

AST 723, Fall 2012

Astrophysical Fluids

Professor: Daniel Proga, Department of Physics and Astronomy, UNLV
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Class time: Monday/Wednesday 10:00-11:15 pm, BPB 249

The Reference Book: *The Physics of Astrophysics, Vol. II: Gas Dynamics* by F. Shu

Other books: *Fluid Mechanics* by Landau and Lifshitz
Classical Electrodynamics by Jackson

Website: <http://www.physics.unlv.edu/~dproga/AST723F09.html>

Office hours: Formally the office hours are on Tuesday from 10:00 pm to 11:00 pm in my office (BPB Rm. 240). However, feel free to stop anytime with questions/problems/suggestions.

Week	Date	Subject	Reading
1	Aug 27	Overview	
	Aug 29	Introduction to Gas Dynamics	Ch. 1
2	Sept 3	Labor Day Recess	
	Sept 5	Kinetic theory and Fluid Mechanics	Ch. 2
3	Sept 10	Transport Coefficients for Diffusive Effects	Ch. 3
	Sept 12	Fluids as Continua	Ch. 4
4	Sept 17	Equilibria of Self-Gravitating Spherical Masses	Ch. 5
	Sept 19	Inviscid Barotropic Flow	Ch. 6
5	Sept 24	Viscous Accretion Disks	Ch. 7
	Sept 26	Fluid Instabilities	Ch. 8
6	Oct 1	Viscous Shear Flows and Turbulence	Ch. 9
	Oct 3	Mixing-length Theory of Convection	Ch. 10
7	Oct 8	Spiral Density Waves I	Ch. 11
	Oct 10	Spiral Density Waves II	Ch. 12
8	Oct 15	Method of Characteristics	Ch. 13
	Oct 17	Steady Supersonic Flow	Ch. 14
9	Oct 22	Mid-term exam	
	Oct 24	Shock Waves	Ch. 15, 16
10	Oct 29	Blast Waves and Supernova Remnants	Ch. 17
	Oct 31	Opt. Thick Radiative Shocks and Ionization Front	Ch. 19, 20
11	Nov 5	Magnetohydrodynamics	Ch. 21
	Nov 7	Hydromagnetic Equations and Hydromagnetic Waves	Ch. 22
12	Nov 12	Veterans Day Recess	
	Nov 14	Magnetostatics and the Parker Instability	Ch. 23
13	Nov 19	The Magnetic Virial Theorem	Ch. 24
	Nov 21	Hydromagnetic Shock Waves	Ch. 25
14	Nov 26	Magnetic Reconnection and Dynamo	Ch. 26
	Nov 28	Ambipolar Diffusion	Ch. 27
15	Dec 3	Study week	

Dec 5
Dec 10

Study Week
Student Presentations

Course description:

This is an astrophysics course for astronomy major graduate students. It is a survey course designed to introduce the students to the basic concepts and principles of gas microphysics and dynamics. The course comprises three major parts: (i) single-fluid theory (ii) waves, shocks, and fronts, and (iii) magnetohydrodynamics and plasma physics. This course is worth 3 credits and is recommended for all astronomy major graduate students.

Course goals: Identify physical laws governing behavior of matter in astrophysical objects. Apply key concepts in fluid dynamics - such as waves, shock, viscous fluids, fluid instabilities, diffusion -to understand objects in hydrostatic equilibrium (e.g., stars) and very dynamical objects (e.g., supernovae and accretion disk). Learn some numerical techniques used to solve gas dynamics problems.

Grading:

- The course grade will be based on homeworks, a numerical problem assignment, a mid-term exam, and a presentation.
- There will be five homeworks during the semester. Each homework will be worth 5 pts. (the total of 25 pts can be earned from homeworks). You may use any available materials to solve the problems. You are also encouraged to discuss the problems with each other, while you are trying to solve homework problems, with the provision that after the discussions you must write up your solutions yourself, independently from anyone else. This rule will be taken very seriously under the UNLV honor system. In particular, it should be stated in the submitted solutions who you have discussed the problems with (as a form of acknowledgements).
- Each student will be given a problem to be solved using numerical methods. It is to master a concept/idea and use a computer to generate a numerical solution of a specific problem. There will 20 pts. to be earned from this.
- Each student will be assigned to read one or more research papers related to this course. Some additional thinking and possible ideas of research projects are encouraged. Each student will give an hour presentation at the end of the semester. Maximum of 30 pts will be assigned for reading / presentation.
- The mid-term exam is on October 22. There will be 5 problems each worth 5 pts. (i.e., the total of 25 pts can be earned). No printed materials are allowed during the exam.

