PHYS 472C: Advanced Topics in Physics II: Plasma Physics Syllabus Fall 2017

Instructor: Prof. Hui Zhang
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Reichardt 108 (during office hours)
Time: Mondays, Wednesdays, and Fridays, 1:00pm-2:00pm (Aug 28 - Sep 29)
Place: REIC 204
Office Hours: Mondays, Wednesdays, and Fridays 2:00pm-3:00pm, or by appointment.
Credits: 1 credit, 3 hours/week of lecture
Useful Book: (on reserve in the GI-IARC Library)
Introduction to Plasma Physics and Controlled Fusion, Volume 1: Plasma Physics, Francis F Chen, Plenum Press, 2nd Edition, 1984

Course Description

A plasma is a quasi-neutral ionized gas which exhibits collective behavior. The plasma state is often described as the fourth state of matter. More than 99% of the known universe is in the plasma state. A plasma behaves very differently from a normal gas. While electrically neutral particles interact with magnetic fields very weakly, charged particles interact with magnetic fields through the Lorentz force, a long-range force typically many times stronger than gravity. The objective of plasma physics is to study how ionized particles interact among themselves and with electromagnetic fields. Electromagnetic fields and charged particles obey respectively, the fundamental Maxwell equations and the Lorentz equation of motion. Our objective is to study these equations in a systematic way in order to learn how electromagnetic fields and charged particles behave, with an emphasis on understanding the various electrodynamics phenomena observed in space. This course provides an introduction to plasma physics, and its application to space physics, at the upper undergraduate level.

Grading

Class Participation	5%
Problem Sets (one every week)	60%
Final Exam (1-2pm on September 29, Friday, closed book)	35%
Total	100%

> 95 %	A+
90 % -- 95 %	A
85 % -- 90 %	A-
80 % -- 85 %	B+
75 % -- 80 %	B
70 % -- 75 %	B-
65 % -- 70 %	C+
60 % -- 65 %	C
55 % -- 60 %	C-
50 % -- 55 %	D+
45 % -- 50 %	D
40 % -- 45 %	D-
< 40 %	F

Course Policies

Problem sets will be given in class and are due in class on the due date stated in the problem sets. 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.

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. Keep in mind that you will be required to do similar problems on your own during an exam. Plagiarism on homework or on an exam 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/).

Tentative Course Outline

I. Introduction

1. What is a plasma?
2. Characteristic Parameters of a Plasma
3. Approaches to plasma physics

II. Single Particle Motion

1. Uniform Magnetic Field (Gyro Motion)
2. Uniform Magnetic and Electric Field (E x B Drift)
3. General Force Drift
4. Nonuniform Magnetic Field (Gradient and Curvature Drift, Magnetic Mirror)
5. Motions in a Dipole Magnetic Field
6. Adiabatic Invariants

III. Magnetohydrodynamics

1. The Equations of MHD Equations
2. Ideal MHD
3. Hydromagnetic Equilibria
4. Magnetic Pressure
5. Magnetic Field Convection and Diffusion
6. Magnetic Reconnection

Tentative Weekly Schedule

Week	Date	Lecture Subject	Problem Sets
1	M Aug 28	Introduction (Chapter 1)	
	W Aug 30	Single Particle Motion (Chapter 2) Gyro Motion,	
	F Sep 1	ExB Drift	
2	M Sep 4	**Labor Day (no classes)**	
	W Sep 6	Gradient Drift, Curvature Drift	Problem Set 1 is Due
	F Sep 8	Magnetic Mirror, Motion in a dipole field	
3	M Sep 11	Adiabatic Invariants, Violation of Adiabatic	
	W Sep 13	Invariants, Magnetohydrodynamics (MHD)	
	F Sep 15	(Chapters 6.2, 6.3, and 3.4)	Problem Set 2 is Due
4	M Sep 18	MHD Equations, Ideal MHD, Hydromagnetic	
	W Sep 20	Equilibria, Magnetic Pressure,	
	F Sep 22	Plasma beta	
5	M Sep 25	Magnetic Field Convection and Diffusion,	Problem Set 3 is Due
	W Sep 27	Magnetic Reconnection, Review	
	F Sep 29	1:00pm-2:00pm, Final Exam	