# Syllabus – PHYS 673 Space Physics – Fall 2022

**Course Information:**

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| PHYS 673: | Space Physics, 3 credits, Fall 2022 |
| Meeting Times: | Tues 12:30pm - 2:00pm; Thurs 2:45pm - 4:15pm |
| Meeting Location: | Paul B. Reichardt 165 |
| Prerequisites: | Undergraduate E&M |

**Instructor Information:**


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| Instructor: | Peter Delamere, Professor of Physics |
| Office: | 708E Elvey (Geophysical Institute) |
| Email: | padelamere@alaska.edu |
| Phone: | (907) 474-6442 |
| Office Hours: | Tuesday, 2:00-5:00 or by appointment |


**Scope:** The term "Space Physics" encompasses the space environment from the sun to the outer heliosphere. Within this space environment are both magnetized and unmagnetized planets, comets, moons, and asteroids, embedded in a supersonic plasma outflow from the sun – the solar wind. The aim of this course is to provide a broad introduction to *heliospheric physics*, utilizing basic plasma physics concepts. This course will logically progress toward a more detailed course on magnetospheric and ionospheric physics, though a few basic concepts will be introduced.

**Approach:** The emphasis will be a very broad overview of space plasma physics from the sun to the outer heliosphere, to the interstellar wind, and finally to astrophysical plasmas. The basic concepts are applicable to magnetospheric and ionospheric physics, or more generally, to the physics of partially ionized gases. The basic measurements that help us to understand the space plasma environment will be discussed. Particular emphasis will be given to back-of-the-envelope estimates in Space Physics. In addition, this course can be considered as a research preparation course. As such, we will read and discuss historical and contemporary literature and we will develop a Python toolkit for simple computations.

**Topics:** Introduction to basic plasma physics (including MHD and plasma kinetic processes), magnetic dynamos, solar physics, reconnection, solar wind, shocks, interaction of the solar wind with unmagnetized objects (comets, asteroids, moons), interaction of the solar wind with magnetized obstacles (magnetospheres), the heliosphere (termination shock), heliospheric tail, dusty plasmas, and astrophysical plasmas.

**Textbook:** *Physics of Solar System Plasmas* – Tom Cravens – Cambridge University Press.

**Grading:**

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| Homework | 30% |
| Midterm Exam | 20% |
| Final Exam | 30% |
| Term Project | 20% |

**Term project:** The term project will be defined as "Instrumentation in space plasma physics". The students will research an instrument of choice (e.g. particle detectors, magnetometers etc.) and make a 15-minute presentation. A historical overview of the measurement technique should be provided, highlighting some of the most significant scientific discoveries.

**Course Policies:**

(a) Attendance and participation in class is expected of all students.
(b) Assignments are due at the beginning of class on the due date.
(c) Students are encouraged to work together on homework problems, but the final written solutions must be individual work.
(d) Students must acknowledge all sources of information – included fellow students – used in homework solutions and final projects. The UAF catalog states: "The university may initiate disciplinary action and impose disciplinary sanctions against any student or student organization found responsible for committing, attempting to commit or intentionally assisting in the commission of . . . cheating, plagiarism, or other forms of academic dishonesty. . . "
(e) All UA student academics and regulations are adhered to in this course. You may find these in the UAF catalog (section "Academics and Regulations").

**Student protection and services statement:**

(a) 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. As required, if I notice or am informed of certain types of misconduct, then I am required to report it to the appropriate authorities. 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/
(b) The University of Alaska Fairbanks is an AA/EO employer and educational institution and prohibits illegal discrimination against any individual: https://alaska.edu/nondiscrimination/.
(c) 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 at the Center for Health & Counseling (x7043).
(d) 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."
(e) 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 Department's Writing Center (907-474-5314, Gruening 8th floor), and/or CTC's LearningCenter(604 BarnetteStreet,907-455-2860).

**Schedule:**

| Topic | Weeks/Dates | Chapters |
|---|---|---|
| Plasma Basics | 1-2 | 1-4 |
| Dynamo theory | 3 | 5 |
| Stellar atmosphere | 4 | 5 |
| Solar Wind/inner heliosphere | 5-6 | 6 |
| Shocks | 7 | 7 |
| *Midterm Exam* | | |
| Solar wind/outer heliosphere | 7 | 6 |
| Mass loaded plasmas | 8 | 7 |
| Alfvén waves and momentum transfer | 9 | 7 |
| Plasma interaction with unmagnetized obstacles (comets, asteroids, and moons) | 10-11 | 7 |
| Solar wind interaction with magnetized obstacles | 12-13 | 8 |
| Plasma, neutral gas, and dusty plasmas | 14 | 8 |
| Astrophysical plasmas | 15 | |
| *Final exam* | 3:15 - 5:15 p.m., Tues, Dec 13 | |