Syllabus

PHYS 631: The Physics of Astrophysics I
Spring 2024

Instructor: Dr. Eileen Meyer (Office 312, physics)
Time and Days: Monday 2:30-3:45 / Friday 1:00-2:15
Location: ILSB 302
Office Hours: Mondays and Fridays after class, or by appointment.
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: *Radiative Processes* by Rybicki & Lightman

Optional Texts: Longair, High Energy Astrophysics, 3rd Ed.
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 classic text by Rybicki and Lightman (R&L), will explore 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: Each chapter of R&L will be covered in one or two lectures, followed by a lecture primarily focusing on solving problems. *Students must read the entire chapter before coming to class.* For most chapters, we will conclude our discussions with a class devoted to presentations of examples from the recent literature, which students will provide (with instructor approval). On presentation days, the class may extend slightly into the nominal office hours time after class. If this presents an issue for you, please let the instructor know in advance.

Final Grade: Comprised of class preparation (15%), problem sets (15%), presentations (20%) 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 have an associated problem set, mostly from the R&L text. Because the answers are in the back of the book, homework is not a large portion of the total grade in this course.

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 in the back of the book or online, or consulting a friend, etc. If you solve the problem within the hour, you should write it up and only *then* check your solution with the book. If there are differences, you should not change your solution but rather append comments describing the differences. If there are no differences, you can simply write the statement "solved without help".

If you reach the end of the hour without solving the problem, you may then "peek" at the solution, 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).

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 diligince 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 15% 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.

Presentations: Class presentations will be based on recent (roughly the last 10 years) journal articles that apply the principles we are studying in the current chapter or unit. The choice of article is up to the student, but I must approve the paper beforehand. (It is best for all if you do not choose extremely long papers.) The presentations will be approximately 20-25 minutes long and are informal. You do not need to prepare powerpoint slides, but you should be fully prepared to explain the paper and any background information necessary to understand it -- this may include sketches at the board or showing a plot from another source, etc. Students should make sure the professor and classmates have a copy of the article they will discuss at least 3 days prior to the presentation. Each student will do 3 or 4 presentations during the semester.

Reading: You must purchase a copy of the Rybicki and Lightman text, and you must read the *entire* chapter 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 is 15% of the grade.*

Auditors: Should attend class, but can do problems and presentations or not, as they wish.

Nominal Schedule

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

Date	Topic
M 1/29 F 2/2	Orientation Meeting Radiative Transfer I
M 2/5 F 2/9	Radiative Transfer II Radiative Transfer III
M 2/12 F 2/16	Radiative Transfer - Problems and Presentations [Olivia, Rafael] Radiation Fields I
M 2/19 F 2/23	Radiation Fields II Radiation Fields - Problems and Presentations [Cam, Levi]
M 2/26 F 3/1	Radiation from Moving Charges I Radiation from Moving Charges - Problems and Presentations [Katie]
M 3/4 F 3/8	Relativistic Covariance I Relativistic Covariance II
M 3/11 F 3/15	Relativistic Covariance -- Problems and Presentations [Matt] Bremsstrahlung I
3/18 - 3/22	Spring Break
M 3/25 F 3/29	Bremsstrahlung II Bremsstrahlung -- Problems and Presentations [Ashlyn, Olivia]
M 4/1 F 4/5	Synchrotron Radiation I Synchrotron Radiation II
M 4/8 F 4/12	**Guest Lecture (Agniva R.) Synchrotron Radiation -- Problems and Presentations [Rafael, Cam]
M 4/15 F 4/19	Compton Scattering I Compton Scattering II
M 4/22 F 4/26	Compton Scattering -- Problems and Presentations [Levi, Katie] Plasma Effects I
M 4/29 F 5/3	Plasma Effects II Plasma Effects -- Problems and Presentations [Matt]
M 5/6 F 5/10	Molecular and Atomic Lines I* Molecular and Atomic Lines II
M 5/13	Molecular and Atomic Lines -- Problems and Presentations [Ashlyn]

** Dr. Meyer will be away at the HEAD conference on 4/8

* Last Unit on lines will be a quick summary based on Dr. Meyer's assembled notes, not Rybicki and Lightman. Those interested should do a self-study of chapters 9-11.

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.