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## Term Information

Effective Term Spring 2025

## General Information

Course Bulletin Listing/Subject Area Astronomy  
Fiscal Unit/Academic Org Astronomy - D0614  
College/Academic Group Arts and Sciences  
Level/Career Undergraduate  
Course Number/Catalog 4810  
Course Title Order of Magnitude: 2  
Transcript Abbreviation OoM: 2  
Course Description This course focuses on developing the skills needed to approach problems at an order-of-magnitude level. The methods learned in this course are often sufficient to draw conclusions about phenomena in our universe and also in our daily lives. This course expands on the skills developed in OoM 1 and builds intuition on when to apply various skills.  
Semester Credit Hours/Units Fixed: 1

## Offering Information

Length Of Course 14 Week  
Flexibly Scheduled Course Never  
Does any section of this course have a distance education component? No  
Grading Basis Satisfactory/Unsatisfactory  
Repeatable No  
Course Components Recitation  
Grade Roster Component Recitation  
Credit Available by Exam No  
Admission Condition Course No  
Off Campus Never  
Campus of Offering Columbus, Lima, Mansfield, Marion, Newark

## Prerequisites and Exclusions

Prerequisites/Corequisites Astronomy 3810, or permission of instructor.  
Exclusions  
Electronically Enforced No

## Cross-Listings

Cross-Listings

## Subject/CIP Code

Subject/CIP Code 40.0201  
Subsidy Level Baccalaureate Course  
Intended Rank Junior, Senior

## Requirement/Elective Designation

The course is an elective (for this or other units) or is a service course for other units

## Course Details

### **Course goals or learning objectives/outcomes**

- Students will be able to apply order-of-magnitude skills (dimensional analysis, the use of scaling relations, etc.) in a variety of environments.
- Students will be able to interpret open-ended questions and break them down into solvable pieces.
- Students will be able to approximate physical relationships describing complex systems from fundamental physical concepts.

### **Content Topic List**

- Week 1: How big is a Googol?
- Week 2: Sun's Temperature
- Week 3: Jean's Length
- Week 4: Galactic Phone Disconnection
- Week 5: Goosageddon
- Week 6: Giant's Versus Dwarves
- Week 7: Energy in Storms
- Week 8: Statistical Invisibility
- Week 9: Black Hole Evaporation
- Weeks 10-11: Student Problem Writing
- Weeks 12-13: Student Problem Solving
- Week 14: Stellar Zoo
- Week 15: Course Feedback and Q/A

### **Sought Concurrence**

No

## Attachments

- Astro4810Syllabus.pdf: Astronomy 4810 syllabus  
*(Syllabus. Owner: Westraadt, Lindsay)*
- AstronomyCurriculumMap.xlsx: Astronomy curriculum map  
*(Other Supporting Documentation. Owner: Westraadt, Lindsay)*

## Comments

**COURSE REQUEST**  
4810 - Status: PENDING

Last Updated: Vankeerbergen, Bernadette  
Chantal  
11/18/2024

**Workflow Information**

Status	User(s)	Date/Time	Step
Submitted	Westraadt, Lindsay	10/25/2024 01:55 PM	Submitted for Approval
Approved	Thompson, Todd Alan	10/25/2024 02:11 PM	Unit Approval
Approved	Vankeerbergen, Bernadette Chantal	11/18/2024 10:09 AM	College Approval
Pending Approval	Jenkins, Mary Ellen Bigler Hanlin, Deborah Kay Hilty, Michael Neff, Jennifer Vankeerbergen, Bernadette Chantal Steele, Rachel Lea	11/18/2024 10:09 AM	ASCCAO Approval

# ASTRONOMY 4810 – ORDER OF MAGNITUDE: 2

Spring 2025

Tuesday 3:00 pm – 3:55 pm

McPherson 1040

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<b>Instructor:</b>	Jack Roberts	<b>Office:</b>	McPherson 4020
<b>Office Hours:</b>	TR 2-4 or by appointment	<b>Email:</b>	<a href="mailto:roberts.2158@osu.edu">roberts.2158@osu.edu</a>

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## Course Description:

Orders of magnitude (factors of 10) are used to make approximate comparisons. If  $x$  is an order of magnitude greater than  $y$ , then it is ten times larger. Comparisons on these scales are often sufficient to draw conclusions about phenomena in our universe at large and also in our daily lives. This course focuses on developing the skills needed to approach problems at an order-of-magnitude level. This class expands on the first class by pushing further practice with the skills and techniques learned in the first class and helping build an intuition of when to apply various skills.

