AST 6245 - RADIATIVE PROCESSES AND STELLAR ATMOSPHERES

INSTRUCTOR: Dr. Rana Ezzeddine

Semester: Fall 2023

Email:
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Office Location: 324 Bryant Space Science Center

Office Hours: Fridays 11-12pm or by appointment via email

Class Periods:
T 1:55-2:45 pm,
Th 1:55-3:50 pm

Class Location: BRT room 3

Course Overview

Almost everything we know about astronomical objects is learned from the analysis of their light. This course covers basic radiative processes, radiative transfer and the interpretation of astronomical spectra in astrophysical settings. We will focus on stellar atmospheres and common radiative astrophysical processes, but the concepts have much wider applications. Specific topics include basic atomic physics, thermodynamic and statistical equilibrium, radiative transfer, spectral line and continuum formation, line broadening, modeling stellar atmospheres, stellar winds, nebular line diagnostics, as well as many other topics.

Recommended Textbooks

- ***"The Observation and Analysis of Stellar photospheres"***, *David Gray*, Cambridge University Press, edition 3, *ISBN: 9781316036570*
- ***"Stellar Atmospheres"***, *Dimitri Mihalas*, *ISBN: 9780716703334*
- ***"Radiative Processes in Astrophysics"***, *George B. Rybicki & Alan P. Lightman, ISBN: 9780471827597*

Online Resources

- ***"Radiative Transfer in Stellar Atmospheres"***, R.J. Rutten (2003, free online: http://www.staff.science.uu.nl/~rutte101/Course_notes.html)
- ***"The Fundamentals of Stellar Astrophysics"***, Part 2, Stellar Atmospheres, G.W. Collins II (2003, chapters 9+, free online: http://ads.harvard.edu/ books/1989fsa..book/)

Course Schedule

Week	Subject	Details	Assignments
Aug 21 - Aug 25	Introduction	Intro + review of elementary atomic and molecular physics	
Aug 28 - Sep 1	Radiative transfer	Specific Intensity, thermal radiation, radiative transfer eqn, optical depths, source function, Kirchhoff's theorem	HW1 due Sep 8
Sep 4 - Sep 8	Emission and absorption	Emission and Absorption, Planck function, Einstein coefficients, oscillator strengths	
Sep 11 - Sep 15	Stellar Atmospheres	Radiative diffusion, Rosseland approximation, radiation pressure, Classical assumptions: plane-parallel geometry and grey atmospheres, LTE, Non-LTE	HW2 due Sep 22
Sep 18 - Sep 22	Stellar Atmospheres	Eddington-Barbier relation, Limb Darkening, Equivalent widths and curve of growth	
Sep 25 - Sep 29	Statistical Equilibrium	Bound-bound radiative and collisional transitions, Bound-free (photoionization an	HW3 due Oct 6
Oct 2 - Oct 6	Spectral line formation	Line profiles and broadening mechanisms	
Oct 9 - Oct 13	Review + MIDTERM		
Oct 16 - Oct 20	Stellar wind	History and literature review, Spectroscopic signatures, mass loss, Galaxy evolution	
Oct 23 - Oct 27	NO CLASSES RE TRAVELING		HW4 due Nov 3
Oct 30 - Nov 3	Physical Parameters from Stellar Spectra	Effective temperature calibrations, surface gravity indicators, chemical abundances	

Course Schedule

Week	Subject	Details	Assignments
Nov 6 - Nov 10	Radiation from Accelerating charges	Free-free emission, ionized nebulae emission	HW5 due Nov 27
Nov 13 - Nov 17	Synchrotron radiation	Synchrotron radiation, Magneto-Bremsstrahlung, radio emission from AGN	Final Project due last day of classes
Nov 20 - Nov 24	NO CLASSES THANKSGIVING		
Nov 27 - Dec 1	Compton radiation	Compton scattering	
Dec 4 - Dec 8	Multimessenger Astronomy	Neutrinos & Gravitational Waves	Paper presentations
Dec 11 - Dec 15	REVIEW		

Assignments & Grading Percentages

Assignment	Modality/Date	Percentage
Midterm	October 12	30%
HWs	Bi-weekly	40%
Final Project	Due last day of classes	20%
Paper Presentations	In class discussions	10%

Communication & Email Policy

Canvas messaging or email are the preferred methods of communication outside of class time and office hours. I check my emails regularly Monday-Friday from 9am-5pm and reply within 24 hrs. Note that an email received after 5:00pm on a Friday may not be answered until Monday.

Attendance Policy and Class Expectations

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies.

Final Project assignment will be handed out one month ahead of its due date (last day of classes). Point assignments will be associated with each problem in each homework. Homework assignments must be completed on time to receive full credit. Partial credit will be assigned where work has been carried out the full correct answer is not provided. Projects handed in after the graded, corrected projects have been distributed out to the rest of the class will not be accepted.

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center. Click here to get started with the Disability Resource Center. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Grading Policy

The following is given as an example only:

Percent	Grade
90-100	A
87.0-89.9	A-
84.0-86.9	B+
81.0-83.9	B
78.0-80.9	B-
75.0-77.9	C+
72.0-74.9	C
69.0-71.9	C-
66.0-68.9	D+
63.0-65.9	D
60.0-62.9	D-
0-59.9	F

More information on UF grading policy may be found at:
https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals.

Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/ public-results/

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor in this class.

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html

Campus Resources

Health and Wellness:

U Matter, We Care: If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS) Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/

UF Health Shands Emergency Room / Trauma Center: For immediate medical care call 52-733-0111 or go to the emergency room at 1515 SW Archer Road, Gainesville, FL 32608; Visit the UF Health Emergency Room and Trauma Center website.

GatorWell Health Promotion Services: For prevention services focused on optimal wellbeing, including Wellness Coaching for Academic Success, visit the GatorWell website or call 352-273-4450

Academic Resources:

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601.

Career assistance and counseling, https://www.crc.ufl.edu/.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420.

General study skills and tutoring, https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138; Help brainstorming, formatting, and writing papers: https:// writing.ufl.edu/writing-studio/.

Student Complaints Campus: https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: http://www.distance.ufl.edu/student-complaint-process.