

Syllabus  
PTY5/ASTR/PHYS 558 – Spring 2020  
Plasma Physics with Astrophysical and Solar System Applications

**Course Description/Objectives:** 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)

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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](http://www.lpl.arizona.edu/classes/Giacalone%20558)

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.

**Learning Outcomes:** Upon completion of the course, students will have gained a broad knowledge of plasma physics of tenuous plasmas in space, such as those found to be ubiquitous in the solar system and interplanetary medium, and which can be applied to astrophysical and solar system plasmas at a level appropriate of a scientists planning to pursue a career in this area.

**General Policies:**

For a list of general University policies pertaining to this course, please visit <https://academicaffairs.arizona.edu/syllabus-policies>

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