

PHYSICAL SCIENCES 12710: GALAXIES

Winter 2019



THE UNIVERSITY OF
CHICAGO

CONTACT INFORMATION

- Lecturer / Lead: Prof. Mike Gladders
- Office: ERC 527
- Telephone: 773 834-0392
- E-mail: gladders@oddjob.uchicago.edu
- Teaching Support Manager / Lab Supervisor: Dr. Brent Barker
bbarker@uchicago.edu KPTC314
- Lab TAs :
Sam Usman, samanthausman@astro.uchicago.edu
Mandy Chen, mandychen@uchicago.edu
- Grader:
Greg Gilbert, gjgilbert@uchicago.edu

Office Hours: Sam – Thu 11-12; Mandy Fri 2-3

COURSE INFORMATION

- The course website is on the university's Canvas system. Material will be posted incrementally as the course proceeds. The class site should go live within a day or two.
- Login with your CNET ID. Email me if you are unable to access the course by the end of the day Wednesday January 9th
- At the site you will find all information you need for the course in including:
 - Lectures
 - Labs
 - Homework Assignments

GRADING

- The grading for the course is as follows:

• Homework	28%
• Labs	30%
• In-class exams (2)	20%
• Final Project	22%

- Note that the Homework grade will be comprised of the aggregate score of (likely) 7 problem sets. Each problem set will have the same weight in the total Homework grade. Similarly the Labs grade will be comprised of the aggregate score of 3 equally weighted labs.

TEXTBOOK

- There will be no primary assigned textbook. Instead, the lecture notes, published to the course site, will be the primary written reference for the course. Secondary reading online will be assigned intermittently, in class.
- The published lecture notes will frame the discussion in class, but you should not assume that the lecture notes include *every* detail necessary to best performance and learning in this course. Come to lectures, and take notes. There is no participation grade, but extensive experience makes it abundantly clear that you will do better, and learn more, the more engaged you are.

HOMework PROBLEM SETS

- Homework problem sets will be assigned each Wednesday, beginning on January 16th. The homework will be made available as a PDF on the course site at that time. Completed homework is due at the end of lecture on the following Wednesday. *Late homework will be accepted up until the start of the next lecture after the due date (nominally a Friday) with a 25% penalty.*
- Solutions will be published to the course site at the beginning of the lecture following the due date, so any problem set handed in after that deadline will receive a grade of 0.
- Nominally, hand in your homework as you leave the lecture. You can also make other arrangements to hand in homework with your TA prior to the due date.
- Graded homework will generally be returned by the TAs during lab sessions.

HOMework PROBLEM SETS

- Problem sets will be structured to help deepen your understanding of concepts discussed in lectures and labs. *You should expect the problem sets to be difficult at times*; ask questions and discuss solutions, with your fellow students, your TAs, and the course instructors.
- *However, be sure to submit your own work; share with us your own understanding, even if it is developed in part in discussion with your colleagues.*

LABS

- The labs are designed to complement the other parts of the course with computer and hands-on experiments that demonstrate the observations and analyses that underpin our understanding of galaxies and dark matter. We are planning to do three labs; each will take a week or more.
- The **first lab will begin in week two**, and should take two weeks if weather and equipment both cooperate.

- ## Lab 1: The Milky Way at Radio Wavelengths

- Lab reports are due one week after completion of the lab.
- *Labs are an important component of this course, and you cannot pass the course if you fail to complete two or more labs. If you fail to complete one lab you will receive a grade of 0 on that lab report and your overall lab grade will be further reduced by 20%. Do not fail to attend and participate in the labs. Make sure you hand in a completed lab report for each lab!*

EXAMS

- The course will have two in-class exams. The purpose of these exams is to allow you to ‘check in’ with your progress in a structured manner, and to provide an assessment and grading tool. The exams also provide a breadth of opportunity for students with varied strengths to excel. The exams are scheduled for

Wednesday January 30th

Monday March 4th

- Each exam will cover only a portion of the course material (i.e., the second exam will not be cumulative, apart from the natural progression that some of the material in the latter portion of the course depends on understanding and using that from the initial portion...)

