Syllabus
PTYS/ASTR/PHYS 558 – Spring 2018
Plasma Physics with Astrophysical and Solar System Applications

Course Description: The goal of this course is to present an introduction to fundamental plasma physics and magnetohydrodynamics, beginning with kinetic theory. The various important limits including the Vlasov and Boltzmann equations and MHD equations will be derived. Applications will be mostly from astrophysics and the solar system, including, the main dynamical processes in the solar atmosphere, interplanetary medium, magnetospheres, interstellar medium, blast waves, accretion disks, etc. General topics in plasma physics, such as charged-particle orbit theory, macroscopic fluid theory, plasma waves, shocks, and turbulence, and relevant applications will also be discussed, The emphasis throughout will be on basic physical processes and the various approximations used in their application to concrete problems

Meeting Time: M, W 9:30-10:45AM – Kuiper Space Sciences Room 312

Instructor: Joe Giacalone, Professor of Planetary Sciences)
Office: Kuiper Space Sciences – Room 411
Tel: 626-8365; Email: giacalon@lpl.arizona.edu
Office Hours: after class (or just stop by)
Administrative Assistant: Vicki Robles de Serino (Room 415; tel: 621-9692)

Prerequisites: There is no formal pre-requisite for this course. Students should be familiar with classical physics, including mechanics, electricity and magnetism, and be comfortable with mathematical methods of calculus, including vector calculus, and differential equations. If you are uncertain of your preparation for this class, please come see me!

Grading: Your final grade will be based on a cumulative performance on homework, in-class presentation (see below), and a final exam, which is expected to be take home. Final grades may be based on a common statistical curve, but you are assured of the following grade based on your overall final average: (A) 90% or above, (B) 80-90%, (C) 70-80%, (D) 60-70%. The weighting of the assignments is as follows:

50% Homework
20% In-class presentation of a journal article
30% Final Exam

Assignments and Exams: There will be ~5 homework assignments. They will be announced in class and will be available for download from the course website. The assignment must be turned in on the due date at the beginning of class, generally one week after it is assigned. Solutions to the homework assignments will be made available on the website. Late homework will usually incur a late penalty, and will not be accepted once solutions have been posted on the course website.

The final exam will (tentatively) be a take-home exam. Details will be discussed in class.

Each student will also be required to read a journal article and present it to the class. Details will be provided in class.

Course Website:
www.lpl.arizona.edu/classes/Giacalone 558
The website will post class lectures (scanned transparencies in pdf format, some PowerPoint slides and movies), and solutions to homework.

Textbook: There is no required textbook for this course. However, the following four text books are particularly relevant to topics to be discussed in this class and are among my favorites for plasma physics applied to the solar system and astrophysical plasmas.

1. "The Physics of Plasmas" T.J.M. Boyd and J. J. Sanderson, Cambridge University Press
2. "Physics of Solar System Plasmas" Thomas E. Cravens, Cambridge University Press (Atmospheric and Space Science Series)
3. "The Physics of Astrophysics, Volume II: Gas Dynamics", Frank H. Shu, University Science Books
4. "Solar Astrophysics", second edition, Peter V. Foukal, Wiley-VCH

In addition to these, you may also find a smaller book, by Gene Parker titled "Conversations on Electric and Magnetic Fields in the Cosmos" to be quite useful as well.

General Policies:

Academic Integrity: For general guidelines on this, please refer to the University's code of academic integrity: http://deanofstudents.arizona.edu/codeofacademicintegrity
With regards to homework for this class, you are encouraged to work with other students; however, the work that you turn in must be your own.

Attendance: This course will adhere to the University's policies, as found in the linksbelow

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, http://policy.arizona.edu/human-resources/religious-accommodation-policy.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: https://deanofstudents.arizona.edu/absences

Note, although lectures and assignments will be posted on the course website, success in this course will require that you attend and participate in each class

Threatening Behavior Policy: This course will adhere to The UA Threatening Behavior by Students Policy, which prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

Accessibility and Accommodations: It is the University's goal that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, please let me know immediately so that we can discuss options. You are also welcome to contact Disability Resources (520-621-3268) to establish reasonable accommodations. Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Non-discrimination and anti-harassment policy: This course will adhere to the UA Nondiscrimination and Anti-harassment Policy. The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

Note that the workload and course requirements are subject to change at the discretion of the instructor with proper notice to the students.

TENTATIVE SCHEDULE OF LECTURE TOPICS

	Jan 10 Course orientation. Units – cgs vs. SI	Jan 12
Jan 15 NO CLASS – MLK Holiday	Jan 17 NO CLASS – Out of town	Jan 19
Jan 22 Charged Particle orbits in constant electric and magnetic fields	Jan 24 Charged Particle orbits in varying electric and magnetic fields #1: drifts, invariants	Jan 26
Jan 29 Distribution function	Jan 31 Vlasov and Boltzman equations, and Liouville's theorem	Feb 2 (makeup lecture) Moments of Boltzmann eq., MHD equations #1
Feb 5 MHD equations #2	Feb 7 Electric field in MHD. Energy equation	Feb 9
Feb 12 Frozen Flux theorem	Feb 14 Solar Magnetic Fields #1	Feb 16
Feb 19 Solar Magnetic Fields #2	Feb 21 Heliospheres/Astrospheres: Parker's potential-flow solution	Feb 23
Feb 26 (guest lecture) Solar/Stellar Winds #1	Feb 28 Solar/Stellar Winds #2	Mar 2
Mar 5 NO CLASS – Spring Break	Mar 7 NO CLASS – Spring Break	Mar 9
Mar 12 NO CLASS – Out of town	Mar 14 Heliospheric magnetic field	Mar 16
Mar 19 Galactic magnetic field, debris disks and Shu's X-Wind model	Mar 21 Plasma Waves #1	Mar 23
Mar 26 Plasma waves #2	Mar 28 Plasma waves #3	Mar 30
Apr 2 Shocks and blast waves #1	Apr 4 Shocks and blast waves #2	Apr 6
Apr 9 Plasma Turbulence #1	Apr 11 Plasma Turbulence #2	Apr 13
Apr 16 STUDENT PRESENTATIONS #1	Apr 18 STUDENT PRESENTATIONS #2	Apr 20
Apr 23 Particle orbits in varying electric and magnetic fields #2: diffusion	Apr 25 Particle diffusion. Cosmic-ray transport in the Heliosphere and Galaxy	Apr 27
Apr 30 Cosmic ray acceleration at shocks	May 2 Other acceleration mechanisms	May 4