ASTR 123 - Galaxies and The Expanding Universe

Essential Information

- **Instructor Contact**
  - **Name & pronouns:** Dr. Andrea Goering (she/her) - please call me Andrea
  - **Email:** ayocom@uoregon.edu
  - **Office Hours:** Willamette 377, F 2:00 - 3:00pm (can stay until 5:00 by request)

- **Classes**
  - **Class Times:** MWF 1:00 pm - 1:50 pm, Willamette 100
  - **Zoom Link (if needed):** [https://lanecc.zoom.us/j/97903296637](https://lanecc.zoom.us/j/97903296637)

- **Teaching Assistants**
  - Philip Andrago, pandrang@uoregon.edu, office hours:
    - Wednesday 2:00 - 2:50pm, Science Library Drop-In center
    - Friday 3:00 - 3:50pm, [https://uoregon.zoom.us/j/98520745178](https://uoregon.zoom.us/j/98520745178)
  - Conner Carnahan, ccarnah2@uoregon.edu, office hours:
    - Wednesday 12:00 - 12:50pm, Science Library Drop-In center
    - Tuesday 3:00 - 3:50pm, [https://uoregon.zoom.us/j/9123893941](https://uoregon.zoom.us/j/9123893941)

- **Course Materials**
  - **Textbook:** Astronomy, by Fraknoi, Morrison, Wolff, et al., free online.
  - **Assignments:** Our Canvas Page

Course Description and Learning Goals

ASTR 123 is an introduction for non-science majors to the contents, formation and evolution of the Universe. This aspect of astronomy, also known as cosmology, asks basic questions about humankind's existence: where do we come from and what is our fate? Cosmology is where observational astronomy, philosophy and theoretical physics meet. This course traces the history of cosmology in order to explore how the scientific method works and what civilization has gained from the progress of science and technology.

The specific goals of this class are:

1. To gain an understanding of basic science that underlies Astronomy.
2. To understand the properties of the objects that make up our Universe
3. To formulate a coherent philosophy for interpreting the observational evidence of the hot Big Bang and relating this world-view to new areas of research.

The laws governing the Universe are formulated in the language of mathematics, but the course will not go beyond high-school level algebra. The class does not assume prior knowledge of science, but it will require quantitative reasoning. Your chances of success in this course are high if you come to class with a desire to dig deeper into the causes of things you see around you. I hope you'll ask a lot of questions starting with "why," "how" and "what if" - because curiosity is what makes scientists tick.
Learning Plan for 2022

The coronavirus pandemic is not over, so please be aware of these safety precautions:

1. **To prevent the risk of spread, all of us must:**
   a. Comply with [vaccination policy](#)
   b. Wear [well-fitting face coverings](#) in all indoor spaces on campus
   c. Complete weekly [testing](#) if not fully vaccinated or exempted
   d. [Wash hands](#) frequently and practice social distancing when possible
   e. Complete daily [self-checks](#)
   f. Stay home/do not come to campus if feeling [symptomatic](#)
   g. Complete the UO [COVID-19 case and contact reporting form](#) if you test positive or have been in close contact with a confirmed or presumptive case.
   h. If a student in class tests positive for COVID-19, all relevant classes will be notified via an email by the Corona Corps Care Team with instructions for students and staff based on their vaccination status.

2. **If you test positive for Covid-19 or feel symptomatic, do not come to class.** I will make sure you are still able to participate as fully as possible. Please notify me before class begins if you want to Zoom in.

3. **If I test positive for Covid-19,** I will need to isolate for 10 calendar days. In that event, I will either have a substitute fill in for me in person, or teach via Zoom.
Instructor’s Teaching Philosophy

Research on learning tells us that people learn best through **active learning**, in which learners are active participants rather than passive observers. The act of recalling information helps to strengthen your brain’s ability to access that information reliably. Our course design provides structured learning opportunities before, during, and after class to help you engage your brain and monitor your own understanding as you build your knowledge about astronomy.

