Syllabus
PTYS 403/503 – Spring 2025
The Physics of the Solar System

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)

Teaching Assistant: David Cantillo, Graduate Student in Planetary Sciences
Office: Kuiper Space Sciences – Room 338
Email: davidcantillo@arizona.edu
Office Hours: t.b.d. (will be announced in class).

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

Course Description: The goal is to give a survey of planetary science with an emphasis on quantitative aspects of the physics of the solar system. The emphasis throughout will be on basic physical processes and the various approximations used in their application to realistic and relevant problems. During the course, students will be introduced to aspects of solar-system physics, including planetary orbits, dynamics of smaller bodies and dust in the solar system, the nature and origin of light, radiative transfer, solar system formation, planetary interiors, surfaces and atmospheres, solar-system magnetism, the Sun, asteroids, comets, and extrasolar planets. A more-detailed list of topics is given in the attached tentative lecture schedule.

This is a co-convened undergraduate/graduate course. The lectures and material will predominantly be aimed at the advanced undergraduate level. Students enrolled in 503, the graduate section, will be required to do some additional, perhaps more-challenging assignments (c.f. the grading policy below), as well as a term paper and possibly an in-class presentation.

Course Format / Teaching Methods: This class is taught in person. The method of teaching will be a standard lecture using a combination of pre-prepared presentations projected onto the screen in the classroom, real-time derivations/diagrams/discussion on initially blank transparencies, and use of the white board (or chalkboard). Questions and interaction are strongly encouraged. We may record some lectures as needed, but this will be determined at a later time. If it is not possible to attend all the lectures in person, please consult the course website (d2l) where lecture notes will be posted, as will be homework assignments, additional reading, 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.

Prerequisites/Co-requisites: As quoted in the departmental catalogue of classes, either PHYS142 or PHYS251 is a prerequisite for this class, although it should be noted that there are **no enforced requisites** for the class. Basically, you should have some calculus-based physics background as this course will focus primarily on the physics of the solar system and will use calculus-level mathematics, such as derivatives, integrals, vector analysis, and algebra. You should consult with the instructor if you have any questions about your level of preparation for this course.

Grading Scale / Policy: 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:

Students enrolled in 403
- 35% Problem sets (~5 assignments)
- 35% Average of 2 mid-term exams
- 30% Final Exam

Students enrolled in 503 (graduate credit)
- 30% Problem sets (~5 assignments*)
- 30% Average of 2 mid-term exams
- 30% Final Exam
- 10% Term Paper (and presentation, if required)

* there will likely be additional problems on each homework assignment for students enrolled in 503.

Assignments and Mid-Term Exams: There will be ~5 homework assignments during the course. The assignments consist of a few to several problems to be solved and may involve a combination of physical reasoning and quantitative derivation/solution. In most cases, each problem of each homework assignment will have equal weight towards the final grade on the assignment or will be explicitly noted in the assignment. The assignments will be announced in class and will be available for download from the course website. The assignment must be turned in (uploaded to the course website) on the due date at the beginning of class or as noted in the assignment, 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.

There will be two mid-term exams, both of which will be "take home".. The tentative dates are given on the last page of the attached lecture schedule, and will be announced in class, and are also available on the course website.

Final Exam:

The final exam, or summary assessment, will be "take home", and tentatively scheduled to be assigned on Thursday, May 1, and due on Tuesday, May 6. If there is a change to these dates, it will be announced in class at least two weeks prior to the end of the semester.

Term Paper (and Presentation) for Students enrolled in 503:

For students enrolled in the graduate-credit section of this class (503), you are required to research a topic related to the material discussed in class and write a paper about it. You should set up a meeting with the instructor to discuss your topic. In some instances, your topic may relate to research you are doing as part of your PhD program, including potentially publishable works, or a summary of your current research project. You may also be required to give a short presentation about your topic to the class. Further details of this will be given in class, and in consultation with the instructor. The anticipated due date for this term paper is before the last day of class (May 6) but may be turned in any time before this.

Textbook: There is no required textbook for this course. Much of the material to be covered in this class can be found on the internet, and the instructor will provide the relevant links, or instructions in class. There are, however, a number of relevant and possibly useful books that cover some of the material that will be covered in this class. They include:

1. "Planetary Sciences" Imke de Pater and Jack J. Lissauer, Cambridge University Press
2. "Worlds Apart: A Textbook in Planetary Sciences" Consolmagno and Schaefer, Prentice Hall
3. "Physics and Chemistry of the Solar System (revised edition)" John S. Lewis, Academic Press
4. "Planetary Science: The Science of Planets Around Stars" G.H.A. Cole, M. M. Woolfson, Institute of Physics Publishing
5. "The Solar System (second edition)" John A Wood, Prentice Hall
6. "Moons and Planets (fifth edition)" William. K. Hartmann, Cengage Learning
7. "Universe" Freedman and Kaufman, WH Freedman and Co.

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 assignments.

