ASTRONOMY 236 – "History of Matter in the Universe" FALL 2024

Credits: 3 credit hours, meets Tuesday, Thursday 9:30-10:45 in 1313 Sterling

Final Exam time: 12/18, 12:25pm-2:25pm (room TBD)

This course meets its 3 credit-hour designation by meeting twice weekly for 75 minutes and assigning approximately 6 hours of out-of-class work per week.

Instructor: Professor Sebastian Heinz, 4506 Sterling Hall, heinzs@astro.wisc.edu

Office Hours: Monday 1:00-2:00pm, Thursday 1:00-2:00pm, or by appointment. Note that office hours will start after the first class on Thursday 09/05.

You will need to make an appointment in the first third of the semester for a brief face-to-face conference regarding your communication skills in the context of this course, per Comm-B requirements.

Course Description: This is a multidisciplinary study of how the distribution of elements in the Universe has changed over cosmic time by tracing the history of matter from the Big Bang to the formation and evolution of the Solar System, ultimately leading to conditions conducive to the existence of human life on Earth and the formation of other habitable planets. The course will emphasize connections between astronomy, geology, and chemistry and will touch aspects of philosophy. Readings will draw both on scientific literature and the popular press to allow us to engage with the material on multiple levels.

Course Designation: This course meets the University's Comm-B requirement and counts as an elementary physical science.

Required equipment: You will need an internet enabled electronic writing device (a laptop or tablet) that you can **bring to class** in order to perform in-class writing assignments and other activities, such as assessments and the lab component, and to complete the homework assignments. Please contact your instructor if you do not have access to such a device. A smart phone will be useful but is insufficient for many of the writing activities.

What is this course all about? Science advances are not just as a result of discovery, but, perhaps more importantly, as a result of the scientist's ability to communicate those discoveries to their colleagues and the broader community. It is, in fact, the obligation of scientists to communicate, and this is the essence of what is known as "Galileo's Commandment." Galileo did not invent the telescope. He was probably not even the first person to point a telescope at the sky. He was, however, the first person to systematically study the sky with a telescope and communicate what he saw.

Learning Outcomes: Our goal is that you leave this course with a deeper understanding of the chemical evolution of the Universe. It is an absolutely fascinating story that has spanned some 13 billion years and involves the modern disciplines of astronomy, chemistry, geoscience, and physics. Along the way you should also gain an appreciation of how science advances and how scientists go about doing their work. Out hope is that you will learn that the "scientific process" is not linear. Scientists have flashes of insight, brilliant deductions, clever observations, and just plain good luck. All of that combines to advance science. You should also gain an appreciation of the different forms of scientific writing and their purposes. Importantly, you will enhance your own ability to communicate and distill complex information into a concise and approachable form. You should leave this course a better writer and communicator than you are today.

Your enjoyment of and success in this course will depend to a large degree on how you engage with it. Ask questions, share your opinions, and get to know each other. We strive to have an open and inclusive classroom for everyone; if you, at any time, feel that is not the case please let me know. You may or may not be aware that our society is in the midst of a debate about the value of the "liberal arts" in higher education and about the value of the experience that comes from attending college or university at a place like UW-Madison. There is value in sitting in class with a number of your peers from a broad range of majors and interests, exchanging ideas, and engaging in the same material at the same time. Let's take advantage of that and have a lively classroom.

Texts: We will not have an assigned textbook for this course. Rather, readings will be made available on the course web site in canvas as required. Readings will include popular science writing as well as some scientific articles to provide you with both an approachable, comprehensive way to understand the underlying scientific concepts and to see how scientists communicate with each other.

Writing in Astronomy 236:

As you know, this course fulfills the University's Comm-B requirement. The rules and regulations governing such courses dictate that students turn in at least 30 pages of writing over the course of the semester. This includes drafts that are reviewed by the instructor. The course assignments are designed to fulfill the requirements of the Comm-B designation while improving your communication skills and enhancing your knowledge of the history of matter in the Universe. The readings and writing assignments are also designed to introduce you to a variety of different styles of scientific writing.

