Syllabus

PHYS 631: The Physics of Astrophysics I
Fall 2025

Instructor: Dr. Eileen Meyer (Office 312, physics)
Time and Days: Mon/Wed 1-2:15 pm
Location: Sondheim 101 (location may change)
Office Hours: Mon/Wed 10 - 11:30 AM in PHYS 306A
Phone: 410-455-2534 (52534 on campus), 832-877-2487 (cell phone, for emergencies)
Email: meyer@umbc.edu

Communication: Discord Server is preferred. Students not already in the Meyer research group will be temporarily added, and a dedicated channel will be made for the course. In general, questions about course content should be made in the class channel rather than by DM, to aid other students in learning and to encourage class discussion. You may use '@Dr Meyer' to get my attention as many times as necessary, should a question to unanswered longer than 24 hours. (Generally speaking, responses should be made in a matter of minutes to hours in most cases.)

Required Texts: *High Energy Astrophysics* by Longair, 3rd Ed.

Optional Texts: *Radiative Processes* by Rybicki & Lightman (highly recommended)
Melia, High-Energy Astrophysics

Some reading from current and historically significant literature will also be assigned at points during the semester, in addition to literature that will be collected by students for discussion, as described below.

Overview

This course, based primarily on the sequence of topics in the first half of the Longair High-Energy Astrophysics text, will explore fundamental topics in Astrophysics from a high-energy perspective. In the first part of the course we will survey the Universe from stars and stellar structure to galaxies and clusters. We then embark on the fundamentals of radiation in astrophysical environments. While the regular detection of gravitational waves, neutrinos, and cosmic rays means we have solidly entered the multi-messenger era of astronomy, it still remains the case that the vast majority of what can be learned about the Universe outside our door is accomplished through the collection of light signals. The range of physical conditions and processes in the Universe is quite vast, from rarefied plasmas in the interstellar medium, to near-blackbodies such as stars, to the extreme high-energy environments around black holes and neutron stars. Topics to be discussed include thermal and non-thermal radiation, and the scattering and re-emission of light from e.g., dust and gas. Students are expected to have a strong background in undergraduate physics and while previous astronomy coursework is helpful, it is not required.

Lectures: We will aim to cover about 1 chapter per week, with occasional detours to expand on topics which are only briefly covered in the text. *Students must read the assigned sections of the book before coming to class.* As this is a graduate-level class, all students are expected to participate in lively discussion, and small assignments, such as reading a paper and reporting back on it in the next class, should be expected as well.

Final Grade: Comprised of class preparation and participation (15%), problem sets (35%), and the final exam (50%).

Problem Sets: Solving problems and applying the theory you are learning to various astrophysical scenarios is a vital part of the learning in this course. Each unit/chapter will generally have an associated problem set. Because one can very often find full solutions online to standard problems, **I will be applying an "honor code" expectation to the problem sets**, which will work in the following way: you must attempt each problem alone for at least one hour without looking at the solution (e.g. in the back of the R&L book or online), or consulting a friend, etc. If you solve the problem alone, you should write it up and only *then* check your solution with the book or a friend. If there are differences, you should not change your solution but rather append comments describing the differences and where your intuition (or math) went wrong. If there are no differences, you can simply write the statement "solved without help". If you reach the end of the ~hour without having a clue how to solve the problem, you may then "peek" at a solution or contact others, but try to do this minimally. e.g., if the first couple of lines jog your brain into motion, stop and go back to working on your own. In any case, at the end of your eventual solution, write a comment about the degree of assistance you required from the book (or other source, if applicable). There is absolutely no penalty for using help in this manner, I simply request honesty about doing it (I find this also helps us to keep *ourselves* honest about how well we are doing at applying the material and can help identify weak points -- e.g. math skills or reading comprehension.)

Solutions should also be clear, with well-labeled figures if appropriate, and neat (or at least legible) handwriting. If you are unable to write legibly, then you should typeset your solutions using e.g. latex. You should also practice due diligence in checking your answer by various means (i.e., plugging back in, checking units, checking limits, etc).

