PHYS 673: Space Physics **Syllabus** **Fall 2020**

Time: Tuesdays and Thursdays, 9:45am-11:15am
Place: Zoom link: https://alaska.zoom.us/j/96632742580 Passcode: space
Credits: 3 credits, 3 hours/week of lecture
Course Type: Online synchronous
Prerequisites: PHYS F341, PHYS F342, PHYS F343, PHYS F421, or permission of instructor
Instructor: Prof. Hui Zhang
Office: 708D Elvey Building; Tel: (907)474-5914; E-mail: hzhang14@alaska.edu
Office Hours: By appointment
Useful Books: (all on reserve in the GI-IARC Library)

Physics of Solar System Plasmas, Author: Thomas E. Craven, Cambridge University Press (2004), ISBN-13: 978-0521611947

Introduction to Space Physics, edited by Kivelson and Russell, Cambridge University Press (1995), ISBN-10: 0521457149

Space Physics: An Introduction, Author: C. T. Russell, J. G. Luhmann, R. J. Strangeway, Publisher: Cambridge University Press (2016), ISBN-10: 1107098823

Physics of Space Plasmas: An Introduction, Second Edition, Author: George Parks, Publisher: Westview Press (2003), ISBN-10: 0813341302

Basic Space Plasma Physics, Author: W. Baumjohann and R. A. Treumann, World Scientific Publishing Company (1996), ISBN-10 186094017X

Course Description
The UAF Catalog listing for PHYS 673: "Plasma physics of the heliosphere from the solar core to the interstellar medium. Includes coronal structure, interplanetary magnetic field and solar wind, shocks, interactions with planets, planetary magnetospheres, cosmic rays, solar-terrestrial relations and instrumentation."

Student Learning Outcomes
On completion of the course, the student should be able to:
- Use adequate terminology to describe the structure of the sun, the basic properties of the solar wind, including its behavior near the Sun, near the planets and at the boundary of the heliosphere.
- Explain how certain important plasma populations in the solar system, e.g. the Earth's ionosphere and magnetosphere, get their basic properties, and how these properties may differ between the planets.
- Use adequate terminology to describe the solar wind interaction with unmagnetized bodies, such as comets, the Moon and Venus.
- Use adequate terminology to describe the solar wind interaction with magnetized planets, such as Earth.
- Apply key concepts in plasma physics (such as particle drifts, adiabatic invariants, magnetic mirroring, frozen-in field theorem, hydromagnetic equilibria) to analyze the

structures and dynamics in the solar system.

- Conduct a thorough literature search and a systematic review on an instrument in space physics and highlight some of the most significant scientific discoveries using measurements from the instrument.

Grades

45% of the grade will be based on problem sets (expect one every week), 15% on the mid-term exam, 20% on the final exam, and 20% on the project.

The course will be graded approximately on the following scale:

> 85 %	A
80 % -- 85 %	A-
75 % -- 80 %	B+
70 % -- 75 %	B
65 % -- 70 %	B-
60 % -- 65 %	C+
55 % -- 60 %	C
50 % -- 55 %	C-
45 % -- 50 %	D+
40 % -- 45 %	D
35 % -- 40 %	D-
< 35 %	F

Project

The project will be defined as “Instrumentation in space physics”. The students will research an instrument of choice (e.g. particle detectors, magnetometers, electric field instruments, aurora imagers, energetic neutral atom imager, soft X-ray imager, spectrometer, radars, etc.), write a review article, and make an in-class presentation. A historical overview of the measurement technique should be provided, highlighting some of the most significant scientific discoveries using measurements from the instrument.

Contents of the paper: Title, Author, Abstract, Main body of the paper, which can be divided into several sections, Discussion and Conclusions, References. The presentation should be organized in the same way as the paper.

Formats for the review paper: Single-spaced, 12 point times new roman font, 1-inch margins on all sides, ~10 pages (including all illustrations, tables, and figures)

The students will also review papers written by other students and write a one-page report for each paper. The referee report should contain a brief (one paragraph) summary, (major or minor) strengths and weaknesses of the paper, and a score (maximum 100).

Course Policies

Homework and the course project will be assigned and collected via Google Classroom (class code: l32mb65). On the due date, homework assignments should be submitted to the Google Classroom site in electronic format (a single pdf file preferred, you may find CamScanner useful:

www.camscanner.com). You are expected to show not only your answer but also steps leading to that answer. Your work should be clean and clear enough for me to understand. Assignments turned in up to 1 day late will earn a 10% deduction; 2 days late, 20% deduction; 3 days late, 30% deduction; 4 days late, 50% deduction. Assignments submitted on or after the 5th day will not be graded and will earn zero.

High ethical standards are essential for maintaining credibility. Plagiarism is defined as appropriating passages or ideas from another person's work and using them as one's own. You may work with your classmates on problem sets, however, you should submit your own work, not a copy from another source. Plagiarism on homework or on a project will result in a failing grade.

Students with Disabilities Notice
The University of Alaska Fairbanks is committed to equal opportunity for students with disabilities. Students with disabilities are encouraged to contact the coordinator of Disability Services (Mary Matthews) at the Center for health & Counseling (x7043). See section on "Disability Services" of the UAF Class Schedule (http://www.uaf.edu/schedule/).

