Syllabus
PTYS 403/503 – Spring 2023
The Physics of the Solar System

Instructor: Joe Giacalone, Professor of Planetary Sciences
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Office Hours: after class (or just stop by)

Meeting Time: T, Th 11:00AM-12:15PM – 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 an in-class presentation.

Course Format / Teaching Methods: This class is taught in 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, 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

- 50% Problem sets (~5 assignments)
- 25% Average of 2 mid-term exams
- 25% Final Exam

Students enrolled in 503 (graduate credit)

- 45% Problem sets (~5 assignments*)
- 20% Average of 2 mid-term exams
- 20% Final Exam
- 15% Term Paper and presentation

* there will likely be additional problems, per homework assignment, for students enrolled in the 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, 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 take place during the regular class period in the same room as the lectures. The tentative dates are given in the attached lecture schedule and are also available on the course website.

Final Exam:

The final exam is currently scheduled for Tuesday, May 9 from 10:30AM-12:30PM, also in the same room as the lectures.

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 and give a presentation to the class. Further details of this will be given in class.

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 homework.

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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, to be presented to the class.

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:
All university policies related to a syllabus are available at: https://academicaffairs.arizona.edu/syllabus-policies. By placing this link in your syllabus, you no longer need to have each individual policy included in your syllabus.

Subject to Change Notice:
Information contained in the course syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor of this course.

Accessibility, Accommodations and Student Resources: 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. The University's Basic Needs Resources website is: http://basicneeds.arizona.edu/index.html

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: 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 links below

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.

Tentative Schedule for PTYS403/503 – Spring 2023

week	dates	Lecture 1	Lecture 2
1	1/12		Course intro, units, back-of-the-envelope calculations
2	1/17-1/19	Continued discussion of notation, distance scales, angular measure, orbital periods	Planetary Orbits 1: Kepler's laws, Newtons Laws
3	1/24-1/26	Planetary Orbits 2: The two body problem	The restricted three-body problem, Hill sphere, Hohmann transfer orbits
4	1/31-2/1	Orbits of small bodies and dust: Radiation pressure	Orbits of small bodies and dust: Poynting Roberson drag
5	2/6-2/8	(NO CLASS)	Yarkovsky effect, Orbital decay
6	2/13-2/15	Electromagnetic forces on charged dust grains, Orbital resonances, Kirkwood gaps, planetary rings	Solar System Formation: Jeans instabilityn
7	2/20-2/22	**Mid-Term Exam #1**	Solar System Formation: Angular momentum conservation, protoplanetary disks
8	2/27-3/1	Blackbody Radiation, Nature of light and radiation. Solar radiative heating and the equilibrium temperature of the planets	Basics of radiative transfer (optical depth, radiative transfer equation)
9	3/6-3/8	*(spring break)*	*(spring break)*
10	3/13-3/15	Physics of planetary interiors, interior temperature	Tidal forces
11	3/20-3/22	Planetary Atmospheres 1: Introduction, basic structure, retention, exosphere	Planetary Atmospheres 2: Hydrostatic Equilibrium
12	3/27-3/29	Planetary Atmospheres 3: Onset of convection, turbulence, vorticity, circulation	Expanding Atmospheres, Solar Wind
13	4/3-4/5	Blast Waves and Shocks	Solar System Magnetism 1: Overview, dynamo theory
14	4/10-4/12	**Mid Term Exam #2**	Solar System Magnetism 2: Planetary magnetospheres
15	4/17-4/19	Solar System Magnetism 3 The Sun's magnetic field, solar activity, sunspots	The Heliosphere
16	4/24-4/26	Cosmic Rays and Solar-Energetic Particles	Turbulence in fluids, atmospheres, solar wind, and interstellar space
17	5/1	t.b.d.	
18	5/5-5/11	**FINAL EXAM T.B.D.**	