**Prerequisites:** Astronomy 3810, or permission of instructor.

## Course Goals and Learning Objectives:

This course aims to prepare students to be able to use order-of-magnitude skills in a variety of environments. Problems will continue to use skills required in the first class: dimensional analysis, the use of scaling relations, etc., but further emphasis will be placed on interpreting open-ended questions and breaking them down into solvable pieces. The course will also feature questions that may have been too imposing for the first semester, but demonstrate the ability to derive a physical understanding of complex systems from first principles.

## Format of Instruction:

The course will meet once per week for 55 minutes in the designated classroom and time. The format is an interactive seminar, with the instructor acting primarily as a facilitator. Each week a problem will be posed. Students will work together in small group discussions to develop ideas about how to approach the problem and then interact with the instructor and the other groups to converge on a path toward a solution. The goal is that all students will participate within the groups, even if someone in the group already “knows” the answers. Throughout the class, the instructor will collect input from the groups and discuss the merits of the various approaches, illuminating what further information might be needed for a solution and driving the students to think about their assumptions and uncertainties. There will be a cycle where groups share ideas, the instructor facilitates discussion, and then the students return to their groups to reconsider their ideas and calculations. The goal will be to reach approximate solutions by the end of each class period.

At the end of the semester, students will be asked to create their own Order of Magnitude problems in groups and solve them with the class as the instructor does.

## Grading and Attendance:

This is a 1 credit course and is graded Satisfactory/Unsatisfactory (S/U). There are no submitted assignments or examinations for this class. Instead, a passing grade is earned through attendance and active class participation in the student groups and in-class discussions. Participation in the group discussions is determined simply by attempted contributions, rather than the accuracy or correctness of those contributions, as the course aims to help students gain experience in problem-solving using methods that may be unfamiliar. During group discussions, the instructor will listen to the various discussions going on, both to check for understanding and to ensure students are participating in discussions. Additionally, students will occasionally be asked to serve as the “scribe.” The scribe stands at the board to sketch ideas or algebraic steps during full class discussions. The scribe will not be asked to solve the problem in front of the class, but merely write down suggestions from the class groups. In order to receive a Satisfactory (S) grade in the class, students must engage in group and full class discussions each week and perform the role of the scribe at least once in the semester.

If the instructor believes a student to not be participating at a satisfactory level, they will communicate this to the student. If the lack of participation continues, the student may not receive credit for the class that day.

Up to three classes can be missed without the need for an excuse. If a student misses more than three classes, either through lack of attendance or unsatisfactory participation, they will receive an Unsatisfactory (U) grade unless they have arranged for makeup credits with the instructor.

Students who need to miss class or who are not able to participate due to illness (COVID-19 or other illnesses), illness exposure, care for family members, or other reasons are expected to contact the instructor as soon as possible to arrange for accommodation. Note that, per university guidance, students are not required or expected to disclose COVID test results to faculty; nor will the instructor ask for information about any diagnoses. Students are not required to provide external medical documentation to support an absence related to COVID-19.

Students in special situations or those requiring specific, long-term, or other accommodation should seek support from appropriate University offices including but not limited to: Student Advocacy, Student Life Disability Services, and the Office of Institutional Equity.

Should in-person classes be canceled, students will be notified via CarmenCanvas or OSU email. In these instances, alternative methods of teaching (e.g., via Zoom) will be offered to ensure continuity of instruction for this class.

## Course Materials:

### Book / Printed Materials

There is no required textbook for the class. Students are required to bring scratch paper and a writing implement. The problems will be provided on a sheet of paper each week.

If students wish to learn more about specific mathematical tricks, *Street-Fighting Mathematics* by Sanjoy Mahajan is an excellent resource. The PDF can be found for free on MIT's programs website. While not required, this book provides excellent explanations of many mathematical tricks that will be helpful throughout this course.

### Class Webpage:

CarmenCanvas (<http://carmen.osu.edu>) - The Carmen course site will be used to host weekly activities, post problems and solution sets, distribute and collect course materials and assignments, and make announcements of various kinds, including when the weekly activities are due.

## Weekly Course Outline:

- Week 1: How big is a Googol?
  - Topics: Size Comparisons, Scale of Universe
  - Skills Used: Estimation and Bounding
- Week 2: Sun's Temperature
  - Topics: Stellar Structure, Hydro-static Equilibrium, Force Balancing
  - Skills Used: Deriving from First Principles, Finding Boundary Conditions
- Week 3: Jean's Length
  - Topics: Stellar Formation, Interstellar Medium
  - Skills Used: Problem Solving, Comparing Timescales
- Week 4: Galactic Plane Disconnection
  - Topics: Doppler Shifts, Active Galactic Nuclei, Inverse Square Laws
  - Skills Used: Problem Solving, Estimation of Scales
- Week 5: Goosedon
  - Topics: Sound Energy, Gravitational Binding Energy
  - Skills Used: Problem Solving, Converting Logarithmic Units
- Week 6: Giant's Versus Dwarves
  - Topics: Stellar Evolution, Stellar Energy Generation, Initial Mass Function
  - Skills Used: Approximate Integration
- Week 7: Energy in Storms
  - Topics: Planetary Atmospheres, Weather Phenomena, Statistical Mechanics
  - Skills Used: Dimensionless reduction, scaling factors
- Week 8: Statistical Invisibility
  - Topics: Quantum Mechanics
  - Skills Used: Combining Probabilities