Here are the objectives for a Comm-B class at UW-Madison:

- Critical reading, logical thinking, and the use of evidence
- The use of appropriate style and disciplinary conventions in writing and other forms of communication
- The productive use of core library resources specific to the discipline
- Communication to diverse audiences in ways attentive to differences in backgrounds, values, viewpoints, and experiences.

In addition, each course is typically expected to include:

- Numerous assignments, spaced through the semester, that culminate in products that share the results of research in writing and at least one other mode of communication. The balance among modes of communication may vary, as appropriate to the discipline, so long as the total amount of graded communication remains reasonably consistent from course to course. Students should submit at least 20 pages of writing (in multiple assignments, including drafts) and present findings or share their work at least twice in ways commonly used in the discipline.
- At least two opportunities for each student to be graded for presenting research findings, creative work, or other coursework, in modes other than writing common to the discipline as well as two or more opportunities to be graded for writing. Comm-B courses should also include activities that give students further opportunities to develop and receive feedback on their communication skills in writing and at least one other mode of communication in informal settings such as discussion or brainstorming.
- At least two assignments that require students to submit drafts, receive and incorporate feedback, and revise. Additional opportunities for feedback and revision would be better yet.
- At least one individual conference with a course instructor, preferably early in the semester, to discuss the student's communication skills in the context of course assignments.
- An information-gathering component beyond a beginning level.

Definition: A "polished draft" represents your best effort at the assignment. They should be double-spaced and ***have a complete set of references*** (we'll talk more about this during the semester). The draft should be of a quality similar to what you would turn in for grading. Polished drafts are not outlines, rough drafts, or even a first draft. Proofread carefully to remove any grammatical errors.

The use of AI language models:

We will discuss writing in the era of AI language models like ChatGPT in detail and at multiple points in this class. Over the past year, AI has become a mainstay in internet workflows and many of you will already have useful experience with AI language models. Beyond the rapid **adoption** of these tools, what is obvious is the rapid **evolution** of their abilities and how we engage with them. Some of what we discuss regarding ChatGPT etc. will already be obsolete next year, but some practices and cautions will be useful for years to come.

This will be the first time that the course will be offered after ChatGPT has become available and we are all adopting to the new paradigms that flow from it. Recognizing that you will use these tools in your everyday work both in college and in your future career, you will be allowed and even encourage to use ChatGPT and other similar tools throughout the course. At the same time, a key outcome of this course will be for you to understand the many significant limitations and shortcomings of AI language models and their implications for academic honesty and intellectual property. In fact, society is still coming to terms with the new reality and grappling with the resulting questions, and you are just as much part of this work as the rest of campus. Embrace this opportunity to develop your own approach to writing in the era of ChatGPT. And **most importantly**, a critical component of this course is to learn **proper attribution**. If and when you use an AI language model, you must give proper credit to which tool you used and you must include the prompts you used to generate drafts or text snippets as additional documents.

These do not count towards the word limit of your piece. You will not be penalized for using ChatGPT or similar tools, as long as you acknowledge that use. Your submissions will, of course, still be graded for accuracy, style, grammar, and orthography. As you will learn, AI generated text can often be stale and incorrect, so do not blindly trust the output of ChatGPT. Rather, use it as a first draft, and do your due diligence to fact check, edit, and improve if you choose to use it.

Writing Assignments:

Please submit all writing assignments through Canvas and adhere by the word and time limits of the assignments. Grading will disregard any content in excess of the posted limits. The ability to stay within given constraints is an important aspect of communication training.

Editing your work is just as important as creating your first draft. To this end, you will share some of your work with your peers and provide feedback to each other. This feedback will become part of your work and will also be graded, as will your edits in response to peer feedback. You will also receive feedback from your instructors and we allow you to edit your work in response. More instructions on how to provide peer review will be provided with the assignments in Canvas, but the most important aspect of any peer review will always be to provide constructive criticism and to stay polite and respectful.

1. "Who Is More Intelligent, AI or I? Writing in the Era of ChatGPT." 2000-word limit.

   What is the future of writing? How do we use AI language models productively? How do we maintain accuracy and good style? How do we ensure proper attribution? Do Large Language Models create good writing? These are some of the questions facing us today and in the future. In this project, you will engage with some of them to critique AI writing, explore how to adapt and improve your own writing, and contemplate what you would like to see in terms of AI-enabled writing.