FINAL PROJECT

- Rather than a final exam, you will each complete a final project based on actual observations of galaxies and star clusters, taken with modern research telescopes during the next two months. A modest amount of data, recently acquired, will also be provided to you.
- The final projects will be organized for small groups, using the lab groupings as a basis, and you will use lab computer resources and scheduled time in labs to help complete the project.
- Thematically, the goal of the final project is to have you work with actual modern observations of galaxies, and analyze them in the context of the course lecture content, to discover and report on what those data tell us about the galaxies observed. In other words, we will learn some principles in the lectures, and you will apply them to deduce the nature of the observed objects.
- The grading for the final project will be based on a report that you submit, similar to a lab report, that details the observations and your analysis.

EXAM AND COURSE POLICIES

There are no makeup or supplemental exams.

- Sometimes, schedule conflicts arise. Under some particular circumstances, where an exam conflicts with an ad hoc academic opportunity from another class, an exemption from an exam is possible; details will be worked out as situations arise. You **MUST** however contact me at least a week in advance in such circumstances.
- If you miss an exam for an unforeseen reason (typically illness) details to compensate for the missed exam will be worked out as situations arise.

Homework is accepted late only as detailed above.

Failure to complete two or more labs will result in a failing grade for the course, regardless of grades on any other course material.

COLLEGE POLICIES

"WITHDRAWALS

- Students must request a withdrawal, “W”, from their adviser by Friday of 10th week or the day before the final project/exam is due – whichever is *earlier*. Once a student requests a W, it may not subsequently be changed to any other mark.
- Please note that starting this year, students will no longer write to their instructors to request a course withdrawal (e.g. a W grade). Instead, students will write to their Academic Adviser to request the W. The Adviser will contact the faculty member to inform them about the withdrawal.
- We have made this change to ensure that students are receiving the support they need from their advisers, particularly when they are struggling or need additional resources, whether that be support for academics, mental health, or other needs. The change will also ensure that students receive timely information about potential implications of the course withdrawal, e.g. delay in graduation, academic probation or suspension, etc. Our goal is to support all College students and provide them with the guidance and resources they need to successfully pursue their education. "

COLLEGE POLICIES

"PASS/FAIL GRADING

- Students who wish to receive a passing grade rather than a quality grade may request to take a course Pass/Fail (P/F). *Students considering P/F grading should consult with their College Adviser early in the quarter because this option is subject to conditions and restrictions.* For P/F grading, the student and instructor reach an informal agreement, at the discretion of the instructor and according to departmental policy, before the instructor submits a grade for the course. A mark of P may not later be changed to a quality grade, and a quality grade may not be changed to a P. A grade of F may not be subsequently changed, except when entered in error by the instructor or the Registrar. "

THE GAME PLAN...

The primary focus of this course is galaxies – collections of stars, gas, dust, and (as we shall see) dark matter that form much of the visible structures in the Universe. The organizing narrative of the course will be the discovery and understanding of dark matter, motivated and enabled by our understanding of galaxies themselves. The following topics will be addressed, to varying depths, and approximately in the order listed:

- Observing Stars (reminders from PHSC12(6/7)00 ...) from solar spectrum and onward to the stars: spectral lines, and blackbody radiation, stellar spectra versus temperature versus
- Stellar Populations
- The Milky Way
- Optical/Near-Infrared Telescopes and Instruments
- The Multi-Wavelength Sky
- Radio, Thermal IR, X-ray and Gamma-Ray Telescopes and Instruments
- The Interstellar Medium
- Galaxy Populations – Lessons From Our Neighbors
- Distances to Galaxies – The Distance Ladder
- Galaxy Morphologies

THE GAME PLAN...

- Dark Matter I – The Internal Dynamics of Galaxies
- Redshift and The Hubble Law
- The Centers of Galaxies
- Quasars
- Dark Matter II – Black Holes (are not a solution...)
- Galaxy Redshift Surveys
- Clusters of Galaxies
- Dark Matter III – Galaxy Cluster Dynamics
- Dark Matter IV – Gravitational Lensing
- Large Scale Structure
- Galaxies at Cosmic Noon
- Dark Matter V – Structure Formation and N-Body Simulations
- The Most Distant Galaxies and 'First Light'
- The Next Ten Years