Syllabus
PTYS 505A – Fall 2020
Principles of Planetary Physics

Course Description: Introductory physics of planetary and interplanetary gases, fluids and plasmas. Thermodynamics, kinetic theory, plasma physics, hydrodynamics, and magnetohydrodynamics with solar-system applications. This includes planetary atmospheres, solar wind, solar-system magnetic fields, dynamo theory, planetary magnetospheres, the heliosphere, and cosmic rays.

Meeting Time: T, Th 9:30-10:45AM.

Modality: This class in taught in the "In-Person" modality. Initially, until the University notifies us it is safe to return to the classroom, we will be meeting remotely, via zoom (our class website on D2L has the complete schedule). When the University moves to Stage 2 of the ramp-up, we will have an in-person component in Kuiper Space Sciences Room 308, and simultaneously a live online component, on zoom. After Thanksgiving, the class will be live online, using zoom. We may record the lectures on zoom, but this will be determined at a later time. If it is not possible to attend the lectures live online, the lecture notes will be posted, as will be homework assignments, and class announcements. Note that we will follow the University's Administrative Directive regarding the wearing of face coverings, social distancing in the classroom, and classroom attendance (if you feel sick, or are in contact with someone infectious, stay home). Please review the UArizona-COVID-19 webpage for regular updates).

Instructor: Joe Giacalone (Professor, Department of Planetary Sciences)
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Tel: 626-8365; Email: giacalon@lpl.arizona.edu
Office Hours: Just top by, but please send an email before coming over. After class is best If you cannot meet in person, you may send me an email and we can set up a remote conversation, either with Skype or Zoom.
Administrative Assistant: Vicki Robles de Serino (Room 415; tel: 621-9692)

Prerequisites: Students should be familiar with classical physics, thermodynamics, electricity and magnetism, vector calculus and both ordinary and partial differential equations.

Grading: Your final grade will be based on a cumulative performance on homework and exams. 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% Problem sets (~5-6 assignments)
20% Mid-term exam
30% Final exam

Assignments and Exams: There will be ~4-5 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. Homework may be emailed, preferably in pdf format, or posted to the D2L website. Solutions to the homework assignments will be made available on the website.   Late homework will not be accepted once solutions are posted on the course website.

The mid-term and final exams will be take-home format, to accommodate all students, including those who are unable to come to the classroom in person. Instructions will be given before the exam, but you should plan on either emailing or uploading the completed exam electronically.

Course Website:
This course is registered in the University's D2L system (d2l.arizona.edu). This is the official source and our class will have posted class lectures in pdf format, some PowerPoint slides and movies, and solutions to homework.

Textbook: There is no required textbook for this course. However, the following two 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.   The first one should be at about the right level for students in this class, the second one is a bit more for students interested in delving a bit deeper into plasma physics.

1. "Physics of Solar System Plasmas" Thomas E. Cravens, Cambridge University Press (Atmospheric and Space Science Series)
2. "The Physics of Plasmas" T.J.M. Boyd and J. J. Sanderson, Cambridge University Press

In addition to these, the internet is (usually) a good source of information for classical subjects such as thermodynamics, covered in the beginning of the semester, kinetic theory, distribution function, etc. If you find a good discussion on the internet, but have questions, bring them to class and lets talk about them.

Learning Outcomes: Upon completion of the course, students will have gained a broad knowledge of kinetic physics, fluid mechanics, and the physics of plasmas in space, such as those found to be ubiquitous in the solar system and even extended to some astrophysical situations. Students will have a solid grasp of the physical foundations of the basic equations and be able to apply them to the study of a range of planetary and space physics topics such as planetary atmospheres, the Sun, solar wind, and heliosphere.

General Policies:

Statement regarding the recording of lectures: In the event that lectures are recorded, students should be aware that such recordings are part of the students' educational record and should NOT be shared with anyone outside of class.

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 strongly 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.

(REVISED) TENTATIVE SCHEDULE OF LECTURE TOPICS

Aug 25 Course orientation. Introduction.	Aug 27 Review of Classical thermodynamics 1.
Sep 1 Review of Classical thermodynamics 2	Sep 3 Review of Classical thermodynamics 3
Sep 8 Kinetic Theory of Gases, Macroscopic equations	Sep 10 Application to plane-parallel, adiabatic, and spherical atmospheres (hydrostatic equilibrium)
Sep 15 Distribution function	Sep 17 The Boltzmann and Vlasov equations, Lioville's theorem
Sep 22 Maxwell-Boltzmann distribution, Jean's escape in a planetary atmosphere	Sep 24 A non-static atmosphere: Parker's solar wind solution
Sep 29 Solar wind, continued, general properties	Oct 1 Hydrodynamics I: overview, basic equations
Oct 6 Hydrodynamics 2: Bernoulli's principle and applications	Oct 8 Hydrodynamics 3: gravity waves, water waves
Oct 13 Application: flow of a fluid past a sphere	Oct 15 Application: Parker's potential-model heliosphere solution
Oct 20 Other applications: raindrops, gas drag, orbital decay	Oct 22 Sound waves, introduction to shock waves
Oct 27 shock jump conditions, conservation relations	Oct 29 Shocks continued. Blast waves, Sedov solution
Nov 3 Introduction to Space Plasma physics.	Nov 5 Introduction to Magnetohydrodynamics
Nov 10 The plasma beta, application to Sunspots, Potential Source Surface Model of Solar Magnetic Field	Nov 12 The Magnetic induction equation and frozen flux theorem.
Nov 17 Planetary dynamos, including "turbulent" dynamos	Nov 19 The Parker spiral magnetic field of the solar system.
Nov 24 Electric Fields in MHD. Ambipolar Electric field in a planetary atmosphere	Nov 26 NO CLASS: Thanksgiving
Dec 1 Charged particle motion in electric and magnetic fields	Dec 3 Application to trapped radiation in a planetary magnetosphere
Dec 8 Cosmic rays in the solar system	