Ia supernovae |
| **Mar 5/7** | **Spring Break** |
| Mar 12/14 | (D) Exotica (compact objects in binaries, mergers, GW sources & counterparts) |
| Mar 19/21 | (D) Intermediate-mass stars and the transition to massive stars |
| Mar 26/28 | (N) Massive main-sequence stars, winds, upper mass limit |
| Apr 2/4 | (N) Massive stars: rotation, binaries, mass loss |
| Apr 9/11 | (N) Massive evolved star zoo: red/blue supergiants, LBVs, Wolf-Rayet stars |
| Apr 16/18 | (N) Core collapse supernovae, remnants **** Observing proposal due 4/18 in class.** |
| Apr 23/25 | (D) GRBs, Feedback, population synthesis |
| Apr 30/May 2 | (D) Low-metallicity, Pop III, First stars and reionization |

**OBSERVING PROPOSAL:** A required assignment for graduate students is to write a fake but realistic observing proposal appropriate for one of the topics discussed in class – preferably one for which you are the presenter. The goal is to develop a deep enough understanding of the current state of research in that subfield to write a concise and relevant research proposal, applying your new knowledge to an observational test of an idea. The observing project you design should utilize one or more facilities available through Steward Observatory (e.g., LBT, MMT, Magellan, Bok, Kuiper, VATT, UKIRT, or ARO facilities), and you should use the Steward proposal template (or ARO form if appropriate). Follow the proposal template (including page limits) as if this were a real proposal. This should contain a professional-quality scientific justification and experimental design appropriate for peer review by the Steward TAC (although you are not required to actually submit the proposal). The proposal does not need to be realistic in terms of how you think Steward politics might apply to time allocation (for example, you could request all of Arizona's allocation of LBT time to monitor eclipsing binaries, even though in reality this would be unlikely to get accepted), but it should be well justified scientifically. Due date is April 18, hardcopy in class.

**PARTICIPATION IN CLASS:** This seminar course is conducted as a discussion requiring active participation by all students enrolled. This is especially true in a small class. We will conduct interactive discussions in class; this will improve your understanding of the material and will count toward your grade. In fact, class participation is a major component of your grade. Students are expected to ask questions often.

**LITERATURE PRESENTATIONS**: Starting on week 3 (Stellar evolution models) we will begin a regular pattern where every class is spent by students giving in-class presentations accompanied by discussion. We will alternate from one student to the next each day/week. The focus is on work in the literature relevant to the topic that week. There will be some flexibility in format from one topic to the next, but a typical sequence will be (1) a review of important historical work in the literature that set the

stage for the topic, (2) discussion of a the basic theoretical ideas relevant to the topic and the most common current observational approaches, and (3) discussion of a modern review article or other seminal paper to give the updated current state of the field. Each of these could be roughly 10 minutes, although it is up to you, and should allow ample time for engaging discussion.

These do not need to be polished power-point presentations as one might do in a Journal Club. Instead, the emphasis is on giving background, instigating discussion, engaging the other class members, and answering their questions – the aim should be a presentation more akin to a arXiv coffee discussion. All students in the class will read the papers and participate actively in discussions, but the discussion will be led by one student who prepares the presentation that day. It is the responsibility of the presenter to focus the discussion and plan for the appropriate amount of time. Many of the papers contain too much material to cover everything in two 50-min class periods, so a selection of some subset of the material will often be appropriate. The number of presentations will depend on enrollment. Grades will be awarded based on effort, preparation, and mastery of the topic, as well as partly on an individual's facilitating of the discussion. Graduate students will be expected to present a more comprehensive and thorough discussion of the topic than undergraduates, and will be expected to be less reliant on input from the instructor to guide the discussion than an undergraduate presenter. Graduate students may also present a larger number of times, or may choose more difficult topics.

**ACADEMIC DISHONESTY, etc.:**
Students are expected to follow all of the university-wide student policies, which are available at http://catalog.arizona.edu. Students are also expected to understand and follow the Student Code of Academic Integrity: http://deanofstudents.arizona.edu/codeofacademicintegrity. Other than grade and absence policies, information contained in this syllabus may be subject to change with advance notice.

**STUDENTS WITH DISABILITIES:** If you anticipate issues related to the format or requirements of this course, please meet with an instructor. We would like to discuss ways to ensure your full participation in the course. If you determine that formal, disability-related accommodations are necessary, it is very important that you be registered with Disability Resources (621-3268; http://drc.arizona.edu ) and notify Dr. Smith or Dr. Sand of your eligibility for accommodations well in advance of any assignment. We can then plan how best to coordinate your accommodations.

**CLASS PARTICIPATION / LEARNER-CENTERED EDUCATION:** The University of Arizona has designated itself a "Learner-Centered University." This means that the student is expected to take an active role in his/her learning. Class time will be peppered with various activities that will require your participation. Be prepared to interact with your classmates, ask questions, and participate in group discussions. This is a seminar course, and will rely heavily upon student in-class participation for presentations as well as discussion. Attendance is therefore required. If you must miss class for one of the reasons below, let an instructor know ahead of time (in all cases that are not emergencies) and please speak with Prof. Smith, Prof. Sand, or another student about what you missed.

- All holidays or special events observed by organized religions will be honored for those students who show affiliation with that particular religion,
- Absences pre-approved by the UA Dean of Students (or Dean's designee) will be honored.
- Graduate student activities (such as observing runs or conferences)