- Final Letter grades will be assigned according to the numerical scores (100 total).
A (≥ 85), A- (80-84),
B+ (77-79), B (73-76), B- (70-72)
C+ (67-69), C (63-66), C- (60-62)
D (50-59)
F (< 50)

Other information:

- This is a survey course at the beginning level, which discusses our place in the Universe, astronomy as science, and our and other planetary systems. Topics will include history of astronomy, formation of planetary systems, properties of planets and their atmospheres, properties of other objects in the solar system. A minimum of mathematics is required. Recommended for non-science majors. 3 credits.
- **Copyright** – The University requires all members of the University Community to familiarize themselves and to follow copyright and fair use requirements. **You are individually and solely responsible for violations of copyright and fair use laws. The university will neither protect nor defend you nor assume any responsibility for employee or student violations of fair use laws.** Violations of copyright laws could subject you to federal and state civil penalties and criminal liability, as well as disciplinary action under University policies. Additional information can be found at: <http://www.unlv.edu/committees/copyright/>.
- **Disability Resource Center (DRC)** – The Disability Resource Center (DRC) determines accommodations that are “reasonable” in promoting the equal access of a

student reporting a disability to the general UNLV learning experience. In so doing, the DRC also balances instructor and departmental interests in maintaining curricular standards so as to best achieve a fair evaluation standard amongst students being assisted. In order for the DRC to be effective it must be considered in the dialog between the faculty and the student who is requesting accommodations. For this reason faculty should only provide students course adjustment after having received this “Academic Accommodation Plan.” If faculty members have any questions regarding the DRC, they should call a DRC counselor.

UNLV complies with the provisions set forth in Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990. The DRC is located in the Student Services Complex (SSC-A), Room 143, phone (702) 895- 0866, fax (702) 895-0651. For additional information, please visit: <http://drc.unlv.edu/>.

- **Religious Holidays Policy** -- Any student missing class quizzes, examinations, or any other class or lab work because of observance of religious holidays shall be given an opportunity during that semester to make up missed work. The make-up will apply to the religious holiday absence only. It shall be the responsibility of the student to notify the instructor no later than the last day of late registration of his or her intention to participate in religious holidays which do not fall on state holidays or periods of class recess. This policy shall not apply in the event that administering the test or examination at an alternate time would impose an undue hardship on the instructor or the university which could have been avoided. For additional information, please visit: <http://catalog.unlv.edu/content.php?catoid=4&navoid=164>.

- **Tutoring** -- The Academic Success Center (ASC) provides tutoring and academic assistance for all UNLV students taking UNLV courses. Students are encouraged to stop by the ASC to learn more about subjects offered, tutoring times and other academic resources. The ASC is located across from the Student Services Complex, #22 on the current UNLV map. Students may learn more about tutoring services by calling (702) 895-3177 or visiting the tutoring web site at: <http://academicsuccess.unlv.edu/tutoring/>.
- **UNLV Writing Center** --One-on-one or small group assistance with writing is available free of charge to UNLV students at the Writing Center, located in CDC- 3-301. Although walk-in consultations are sometimes available, students with appointments will receive priority assistance. Appointments may be made in person or by calling 895-3908. The student's Rebel ID Card, a copy of the assignment (if possible), and two copies of any writing to be reviewed are requested for the consultation. More information can be found at: <http://writingcenter.unlv.edu/>
- **Rebelmail** – By policy, faculty and staff should e-mail students' Rebelmail accounts only. Rebelmail is UNLV's Official e-mail system for students. It is one of the primary ways students receive official university communication such as information about deadlines, major campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the university. Students' e-mail prefixes are listed on class rosters. The suffix is always @unlv.nevada.edu.