

PHYS 5391 Space Plasma Physics
Spring 2017

Instructor(s): Ramon Lopez

Office Number: SH 010

Office Telephone Number: 817-272-0386

Email Address: relopez@uta.edu

Faculty Profile: <https://www.uta.edu/profiles/ramon-lopez>

Office Hours: Tuesday/Thursday 2:30-3:00 or by appointment

Section Information: PHYS 5391-001

Time and Place of Class Meetings: [Insert building, classroom number, day and time of meeting]

Description of Course Content: The course will cover topics relevant to plasma physics and space and astrophysical plasma systems. Advanced classical mechanics, E&M, and a familiarity with vector calculus are all that is required. The topics covered will be:

1. Single particle motion and drifts, quasineutrality in plasmas, debye length, Langmuir oscillations
2. Adiabatic invariants, betatron and Fermi acceleration
3. Louisville's theorem, Vlasov equation
4. MHD equations and the closure problem, Parker's approximation, energy transport in adiabatic plasmas, perpendicular currents and diamagnetism in plasmas
5. Applications of MHD: Parker solar wind, magnetopause standoff and pressure balance in tail, waves in cold plasma (sound, Alfvén, magnetosonic), MHD shocks, K-H instability
6. Magnetic reconnection: Sweet-Parker, Petschek, modern view (Cassak-Shay, etc.)
7. Solar-Heliosphere: Solar wind, coronal holes, CMEs and Flares, CIRs, interplanetary shocks and particle acceleration, termination shock
8. Magnetosphere-ionosphere: Magnetospheric currents, potential, convection, M-I coupling, ionospheric conductance, ionization and Chapman layers
9. Vasyliunas M-I coupling theory, interchange instability
10. Storms and substorms

Student Learning Outcomes: Students will be able to:

Analyze space systems from a plasma physics perspective

Be familiar with magnetospheric structure and dynamics

Apply the formalism of magnetohydrodynamics to space systems

Identify the major solar sources of space weather

Required Textbook: Basic Space Plasma Physics by Baumjohann and Treumann

(https://www.amazon.com/gp/product/186094079X/ref=oh_aui_detailpage_o08_s00?ie=UTF8&psc=1)

Descriptions of major assignments and examinations: There will be a midterm exam and a final exam. Homework will be assigned regularly and worked in class. Class projects (such as finding examples of specific items in space data, such as Earth's magnetopause) will be conducted in and out class, but presented in class.

Attendance: Attendance is critical since 30% of the grade relies on work done or presented in class.

Grading: Each exam will be worth 35% of the grade. Class participation and having homework and projects prepared to share in class will count for 30% of the grade. Every two weeks students will receive their class participation grade by email.

Drop Policy: Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. **Students will not be automatically dropped for non-attendance.** Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information, contact the Office of Financial Aid and Scholarships (<http://www.uta.edu/aao/fao/>).

Disability Accommodations: UT Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including *The Americans with Disabilities Act (ADA)*, *The Americans with Disabilities Amendments Act (ADAAA)*, and *Section 504 of the Rehabilitation Act*. All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of disability. Students are responsible for providing the instructor with official notification in the form of a **letter certified** by the Office for Students with Disabilities (OSD). Only those students who have officially documented a need for an accommodation will have their request honored. Students experiencing a range of conditions (Physical, Learning, Chronic Health, Mental Health, and Sensory) that may cause diminished academic performance or other barriers to learning may seek services and/or accommodations by contacting:

The Office for Students with Disabilities, (OSD) www.uta.edu/disability or calling 817-272-3364. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability.

Counseling and Psychological Services, (CAPS) www.uta.edu/caps/ or calling 817-272-3671 is also available to all students to help increase their understanding of personal issues, address mental and behavioral health problems and make positive changes in their lives.

Non-Discrimination Policy: *The University of Texas at Arlington does not discriminate on the basis of race, color, national origin, religion, age, gender, sexual orientation, disabilities, genetic information, and/or veteran status in its educational programs or activities it operates. For more information, visit uta.edu/eos.*

Title IX Policy: The University of Texas at Arlington ("University") is committed to maintaining a learning and working environment that is free from discrimination based on sex in accordance with Title IX of the Higher Education Amendments of 1972 (Title IX), which prohibits discrimination on the basis of sex in educational programs or activities; Title VII of the Civil Rights Act of 1964 (Title VII), which prohibits sex discrimination in employment; and the Campus Sexual Violence Elimination Act (SaVE Act). Sexual misconduct is a form of sex discrimination and will not be tolerated. *For information regarding Title IX, visit www.uta.edu/titleIX or contact Ms. Jean Hood, Vice President and Title IX Coordinator at (817) 272-7091 or jmhood@uta.edu.*

Academic Integrity: Students enrolled all UT Arlington courses are expected to adhere to the UT Arlington Honor Code:

I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.