Solutions adhering to these expectations will be graded on completion towards the 35% of the total grade. Homework must be turned in at the beginning of class on the day it is discussed. Late homework will not be accepted.

Reading: You must purchase a copy of the Longair text, and you must read the chapter or sections before it is due to be discussed in class. We will not review derivations during class time, but rather answer questions and gain insight into the material and its applications**. For this approach to work you *must* have done the reading prior to class, and *this is the reason class preparation and participation is 15% of the grade.***

Nominal Schedule

Some slippage and/or changes may occur, but will be communicated in class and by email.

Week of	**Topic / Reading**
8/27 (W)	Orientation Meeting Ch 1: High-Energy Astrophysics - An Introduction
9/3 (W)	Ch 2: Stars and Stellar Evolution (2.1-2.6)
9/8 (M/W)	Ch 2: cont. (2.6-2.10) Ch 3: Galaxies
9/15 (M/W)	Ch 4: Clusters of Galaxies Special Relativity Review (Appendix)
9/22 (M/W)	Ch 5: Ionization Losses
9/29 (M/W	Ch 6: Radiation from accelerated Charges, Bremmstrahlung

10/6 (M/W)	Ch 7: Dynamics of Charged Particles in B fields
10/13 (M/W)	Ch 8: Synchrotron Radiation
10/20 (M/W)	Ch 9: Interactions of HE particles (9.1-9.4)
10/27 (M/W)	Ch 9: cont. (9.5 - 9.10)
11/3 (M/W)	Ch 10: Nuclear Interactions (1 lecture) Ch 11: Some topics in Plasma Physics and Magnetohydrodynamics
11/10 (M/W)	Ch 11: cont + additional reading
11/17 (M/W)	Ch 12: HE Galactic Topics (Ch 12.1-12.5)
11/24 (M)	Ch 12: cont. (12.6-12.7) Ch 13: supernovae (13.1)
12/1 (M/W)	Ch 13: cont.- White Dwarfs and Neutron Stars (13.2-13.6)
12/8 (M/W)	Ch 13: cont.- Pulsars and Black Holes
12/15 (M)	Review and Discussion

Accessibility and Disability Accommodations, Guidance and Resources

Accommodations for students with disabilities are provided for all students with a qualified disability under the Americans with Disabilities Act (ADA & ADAAA) and Section 504 of the Rehabilitation Act who request and are eligible for accommodations. The Office of Student Disability Services (SDS) is the UMBC department designated to coordinate accommodations that creates equal access for students when barriers to participation exist in University courses, programs, or activities.

If you have a documented disability and need to request academic accommodations in your courses, please refer to the SDS website at sds.umbc.edu for registration information and office procedures. SDS email: disAbility@umbc.edu SDS phone: 410-455-2459

If you will be using SDS approved accommodations in this class, please contact the instructor to discuss implementation of the accommodations. During remote instruction requirements due to COVID, communication and flexibility will be essential for success.

Sexual Assault, Sexual Harassment, and Gender Based Violence and Discrimination

UMBC Policy and Federal law (Title IX) prohibit discrimination and harassment on the basis of sex, sexual orientation, and gender identity in University programs and activities. Any student who is impacted by sexual harassment, sexual assault, domestic violence, dating violence, stalking, sexual exploitation, gender discrimination, pregnancy discrimination, gender-based harassment or retaliation should contact the University's Title IX Coordinator to make a report and/or access support and resources:

The Title IX Coordinator can be reached at titleixcoordinator@umbc.edu or 410-455-1717.

You can access support and resources even if you do not want to take any further action. You will not be forced to file a formal complaint or police report. Please be aware that the University may take action on its own if essential to protect the safety of the community.

If you are interested in making a report, please use the Online Reporting/Referral Form. Please note that, if you report anonymously, the University's ability to respond will be limited.