Student Protections and Services Statement
Every qualified student is welcome in my classroom. As needed, I am happy to work with you, disability services, veterans' services, rural student services, etc. to find reasonable accommodations. Students at this university are protected against sexual harassment and discrimination (Title IX), and minors have additional protections. For more information on your rights as a student and the resources available to you to resolve problems, please go the following site: www.uaf.edu/handbook/.

UA is an AA/EO employer and educational institution and prohibits illegal discrimination against any individual: https://alaska.edu/nondiscrimination/.

Your instructor follows the University of Alaska Fairbanks Incomplete Grade Policy: "The letter "I" (Incomplete) is a temporary grade used to indicate that the student has satisfactorily completed (C or better) the majority of work in a course but for personal reasons beyond the student's control, such as sickness, has not been able to complete the course during the regular semester. Negligence or indifference are not acceptable reasons for an "I" grade."

Effective communication: Students who have difficulties with oral presentations and/or writing are strongly encouraged to get help from the UAF Department of Communication's Speaking Center (907-474-5470, speak@uaf.edu) and the UAF English's Department's Writing Center (907-474-5314, Gruening 8th floor), and/or CTC's Learning Center (604 Barnette Street, 907-455- 2860).

COVID-19 Statement
Students should keep up-to-date on the university's policies, practices, and mandates related to COVID-19 by regularly checking this website:
https://sites.google.com/alaska.edu/coronavirus/uaf/uafstudents?authuser=0
Further, students are expected to adhere to the university's policies, practices, and mandates and are subject to disciplinary actions if they do not comply.

Tentative Course Outline

I. Introduction
   1. What is Space Physics?
   2. Review of Single Particle Motions
   3. Review of Magnetohydrodynamics (MHD)

II. The Sun and Solar Wind
   1. Solar Interior
   2. The Solar Atmosphere
   3. The Magnetic Sun and Solar Cycle
   4. Corona Expansion and the Solar Wind
   5. The Heliosphere

III. Planetary Atmospheres
   1. Hydrostatic Equilibrium
   2. Solar Radiation and Thermal Structure of the Atmosphere
   3. Atmospheric Escape and Composition
   4. Atmospheric Dynamics

IV. Planetary Ionospheres
   1. Ionization Production and Loss Processes
   2. Chapman Layer Theory and Ionospheric Structure
   3. Diffusion and Transport
   4. Ionospheric Conductivity and Currents
   5. Radio Wave Propagation and Ionospheric Sounding

V. Solar Wind Interaction with Planets and Other Solar System Bodies
   1. Solar Wind Interaction with Unmagnetized Bodies
   2. Solar Wind Interaction with Magnetized Planets

VI. Planetary Magnetospheres
   1. The Morphology of the Magnetosphere
   2. Solar Wind-Magnetosphere Coupling
   3. Magnetosphere-Ionosphere Coupling
   4. Magnetospheric Dynamics
   5. Space Weather

Tentative Weekly Schedule

Week	Date	Lecture Subject	Problem Sets
1	T Aug 25	Introduction	Problem Set 1
	R Aug 27	Review of Single Particle Motions	
2	T Sep 1		Problem Set 1 is Due
	R Sep 3	Review of MHD	
3	T Sep 8		Problem Set 2 is Due
	R Sep 10	The Sun and Solar Wind-Solar Interior	
4	T Sep 15	Solar Atmosphere	Problem Set 3 is Due
	R Sep 17	Magnetic Sun and Solar Cycle	
5	T Sep 22	Corona Expansion and the Solar Wind	Problem Set 4 is Due
	R Sep 24	Heliosphere	
6	T Sep 29	Planetary Atmospheres	Problem Set 5 is Due
	R Oct 1		
7	T Oct 6	Planetary Ionospheres-Ionization Production	Project topic chosen
	R Oct 8	and Loss Processes	

8	T Oct 13	Chapman Layer Theory and Ionospheric Structure	Problem Set 6 is Due
	R Oct 15		
9	T Oct 20	Diffusion and Transport	Project progress report
	R Oct 22	Ionospheric Conductivity and Currents	
10	T Oct 27	Radio Wave Propagation and Ionospheric Sounding	Problem Set 7 is Due
	R Oct 29		
11	T Nov 3	Solar Wind Interaction with Planets and Other Solar System Bodies	Project progress report
	R Nov 5		
12	T Nov 10	Planetary Magnetospheres	Problem Set 8 is Due
	R Nov 12	The Morphology of the Magnetosphere	Project progress report
13	T Nov 17	Solar Wind-Magnetosphere Coupling	
	R Nov 19	Magnetosphere-Ionosphere Coupling	Project due
14	T Nov 24	Magnetospheric Dynamics	
	R Nov 26	**Thanksgiving Holidays (no classes)**	
15	T Dec 1	Space Weather	Referee reports due
	R Dec 3		Presentations
16	T Dec 8	8:00 a.m.-11:00 a.m., Final Exam	