- Week 9: Black Hole Evaporation
  - Topics: Quantum Mechanics, Hawking Radiation
  - Skills Used: Setting Physical Scales, Dimensional Analysis
- Weeks 10-11: Student Problem Writing
  - Topics: (Chosen by Students)
  - Skills Used: Problem Solving and Critical Thinking
- Weeks 12-13: Student Problem Solving
  - Topics: (Chosen by Students)
  - Skills Used: Explaining Complex Processes
- Week 14: Stellar Zoo
  - Topics: Stellar Lifetimes and Populations
  - Skills Used: Dimensional Analysis, Integration Reduction
- Week 15: Course Feedback and Q/A
  - Topics / Skills Used: - N/A

## **Academic Misconduct:**

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term “academic misconduct” includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-48.7 (B)). For additional information, see the Code of Student Conduct.

## **Disability Services:**

The university strives to maintain a healthy and accessible environment to support student learning in and out of the classroom. If you anticipate or experience academic barriers based on your disability (including mental health, chronic, or temporary medical conditions), please let me know immediately so that we can

privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion.

If you are ill and need to miss class, including if you are staying home and away from others while experiencing symptoms of a viral infection or fever, please let me know immediately. In cases where illness interacts with an underlying medical condition, please consult with Student Life Disability Services to request reasonable accommodations. You can connect with them at [slds@osu.edu](mailto:slds@osu.edu); 614-292-3307; or [slds.osu.edu](http://slds.osu.edu).

### **Religious Accommodations:**

Ohio State has had a longstanding practice of making reasonable academic accommodations for students' religious beliefs and practices in accordance with applicable law. In 2023, Ohio State updated its practice to align with new state legislation. Under this new provision, students must be in early communication with their instructors regarding any known accommodation requests for religious beliefs and practices, providing notice of specific dates for which they request alternative accommodations within 14 days after the first instructional day of the course. Instructors in turn shall not question the sincerity of a student's religious or spiritual belief system in reviewing such requests and shall keep requests for accommodations confidential.

With sufficient notice, instructors will provide students with reasonable alternative accommodations with regard to examinations and other academic requirements with respect to students' sincerely held religious beliefs and practices by allowing up to three absences each semester for the student to attend or participate in religious activities. Examples of religious accommodations can include, but are not limited to, rescheduling an exam, altering the time of a student's presentation, allowing make-up assignments to substitute for missed class work, or flexibility in due dates or research responsibilities. If concerns arise about a requested accommodation, instructors are to consult their tenure initiating unit head for assistance.

A student's request for time off shall be provided if the student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement and the student has notified their instructor, in writing during the first 14 days after the course begins, of the date of each absence. Although students are required to provide notice within the first 14 days after a course begins, instructors are strongly encouraged to work with the student to provide a reasonable



accommodation if a request is made outside the notice period. A student may not be penalized for an absence approved under this policy.

If students have questions or disputes related to academic accommodations, they should contact their course instructor, and then their department or college office. For questions or to report discrimination or harassment based on religion, individuals should contact the Office of Institutional Equity. (Policy: Religious Holidays, Holy Days and Observances)

## **Mental Health:**

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting [ccs.osu.edu](http://ccs.osu.edu) or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available 24/7 by dialing 988 to reach the Suicide and Crisis Lifeline.

## **Title IX:**

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at <http://titleix.osu.edu> or by contacting the Ohio State Title IX Coordinator at [titleix@osu.edu](mailto:titleix@osu.edu)

## **Diversity:**

The Ohio State University affirms the importance and value of diversity of people and ideas. We believe in creating equitable research opportunities for all students and to providing programs and curricula that allow our students to understand critical societal challenges from diverse perspectives and aspire to use research to promote sustainable solutions for all. We are committed to maintaining an inclusive community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among all members; and encourages each individual to strive to reach their own potential. The Ohio State University does not discriminate on the basis of age, ancestry, color, disability, gender identity or expression, genetic information, HIV/AIDS status, military status, national origin, race, religion, sex, gender, sexual orientation, pregnancy, protected veteran status, or any other bases under the law, in its activities, academic programs, admission, and employment. (To learn more about diversity, equity, and inclusion and for opportunities to get involved, please visit: <https://odi.osu.edu/> or <https://cbsc.osu.edu>)