Notice that Faculty are Responsible Employees with Mandatory Reporting Obligations:

All faculty members are considered *Responsible Employees*, per UMBC's Policy on Sexual Misconduct, Sexual Harassment, and Gender Discrimination. Faculty are therefore required to report any/ all available information regarding conduct falling under the Policy and violations of the Policy to the Title IX Coordinator, even if a student discloses an experience that occurred before attending UMBC and/or an incident that only involves people not affiliated with UMBC. Reports are required regardless of the amount of detail provided and even in instances where support has already been offered or received.

While faculty members want encourage you to share information related to your life experiences through discussion and written work, students should understand that faculty are required to report *past and present* sexual assault, domestic and interpersonal violence, stalking, and gender discrimination that is shared with them to the Title IX Coordinator so that the University can inform students of their rights, resources and support. While you are encouraged to do so, you are not obligated to respond to outreach conducted as a result of a report to the Title IX Coordinator.

If you need to speak with someone in confidence, who does not have an obligation to report to the Title IX Coordinator, UMBC has a number of Confidential Resources available to support you:

- Retriever Integrated Health(Main Campus): 410-455-2472 [Monday – Friday; 8:30 a.m. – 5 p.m.] For After-Hours Support, Call 988.
- Center for Counseling and Well-Being (Shady Grove Campus): 301-738-6273; Monday-Thursday 10:00a.m. – 7:00 p.m. and Friday 10:00 a.m. – 2:00 p.m. (virtual) Online Appointment Request Form
- Pastoral Counseling via The Gathering Space for Spiritual Well-Being: 410-455-6795; i3b@umbc.edu; Monday – Friday 8:00 a.m. – 10:00 p.m.

Other Resources:

- Women's Center (for students of all genders): 410-455-2714; womenscenter@umbc.edu. [Monday – Thursday 9:30am-5:00pm and Friday 10:00am-4pm]
- Shady Grove Student Resources, Maryland Resources, National Resources.

Child Abuse and Neglect:

Please note that Maryland law and UMBC policy require that faculty report all disclosures or suspicions of child abuse or neglect to the Department of Social Services and/or the police even if the person who experienced the abuse or neglect is now over 18.

Pregnant and Parenting Students

UMBC's Policy on Sexual Misconduct, Sexual Harassment and Gender Discrimination expressly prohibits all forms of Discrimination and Harassment on the basis of sex, including pregnancy. Resources for pregnant, parenting and breastfeeding students are available through the University's Office of Equity and Inclusion. Pregnant and parenting students are encouraged to contact the Title IX Coordinator to discuss plans and ensure ongoing access to their academic program with respect to a leave of absence or return following leave related to pregnancy, delivery, adoption, breastfeeding and/or the early months of parenting.

In addition, students who are pregnant and have an impairment related to their pregnancy that qualifies as disability under the ADA may be entitled to accommodations through the Student Disability Services Office.

Religious Observances & Accommodations

UMBC Policy provides that students should not be penalized because of observances of their religious beliefs, and that students shall be given an opportunity, whenever feasible, to make up within a reasonable time any academic assignment that is missed due to individual participation in religious observances. It is the responsibility of the student to inform the instructor of any intended absences or requested modifications for religious observances in advance, and as early as possible. For questions or guidance regarding religious observances and accommodations, please contact the Office of Equity and Civil Rights at ecr@umbc.edu.

Hate, Bias, Discrimination and Harassment

UMBC values safety, cultural and ethnic diversity, social responsibility, lifelong learning, equity, and civic engagement.

Consistent with these principles, UMBC Policy prohibits discrimination and harassment in its educational programs and activities or with respect to employment terms and conditions based on race, creed, color, religion, sex, gender, pregnancy, ancestry, age, gender identity or expression, national origin, veterans status, marital status, sexual orientation, physical or mental disability, or genetic information.

Students (and faculty and staff) who experience discrimination, harassment, hate or bias or who have such matters reported to them should use the online reporting/referral form to report discrimination, hate or bias incidents. You may report incidents that happen to you anonymously. Please note that, if you report anonymously, the University's ability to respond will be limited.