I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.

UT Arlington faculty members may employ the Honor Code in their courses by having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System *Regents' Rule* 50101, §2.2, suspected violations of

university's standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student's suspension or expulsion from the University. Additional information is available at <https://www.uta.edu/conduct/>.

Electronic Communication: UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which remains active even after graduation. Information about activating and using MavMail is available at <http://www.uta.edu/oit/cs/email/mavmail.php>.

Campus Carry: Effective August 1, 2016, the Campus Carry law (Senate Bill 11) allows those licensed individuals to carry a concealed handgun in buildings on public university campuses, except in locations the University establishes as prohibited. Under the new law, openly carrying handguns is not allowed on college campuses. For more information, visit <http://www.uta.edu/news/info/campus-carry/>

Student Feedback Survey: At the end of each term, students enrolled in face-to-face and online classes categorized as "lecture," "seminar," or "laboratory" are directed to complete an online Student Feedback Survey (SFS). Instructions on how to access the SFS for this course will be sent directly to each student through MavMail approximately 10 days before the end of the term. Each student's feedback via the SFS database is aggregated with that of other students enrolled in the course. Students' anonymity will be protected to the extent that the law allows. UT Arlington's effort to solicit, gather, tabulate, and publish student feedback is required by state law and aggregate results are posted online. Data from SFS is also used for faculty and program evaluations. For more information, visit <http://www.uta.edu/sfs>.

Final Review Week: for semester-long courses, a period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week *unless specified in the class syllabus*. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.

Emergency Exit Procedures: Should we experience an emergency event that requires us to vacate the building, students should exit the room and move toward the nearest exit, which is located to your right as you exit the room. When exiting the building during an emergency, one should never take an elevator but should use the stairwells. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist individuals with disabilities.

Course Schedule

As the instructor for this course, I reserve the right to adjust this schedule in any way that serves the educational needs of the students enrolled in this course. –Ramon E. Lopez

1/17 and 1/19 - Single particle motion and drifts, quasineutrality in plasmas, Debye length, Langmuir oscillations

1/24 and 1/26 - Adiabatic invariants, betatron and Fermi acceleration

1/31 Louisville's theorem, Vlasov equation

2/2 and 2/7 MHD equations and the closure problem, Parker's approximation, energy transport in adiabatic plasmas, perpendicular currents and diamagnetism in plasmas

2/9 and 2/14 - Applications of MHD: Parker solar wind, magnetopause standoff and pressure balance in tail

2/16 and 2/21 - Applications of MHD: waves in cold plasma (sound, Alfvén, magnetosonic), MHD shocks, instabilities
 2/23 and 2/28 - Magnetic reconnection: Sweet-Parker, Petschek, modern view (Cassak-Shay, etc.)
 3/2 - Review for exam 1
 3/7 – Exam 1
 3/9 - Solar-Heliosphere steady state: Solar wind, coronal holes, termination shock
 3/14 and 3/16 – spring break
 3/18 – Solar-Heliosphere dynamics: CMEs and Flares, CIRs, interplanetary shocks and particle acceleration
 3/20 –Magnetosphere: Magnetospheric currents, structure
 3/21 – Magnetosphere: potential, convection ionospheric conductance, ionization and Chapman layers
 3/23 and 3/28 - Vasyliunas M-I coupling theory, interchange instability, isentropic convection, pressure balance inconsistency
 3/30, 4/4 - Ionosphere: structure, ionization and Chapman layers
 4/6 - Ionosphere: convection, neutral wind dynamo
 4/11 and 4/13 - Solar wind –Magnetosphere coupling: merging, viscous interaction, saturation, northward vs. southward IMF merging cycle
 4/18 and 4/20 - Magnetic storms
 4/25 and 4/27 - Substorms
 5/2 – Bow shock current system
 5/4 - Review for Final Exam

<p> Emergency Phone Numbers: In case of an on-campus emergency, call the UT Arlington Police Department at 817-272-3003 (non-campus phone), 2-3003 (campus phone). You may also dial 911. Non-emergency number 817-272-3381 </p>
--