2. "How Not to Be a Troll: The Op Ed." 800-word limit.

   This assignment is based (in part) on a true story. Assume that the State Board of Education votes that students will no longer be responsible for learning about the Big Bang because "it is not real science" and is "just a theory." Your job is to write an op-ed piece for the local newspaper or an online discussion board arguing for or against the Board's decision. Your response should debate what science is and how the development of our understanding of what is called the Big Bang fits or does not fit that definition. You should also review the body of knowledge and how it either does or does not support the Big Bang. Your positions should be clearly supported with references. Remember that your audience is the general public that you would engage with in a discussion forum or in the OpEd pages of a paper like the New York Times.

3. "Can You Be the Next Neil DeGrasse Tyson? Writing for the Public." 700-word limit.

   Over the course of the semester, you will be asked to write a piece that would be suitable for a press release similar to what is published on the UW Madison News page (https://news.wisc.edu/science-technology). These will need to be concise and "punchy" – as you will have a limited word count to convey your point.

4. "Publish or Perish: Writing for the Journals." 3000-word limit, plus figures and references

   Later in the semester, you will engage with real scientific data in a small science project that will allow you to draw some conclusions about the nature of exoplanets and stars. Your assignment is to do some basic research and write up your results as if you were writing for a scientific journal such as Science or Nature. Remember that your audience will be other scientists. More details will be given on topic choice and preparation.

5. "Getting Stuff Done: The Proposal" 3000-word limit

   Science requires access to instruments/facilities, and funding. Access to funding and facilities is competitive. In order to distribute scarce resources, science is administered both by itself and by governments. To request access, scientists write proposals that are peer-reviewed by panels of scientists, often in a double-blind setting. This way, we hope the best proposals will be chosen and the best science will be done. Here, you can choose to write one of three different types of proposals: A policy proposal/brief, an observing or computing proposal with an existing telescope/instrument or supercomputer, or an instrumentation proposal (a proposal to build a telescope, satellite, or instrument).

The hardware proposal: Scientific exploration requires the construction of laboratories, and the laboratories of astronomers are their telescopes, be they ground- or space-based. Telescopes contain instruments that collect light or other types of information. A telescope with many diverse instruments that allow different types of data to be collected (e.g., images and/or spectra) are called observatories. Building these tools is difficult and expensive and is typically funded by NASA, the National Science Foundation, Universities, and private foundations. Only the best concepts will win funding. If you decide to write a hardware proposal, you will pitch an idea for a telescope or instrument to one of these agencies, with the goal of allowing new types of study. Your piece should have three main sections: A scientific motivation (why is the science your telescope/instrument will address compelling), a list of deliverables (what you hope your instrument will accomplish, and a feasibility section (describing what is required and how your team has the expertise to complete the tasks.) In the last section, you may guestimate the costs based on research about what similar types of instruments have cost.

The scientific proposal: astronomical inquire requires access to telescopes and computers. These resources are expensive, and scientists compete for this access by submitting observing/funding/computing proposals to peer review panels that pick the most promising proposals. The success rates for these proposals is typically between 10% and 20%, so competition is fierce. You will write a science proposal to perform an observation or a supercomputer calculation to investigate a scientific question. Your proposal will contain three parts: A scientific motivation (which lays out the big picture scientific question you will address), a deliverables section (which lays out what you hope to accomplish with the access you are requesting), and a feasibility section (which discusses why your team is well positioned to accomplish those goals and what techniques you will employ.)

The policy proposal: A large fraction of the basic scientific research carried out in the United States is funded by the Federal government, particularly through grants from the National Science Foundation, NASA, the Department of Energy, and the National Institutes of Health. Those agencies tend to distribute funds in a manner that is consistent with national science policy. While national science policy on some subject is typically put forth by the Executive Branch, funding decisions are the responsibility of Congress. What you are asked to do in this assignment is to write a policy brief on a topic relevant to the material covered in this class. Your audience is a Senator or member of the House of Representatives who has asked you for the brief in order to guide their approach to a funding issue. The Writing Center at the University of North Carolina has put together some very nice tips for writing a policy brief (https://writingcenter.unc.edu/policy-briefs/). Your piece should have three main sections – what we know (context and scope of the issue), what the interesting unanswered questions are (we will substitute this for the policy alternatives section the UNC website describes), and how we should go about answering those questions (policy recommendations). For the biggest impact, you should limit the number of questions.

