Physics 405, "Stellar of Astrophysics"

General Information

Instructor: Mark Henriksen
Office: Physics 414
Location: Sondheim Hall 207
Time: MWF 1:00-1:50 PM

email: henrikse@umbc.edu
office hours: After class

Course description

The purpose of this course is to provide undergraduate students with a general background in astrophysics. A good background includes: factual knowledge, the mathematical relationships in astronomy, and how to use both to answer questions. A strong background in stellar interiors and atmospheres is useful for all astrophysical research areas: from stars to cosmology. It is an interesting journey un which we use our background in modern physics to understand the concepts of astrophysics. Along the way, we learn some interesting things about our Universe on large scales.

Grading procedures

Grades will be calculated using the following template: (1) attendance and class participation – 10%, (2) two midterms – 40%, (3) homework – 20%, (4) final exam – 30%. Please note that exams will be based on lecture material so that good attendance and attention in class is required to do well.

Scope of this Course

The following topics will be covered, in order, during lectures. The lecture material is my book and is self-contained. However, you are encouraged to ask questions to further your understanding. You are also encouraged to read related material in the following books.

Primary reference book: "Modern Astrophysics", Ostlie and Carroll, 2nd edition, Pearson.

1. Classification of spectra: MB distribution, Boltzmann equation, Saha equation, Spectral types, HR Diagram
2. The radiation field, Radiative Transfer – macroscopic view, simple cases, Brightness temperature and BB temperature
3. The Microscopic View of Radiative Transfer, Einstein Coefficients, Detailed Balance and Thermodynamic equilibrium, stimulated emission
4. Scattering as a random walk, a physical understanding of optical depth
5. Full Radiative transfer including scattering
6. Transport of radiation through a stellar atmosphere, Rosseland mean opacity
7. Thermal energy conduction (“heat flux”)
8. The structure of spectral lines: line shape, natural broadening, Doppler broadening, pressure broadening, Voight profile, curve of growth, abundances
9. Mean molecular weight
10. Basics of Nuclear astrophysics: probability of decay, binding energy, PPI chain, nuclear timescale in stars, KH timescale, PPII, PPIII branches, abundances
11. Nuclear reaction rate
12. Equations of stellar modeling
13. Convection
14. Derivation of the Lane-Emden equation, solutions
15. Star Formation: Jean’s Mass, B-E mass
16. Gravitational instability, linearization
17. Free-fall collapse, application to star formation
18. The effect of magnetic field on collapse
19. Hayashi Track
20. Initial mass function
21. Visible effects of star formation: HII regions, T-Tauri stars
22. Evolution off the main sequence: 5 solar mass star
23. Evolution of 8 Solar mass star
24. variable stars: pulsating stars and pulsars, magnetic dipole radiation

25. Equation of state for electron degeneracy, application to white dwarfs, Chandrasekhar limit
26. Observation and evolution of white dwarfs
27. Binary accretion
28. Neutrinos
29. Gamma-ray burst

Schedule of Exams

Midterm I: March 13
Midterm 2: May 8
Final Exam: May 22, 1:00 – 3:00 PM

Homework Assignments

Homework is assigned on Monday and collected the following Monday. CO is Carroll and Ostlie

1. CO: 8.6,8.12, 3.9, 3.14, 3.18
2. CO: 9.7,9.8,9.16
3. CO: 9.20,9.23
4. CO: 5.15
5. CO: 9.25,9.27,10.4,10.8, 10.12,10.13
6. CO: 10.17, 10.18, 10.24
7. CO: 12.7,12.11,12.15
8. CO: 12.19, 13.7, ax14.7,14.8,15.6,15.12
9. CO: 16.1,16.12, 16.14,16.18,16.22
10. CO: 18.5,18.13

Achieving Course Goals and Meeting Academic Expectations

Successful students in this course attend all classes and take notes. They are attentive and ask questions, occasionally. They complete all homework assignments on time. They review for exams. Most importantly, they either begin the course with adequate preparation or they fill in their missing background, as needed.

Policy on Academic Integrity

"Academic integrity is an important value at UMBC. By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal."

Student Support /Disability Services

"UMBC is committed to eliminating discriminatory obstacles that may disadvantage students based on disability. Services for students with disabilities are provided for all students qualified under the Americans with Disabilities Act (ADA) of 1990, the ADAAA of 2009, 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 would allow for students to have equal access and inclusion in all courses, programs, and activities at the University."