Ungraded Learning Opportunities:

- **Reading Questions**: Mostly multiple-choice style questions based on videos and readings. You should try these before class begins, monitor your understanding, and then complete them after class to check your learning gains.
- **In-class Activities**: Learning activities done together during class time. These will not be graded, but some homework and quiz questions will be based directly on the activities. Activities will be delivered through Canvas, so please bring either a computer or cell phone to class.
- **Reflections**: A variety of prompts for you to respond to in writing, video, or voice memo. You’ll reflect on your learning, study methods, course work schedule, and how we conduct the course. This is your chance to give me feedback - use it!

Graded Assignments:

- **Homework**: A mixture of multiple choice and short calculations similar to those done in class that summarize the material studied that week.
- **Quizzes**: A mixture of multiple choice, written responses and calculations to check your understanding. Quizzes will consist of two parts. First, you will work on your own. This part is open-book and open-note, but you may **not** work with classmates, tutors, or random strangers on the internet. Then, you will have the chance to work together in class. Your overall quiz grade will come 75% from the individual part and 25% from the group part. For the final exam, you will not have time to dig through course materials to answer questions. So as you take quizzes, keep track of what you have to look up.
- **Final exam**: A mixture of multiple choice, written responses and calculations. It will cover everything in the course and will be done in class during finals week. You can bring a one-page (8.5” x 11”) reference sheet (use quizzes as a chance to develop it!)
- **Science Communication Project**: The Science Communication Project is an opportunity for you to apply concepts from class and research new ideas. The topic and format is largely up to you. This is an opportunity for you to be creative, please take it (I have as much fun grading essays as you have writing them). You can work together in groups if you wish (and I hope you do!). You will also review the work of other groups.
# Grade Breakdown

<table>
<thead>
<tr>
<th>Assignment</th>
<th>When?</th>
<th>Number</th>
<th>Percent of Final Grade</th>
<th>% each</th>
<th>Out-of-class time per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading Questions</td>
<td>Weekly</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2 - 4 hours</td>
</tr>
<tr>
<td>In-class Activities</td>
<td>During most classes</td>
<td>-</td>
<td>3% each (8 highest scores)</td>
<td>3% each</td>
<td></td>
</tr>
<tr>
<td>Homeworks</td>
<td>Weekly</td>
<td>10</td>
<td>30%</td>
<td>3% each</td>
<td>1 - 2 hours</td>
</tr>
<tr>
<td>Quizzes</td>
<td>Week 10</td>
<td>3</td>
<td>30%</td>
<td>10% each</td>
<td>Replaces reading on quiz days</td>
</tr>
<tr>
<td>Project</td>
<td>Week 10</td>
<td>1</td>
<td>10%</td>
<td>&lt; 1 hour</td>
<td></td>
</tr>
<tr>
<td>Final Exam</td>
<td>Monday, March 14, 2:45pm - 4:45pm</td>
<td>1</td>
<td>30%</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>Pre and Post Test</td>
<td>Weeks 1 &amp; 10</td>
<td>2</td>
<td>2% extra credit</td>
<td>1%</td>
<td>-</td>
</tr>
<tr>
<td>Weekly Reflections</td>
<td>Weekly</td>
<td>10</td>
<td>2% extra credit</td>
<td>0.2% each</td>
<td>&lt; 20 minutes</td>
</tr>
</tbody>
</table>

**Grade scale:** A: 90%, B: 80%, C: 70%, D: 60%.

**What is the late policy?**
- Homework is due **Sunday at midnight**. Feedback will become available immediately, so late homework will not be accepted; this is why two are dropped. I highly encourage you to preview the homework questions and work on it throughout the week.
- The individual portion of quizzes is due **by the time class begins**. The group portion is due by Sunday at midnight. To reward your growth throughout the term and account for any missed quizzes, your final exam can replace any and all lower-scoring quizzes.
- Your project is due by the **start of class** on the Wednesday of week 10. However, you can complete the project anytime, and I encourage you to complete it earlier in the term to spare yourself some stress at the end of the term.
## Tentative Class Schedule

Weekly homework is due each Sunday at midnight. Other due dates are noted in red. Bold indicates daily topic; italics indicates planned activities (subject to change).