You may choose your own topic, but it must be closely related to the course content and you must get approval in advance. Learning how to make your point succinctly is critical—brevity is a virtue in writing. You should concentrate on demonstrating your knowledge of the subject, understanding **what** the important unanswered questions are, **why** they are important, and giving an overview of **how** we might go about answering those questions.

Oral Communication Assignments:

As part of your final project, you will create a short, recorded presentation, akin to an "elevator pitch" that convinces the audience of the merit of your proposal. This can be a narrated slideshow (or a slideshow with easily readable captions), or a video- or audio-recording of you making your pitch. You will upload the presentation to Canvas. The time limit for your presentation will be 3 minutes (brevity is a good thing, in the spirit of the elevator pitch.)

In class participation:

An important aspect of this course will be class discussion about topics relevant to the material. This is part of the art of communication, and it is important that you engage in them actively. Additionally, there will be brief writing exercises that you will complete. You will peer review each other's in-class writing to ensure that it is on topic. Instructions on how to complete these assignments will be provided in class.

Grading:

- Writing Assignment #1 – 15%, instructor-reviewed
- Writing Assignment #2 – 10%, peer-reviewed
- Writing Assignment #3 – 10%, partly peer reviewed
- Writing Assignment #4 – 15%, peer reviewed
- Writing Assignment #5 – 15%, instructor-reviewed
- Your Peer feedback – 10%
- In-class writing prompts – 10%
- Class participation – 5%
- Final presentation – 10%

Note: Late assignments will be subject to a 25% point reduction per day late. In-class writing assignments cannot be submitted late.

Evaluation vs. Assessment:

Evaluation is the process of measuring your success in mastering the material and learning outcomes of this course. It results in numerical scores for each exercise and, ultimately, your final course grade.

Throughout this course, we will also encounter **assessment** exercises. It is important to understand the difference between assessment and evaluation. Assessment is a way for your instructors to measure your learning and your progress for the purpose of improving this course both during the semester and in future versions. Assessment can be part of graded work, but can often be in the form of worksheets, questionnaires, or other forms of feedback that are **not** part of your grade. For example, we will sometimes to pre- and post-assessment exercises that are not graded, and we will offer you the opportunity to provide feedback at various points in the semester. Similarly, the course evaluations you fill out at the end of the semester are part of our assessment efforts.

Department Code of Conduct

The UW-Madison Department of Astronomy expects all faculty, staff, teaching assistants, students, and visitors to abide by its code of conduct, as a respectful and professional environment is vital to scientific productivity and educational success. Please familiarize yourself with the code of conduct here: https://www.astro.wisc.edu/climate-diversity/code-of-conduct/. If you have questions about the code of conduct or would like to talk to someone about violations of the code of conduct, please contact a member of the Committee on Departmental Environment (also known as the Climate Committee). Email addresses for current members of the committee are available at the link above. The committee can help remediate violations and access other university resources if needed or desired. The process is confidential.

Course Evaluations

Students will be provided with an opportunity to evaluate this course and your learning experience. Student participation is an integral component of this course, and your feedback is important to me. I strongly encourage you to participate in the course evaluation.

Academic Calendar and Religious Observances

See: https://secfac.wisc.edu/academic-calendar/#religious-observances

Academic Integrity Statement

By virtue of enrollment, each student agrees to uphold the high academic standards of the University of Wisconsin-Madison; academic misconduct is behavior that negatively impacts the integrity of the institution. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these previously listed acts are examples of misconduct which may result in disciplinary action. Examples of disciplinary action include, but is not limited to, failure on the assignment/course, written reprimand, disciplinary probation, suspension, or expulsion.

Accommodations for Students with Disabilities Statement

The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA. (See: McBurney Disability Resource Center)

Diversity & Inclusion Statement

Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals.

The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world.