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Learning Outcomes: Upon completion of the course, students enrolled in both 403 and 503 will demonstrate a broad knowledge of the basic physics involved in the orbits of the planets and other objects in the solar system, the formation of the solar system, nature of light, planetary atmospheres, fluid mechanics and some aspects of space plasmas and magnetic fields such as those found to be ubiquitous in the solar system and even extended to some astrophysical situations. Students enrolled in 403 will demonstrate a basic, but broad familiarity of the underlying equations, and their physical foundations, and be able to apply them to certain aspects of planetary and space physics topics such as orbital dynamics, atmospheres, the Sun, solar wind, and heliosphere. Students enrolled in 503 will demonstrate a solid grasp of the physical foundations of the basic equations and their derivations and will also be able to apply them to the study of a range of planetary and space physics topics. In addition, they will demonstrate a deep understanding of a specific topic of their choosing, in consultation with the instructor.

Classroom behavior policy:
To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Classroom safety:
For a list of emergency procedures for all types of incidents, please visit the website of the Critical Incident Response Team (CIRT): https://cirt.arizona.edu/case-emergency/overview

Also watch the video available at
https://arizona.sabacloud.com/Saba/Web_spf/NA7P1PRD161/common/learningeventdetail/crtfy000000000003560

Nondiscrimination and Anti-harassment Policy:

The University of Arizona is committed to creating and maintaining an environment free of discrimination. In support of this commitment, the University prohibits discrimination, including harassment and retaliation, based on a protected classification, including race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, or genetic information. For more information, including how to report a concern, please see: http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

University Policies:

This class will adhere to university policies related to a syllabus, which are available at: http://catalog.arizona.edu/syllabus-policies

Included in this is a list of policies, and resources available to students, on a variety of topics. Please read through this. The topics include:

- Absence and Class Participation Policies
- Threatening Behavior Policy
- Accessibility and Accommodations Policy
- Code of Academic Integrity
- Nondiscrimination and Anti-Harassment Policy
- Subject to Change Statement

Other 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: https://deanofstudents.arizona.edu/policies/code-academic-integrity

With regards to the assigned problem sets for this class: you are strongly encouraged to work with other students; however, the work that you turn in must be your own.

With regards to the "take home" exams, you are required to work on your own.

Attendance: Please read the University policy on this (link above). Note, although lectures and assignments will be posted on the course website, you are more likely to succeed in this class if you attend and participate in each class

Tentative Schedule for PTYS403/503 – Spring 2025

week	dates	Lecture 1	Lecture 2
1	1/16		Course intro, units, back-of-the-envelope calculations
2	1/21-1/23	Continued discussion of notation, distance scales, angular measure, orbital periods	Planetary Orbits 1: Kepler's laws, Newtons Laws
3	1/28-1/30	Planetary Orbits 2: The two body problem	The restricted three-body problem, Hill sphere, Hohmann transfer orbits
4	2/4-2/6	Orbits of small bodies and dust: Radiation pressure	Orbits of small bodies and dust: Poynting Roberson drag
5	2/11-2/13	Yarkovsky effect, Orbital decay	Electromagnetic forces on charged dust grains, Orbital resonances, Kirkwood gaps, planetary rings
6	2/18-2/20	Electromagnetic forces on charged dust grains, Orbital resonances, Kirkwood gaps, planetary rings (continued)	Solar System Formation: Jeans instability
7	2/25-2/27	Solar System Formation: Angular momentum conservation, protoplanetary disks	Blackbody Radiation, Nature of light and radiation. Solar radiative heating and the equilibrium temperature of the planets
8	3/4-3/6	**t.b.d. (TA lecture)**	NO CLASS LECTURE
9	3/11-3/13	*(spring break)*	*(spring break)*
10	3/18-3/20	Physics of planetary interiors, interior temperature	Tidal forces
11	3/25-3/27	Planetary Atmospheres 1: Introduction, basic structure, retention, exosphere	Planetary Atmospheres 2: Hydrostatic Equilibrium
12	4/1-4/3	Planetary Atmospheres 3: Onset of convection, turbulence, vorticity, circulation	Expanding Atmospheres, Solar Wind
13	4/8-4/10	Blast Waves and Shocks	Solar System Magnetism 1: Overview, dynamo theory
14	4/15-4/17	Solar System Magnetism 2: Planetary magnetospheres	Solar System Magnetism 3 The Sun's magnetic field, solar activity, sunspots
15	4/22-4/24	The Heliosphere	Cosmic Rays and Solar-Energetic Particles
16	4/29-5/1	Turbulence in fluids, atmospheres, solar wind, and interstellar space	Space Weather
17	5/5	NO CLASS LECTURE	
18	5/12-5/14	**FINAL EXAM T.B.D.**	

<u>TENTATIVE</u>* list of assignments and exam dates:

assignment	**Date assigned**	**Due date**
Problem Set #1	Jan 23	Jan 30
Problem Set #2	Feb 6	Feb 13
First Mid-Term Exam**	Feb 20	Feb 25
Problem Set #3	Feb 27	Mar 6
Problem Set #4	Mar 20	Mar 27
Second Mid-Term Exam**	Apr 10	Apr 15
Problem Set #5	Apr 22	Apr 29
Final Exam**	May 1	May 5

*** Dates subject to change – assignments/due-dates will be announced in class.**
**** Take-home exam. Details will be given in class.**