<table>
<thead>
<tr>
<th>Week</th>
<th>Monday</th>
<th>Wednesday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td><strong>Welcome to ASTR 123!</strong> Pre-Test &amp; Surveys</td>
<td><strong>Observing the Universe</strong> 1.1 - 1.3, 1.6 - 1.7</td>
<td>Numbers in Astronomy 1.4 - 1.5, Appendix C</td>
</tr>
<tr>
<td></td>
<td><strong>Galaxy Search</strong></td>
<td><strong>Galaxy Descriptions</strong></td>
<td>Astronomical Distances</td>
</tr>
<tr>
<td></td>
<td><strong>Current Topic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 2</td>
<td><strong>Galactic Distances</strong> 17.1, 19.1 - 19.3</td>
<td><strong>Light from the Cosmos</strong> 5.1 - 5.3</td>
<td><strong>Doppler Shift</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Distance to Andromeda</strong></td>
<td><strong>Survey of Light</strong></td>
<td><strong>5.6</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Current Topic</strong></td>
<td></td>
<td><strong>Doppler Shift</strong></td>
</tr>
<tr>
<td>Week 3</td>
<td><strong>No Class</strong></td>
<td><strong>Laws of Motion</strong></td>
<td><strong>Quiz 1</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>3.1 - 3.3</strong></td>
<td><strong>(Weeks 1-2)</strong></td>
</tr>
<tr>
<td>Week 4</td>
<td><strong>Galaxy Structure</strong> 25.1 - 25.2, 20.1</td>
<td><strong>Galaxy Structure</strong></td>
<td><strong>Mass of the Galaxy 25.3</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Galaxy Structure</strong> 25.1 - 25.2, 20.1</td>
<td><strong>(continued)</strong></td>
<td><strong>Measuring the Milky Way’s Mass</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Galaxy Structure and Color</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 5</td>
<td><strong>General Relativity</strong> 24.1 - 24.4</td>
<td><strong>Black Holes: Theory &amp; Evidence</strong></td>
<td><strong>Center of the Galaxy 25.4</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>24.5 - 24.7</strong></td>
<td><strong>Black Hole Jigsaw</strong></td>
</tr>
<tr>
<td>Week 6</td>
<td><strong>Galaxy Formation</strong> 25.5 - 25.6</td>
<td><strong>Types of Galaxies</strong></td>
<td><strong>Quiz 2</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Spiral Formation</strong></td>
<td><strong>26.1 - 26.2</strong></td>
<td><strong>(Weeks 3-5)</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Elliptical and Irregular Formation</strong></td>
<td></td>
</tr>
<tr>
<td>Week 7</td>
<td><strong>Galaxy Mass and Distance</strong></td>
<td><strong>The Expanding Universe</strong> 26.5</td>
<td><strong>The Discovery of Quasars 27.1</strong></td>
</tr>
<tr>
<td></td>
<td>26.3 - 26.4</td>
<td><strong>Hubble’s Law</strong></td>
<td></td>
</tr>
<tr>
<td>Week 8</td>
<td><strong>Quasars and AGN</strong> 27.2 - 27.3</td>
<td><strong>Galaxy Evolution and Mergers</strong> 28.1 - 28.2</td>
<td><strong>Structure of the Universe 28.3 - 28.5</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Quasar Model Evidence</strong></td>
<td><strong>Galaxy Evolution and Interactions</strong></td>
<td></td>
</tr>
<tr>
<td>Week 9</td>
<td><strong>Age of the Universe</strong> 29.1 - 29.2</td>
<td><strong>Early Universe</strong></td>
<td><strong>Fate of the Universe 29.5 - 29.7</strong></td>
</tr>
<tr>
<td></td>
<td><strong>A Changing Universe</strong></td>
<td><strong>29.3 - 29.4</strong></td>
<td><strong>A Briefer History of Time</strong></td>
</tr>
<tr>
<td>Week 10</td>
<td><strong>Quiz 3</strong> <em>(Weeks 6-8)</em></td>
<td><strong>Final Project Peer Review</strong></td>
<td><strong>Final Review?</strong></td>
</tr>
</tbody>
</table>

**Final Exam:** Monday, March 14, 2:45 - 4:45. Cumulative.
Effective Study Skills

Here are 6 science-backed strategies for effective learning. Practice them throughout the term!

