

ASTR 541: Cosmology

Spring 2024; 3 credits

Instructor: Xiaohui Fan (xfan@arizona.edu)

Course Objectives –

This course will study cosmology, beginning with the fundamentals of modern cosmology, Friedmann Equations, to cosmological tests and cosmological parameters, to hot big bang theory and CMB, structure formation and large scale structure of the universe, to early galaxy formation, cluster of galaxies and gravitational lensing. See *Order of Topics* section for details.

Instructor and Contact Information –

Dr. Xiaohui Fan, xfan@arizona.edu

Class Schedule –

Regular lectures: Mon/Wed/Fri 11am – 11:50am, **Steward Observatory, Room 208**

Office Hours: by appointment, email xfan@arizona.edu

Class Format –

We will have regular in-person lectures (50 min each) on M/W. On some Fridays, we will have one of the students leading a review of the contributions of a cosmologist, based on a review they wrote for the Annual Review of Astronomy and Astrophysics. Paper list, signup, and requirements will be distributed separately.

Grading –

Homework: 50%, Classic Cosmologists Review: 25%, Take Home Final Exam: 25%. We will drop the lowest homework grade.

Homework Assignments –

While we recognize that people often study in groups, we expect homework solutions to represent each individual's independent work.

Many of the problems to be assigned we have assigned to past Astro 541 classes. It is not permitted to look at solution keys or student solution sets from past semesters, and you are on your honor not to do so.

Homework assignments will generally be roughly every two weeks and are due on Fridays. There will be 6 or 7 homework assignments in total.

Late Assignments –

Homework will be due on D2L on the due date. Anything turned in after that time will be considered late. Late assignments turned in before the next class period (usually Monday) will receive 75% credit. Assignments turned in after that will receive no credit. Some exceptions can be made for extraordinary circumstances - e.g. observing runs or out-of-town travels.

Suggested Text –

Galaxy Formation, 2nd Edition, by Malcolm Longair. This book covers many topics to moderate depth and with modern notation. The second edition considerably expands the discussion of recent observations.

Ebook link: <http://ezproxy.library.arizona.edu/login?url=http://dx.doi.org/10.1007/978-3-540-73478-9>.

Other References

Cosmological Physics, by Peacock. A graduate-level book on cosmology. It's harder than Longair and it wanders off onto topics (e.g. field theory) that we're not going to need. The last few chapters, on cosmological perturbations, are very good. Ebook link: <https://www-cambridge-org.ezproxy1.library.arizona.edu/core/books/cosmological-physics/3EA0C68658270C9C3CC48E07A035C327>

Principles of Physical Cosmology, by Peebles. Older (early 90's) and overly complete, this is not a good first book on cosmology, but it's really useful once you know what you're looking for (and where to find it). Available in Parker Library.

Galaxy Formation and Evolution, by Mo, van den Bosch and White. A newer and comprehensive text with excellent coverage on galaxy properties and galaxy formation. Ebook link: <https://www-cambridge-org.ezproxy1.library.arizona.edu/core/books/galaxy-formation-and-evolution/E236D9F26B797202BCA28637BF17E75F>

Galaxies in the Universe, by Sparke and Gallagher. This is an undergraduate textbook on mostly galaxies with a bit of cosmology. A good resource for those needing extra background in extragalactic astronomy. Ebook link: <https://ebookcentral.proquest.com/lib/uaz/detail.action?docID=5120051>

Introduction to Cosmology, by Ryden. This is an undergraduate textbook on cosmology. Available in Parker Library.

Order of Topics (in weeks) –

1. 0112: introduction (0110: no class, AAS)
2. 0117/0119: cosmological principle, measurements (0115: MLK day)
3. 0122/0124/0126: measurements; Friedmann equations
4. 0202: cosmological tests (0129/0131, no class)
5. 0205/0207/0209 (paper 3): cosmological tests, thermal history
6. 0216: Paper 1 (0212/0214, no class)
7. 0219/0221/0223: thermal history, perturbation, Paper 2
8. 0226/0228/0301: perturbation, large scale structure, Paper 3
9. Spring break
10. 0311/0313/0315: large scale structure, CMB, Paper 4
11. 0315/0327/0329: CMB, spherical collapse, Paper 5
12. 0327/0329/0331: spherical collapse, first galaxies, Paper 6
13. 0401/0403/0405: galaxy formation, Paper 7
14. 0410/0412: lensing, Paper 8 (0408: solar eclipse, no class)
15. 0415/0417/0419: clusters, Paper 9
16. 0422/0424/0426: IGM/reionization, Paper 10
17. 0429/0501: JWST, Future of cosmology, final review

Course Website –

Course material including handouts and notes will be posted on the D2L course website. You can find the syllabus, the schedule for the term (including any changes or updates to the schedule), handouts, homework and solutions, and information about papers there.

Department of Astronomy Graduate Program Learning Outcomes—

1. Exhibit an expert-level facility to engage with the principle findings, common applications, current problems, fundamental techniques, and underlying theory of cosmology
2. Demonstrate advanced discipline skills and knowledge necessary to utilize the observational techniques, instrumentation, computational methods, and software applications used to investigate modern astrophysical phenomena and problems.
3. Develop expertise with communicating, translating and interpreting fundamental astronomical concepts and research results in oral and/or written formats.
4. Conduct independent research and/or gain mastery-level knowledge of cosmology
5. Engage in the scholarly, ethical, and discipline specific practices of the field at a professional level.

Attendance and Class Participation Policy —

Class attendance is required. All holidays or special events observed by organized religions will be honored for those students who show affiliation with that particular religion.

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at <http://catalog.arizona.edu/2015-16/policies/classatten.htm>

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable: <http://policy.arizona.edu/human-resources/religious-accommodation-policy>.

Absences preapproved by the UA Dean of Students (or dean's designee) will be honored. See <http://uhap.web.arizona.edu/policy/appointed-personnel/7.04.02>

Absences —

If you feel sick, or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel.

Please let me know if you will not be able to attend because of health reasons.

Campus Health is testing for COVID-19. Please call (520) 621-9202 before you visit in person. Visit the UArizona COVID-19 page for regular updates.

Absences (or difficulty turning in assignments on time) that are pre-approved by the UA Dean of Students (or Dean's designee) will be honored.

There will be make up assignments or special arrangements with a well documented valid excuse.

Life challenges —

If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office can be reached at 520-621-2057 or <mailto:DOS-deanofstudents@email.arizona.edu>.

Physical and mental-health challenges —

If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520-621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.

Academic Integrity —

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: <http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity>

Accessibility and Accommodations —

At the University of Arizona we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, you are welcome

to let me know so that we can discuss options. You are also encouraged to contact Disability Resources (520) 621-3268 to explore reasonable accommodation. Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Incompletes —

Incompletes will only be given if a student has satisfactorily completed the majority of the work in the class and has a valid reason, such as medical, for not completing the remainder of the course. Students must make arrangements with the instructor in order to receive an incomplete.

Other than grade and absence policies, the information contained in this syllabus may be subject to change with reasonable advance notice.

Classroom Behavior Policy –

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Threatening Behavior Policy –

UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See <http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students>.

The class schedule and grading policies are subject to change with advanced notifications to all students.