1. **Spaced Practice**: Put specific time aside to study throughout the week. Take breaks every 30-60 minutes, and after a session take a break and enjoy a healthy reward (a snack, a walk).
   ○ **Try it!** Get out your calendar. Look at the due dates for all of your classes, and consider other obligations. Block off specific times to prepare and study for classes.

2. **Interleaving**: Keep your brain engaged by switching between topics (or even classes) as you study, and review both old and new material in each session.

3. **Elaboration**: Ask yourself questions about how and why things work, then find the answers in your class materials.

4. **Concrete examples**: find or come up with concrete examples of topics, then make sure you understand how the specific features in the example help to illustrate the more general idea.

5. **Dual Coding**: this is about looking at ideas in multiple formats, for example both words and images, or using auditory or kinesthetic (movement) formats. Explain pictures in your own words, act out an idea using gestures, or come up with "catch phrases" for specific ideas.

6. **Retrieval practice**: Put everything away, and then try to write, sketch, or verbally list everything you can remember about the topic you are studying. After this, go back to your materials and check for gaps or errors.

**Putting it all together**: Make an illustrated concept map! This is a great review tool for exams.
- Explore the idea of concept maps by checking out this resource from [UNC Chapel Hill](https://www.chapelhill.org).
- Try making concept maps at different levels - one overarching one that encompasses the entire course, and some smaller ones focusing on distinct ideas or central themes.
- **Retrieval Practice**: Make your map quickly, from memory (set a timer for 5-10 minutes). Then, look back to your notes to fill in the gaps.
- **Elaborative Interrogation**: Make a list of questions, and create maps to answer them.
- **Dual Coding**: Add both words, sketches, and equations (dual coding).
- **Concrete Examples**: Come up with concrete examples for concepts in your map.
Policies and Support Services

Maintain a Climate of Respect
I welcome the diverse perspectives and identities of all students. It takes everyone to maintain a climate of respect, and a physically, emotionally, and intellectually safe environment for open inquiry. If you feel intimidated or unsafe about expressing yourself in class, please let me know.

Accessible Education
Please let me know within the first two weeks of the term if you need assistance to fully participate in the course. Participation includes access to lectures, web-based information, in-class activities, and exams. The Accessible Education Center (http://aec.uoregon.edu/) works with students to provide an instructor notification letter that outlines accommodations and adjustments to class design that will enable better access. Contact the Accessible Education Center for assistance with access or disability-related questions or concerns.

Mandatory Reporting
I am a mandatory reporter of child abuse. Please find more information at Mandatory Reporting of Child Abuse and Neglect. For other discrimination or violence reporting, I am an assisting employee. Students experiencing sex or gender-based discrimination, harassment or violence should call the 24-7 hotline 541-346-SAFE [7244] or visit safe.uoregon.edu for help. Students experiencing all forms of prohibited discrimination or harassment may contact the Dean of Students Office at 541-346-3216 or the non-confidential Title IX Coordinator/OICRC at 541-346-3123. More info: investigations.uoregon.edu/how-get-support.

Mental Health and Wellness
Mental health is a critical factor in your overall well being. Support resources include trained clinicians through University Counseling Services (counseling.uoregon.edu) and from peers at the Duck Nest (in the EMU, health.uoregon.edu/ducknest).

Basic Needs
Resources are available for food, housing, healthcare, childcare, transportation, technology, finances, and legal support: https://blogs.uoregon.edu/basicneeds/food/

Academic Misconduct
The University Student Conduct Code (available at conduct.uoregon.edu) defines academic misconduct. Students should not give or receive outside help on assignments without express permission. Info about plagiarism: https://researchguides.uoregon.edu/citing-plagiarism

Accommodation for Religious Observances
To request accommodations for this course for religious observance, visit the Office of the Registrar's website (https://registrar.uoregon.edu/calendars/religious-observances) and complete and submit the “Student Religious Accommodation Request” form prior to the end of the second week of the term.