SYLLABUS: PHYSICS 8120

PLASMA PHYSICS FALL 2007

Instructor: **Prof. Paul J. Wiita**

Class Timings: Mondays and Wednesdays 10:45 AM – noon

First class, Monday, 20 August; last class, Wednesday, 5 December.

Room: NSC 272

Contacts: 715 One Park Place;

Preferred, via e-mail at: `wiita@chara.gsu.edu`.

Phone: office: (404)413-6022; home: Atlanta (609)273-7177; Princeton office (most Fridays and a few Thursdays): (609)273-7177; Princeton home (most weekends): (609)683-3834.

Office hours: Mondays, 1:00 – 2:00 PM, Tuesdays 1:30–3:00PM. If you can't come during one of these scheduled times, please make an appointment to see me at some other time.

Required Text:

Russell M. Kulsrud, **Plasma Physics for Astrophysics** (Princeton University Press, paperback, 2005); this is the newest, and pedagogically most inviting, text for this subject. Note that I won't cover everything in this textbook and the book doesn't cover everything I will discuss. Also note that because this is a first edition there are errors in the text. You will get a bonus point on an assignment for every typo you catch, so please be on the look-out for them.

Other good texts to which you may wish to refer for additional enlightenment:

1) Vinod Krishan, **Astrophysical Plasmas and Fluids**

2) Peter A. Sturrock, **Plasma Physics**

3) Nicholas A. Krall & Alvin W. Trivelpiece, **Principles of Plasma Physics**

4) Lyman Spitzer, Jr., **Physics of Fully Ionized Gases**

5) George B. Rybicki & Alan P. Lightman, **Radiative Processes in Astrophysics**

COURSE OBJECTIVES: This course will provide an introduction to the physics of the bulk of the known matter in the universe, a.k.a., the plasma state. We will begin with a discussion of the huge ranges of densities and temperatures at which plasmas are found on earth and in space. We next turn to a detailed description of how particles and fluids move in EM fields. Your familiarity with electromagnetic waves in vacuum is expected, so we will concentrate on the many types of additional waves which can be excited in an ionized gas. Plasmas are subject to a wide range of unstable fluctuations which can have interesting (and even devastating) consequences; we will study a small fraction of these instablities. The ways in which heat, momentum and other properties are transported through plasmas will receive some attention. The last third of the course will be devoted to applications of plasma physics in astrophysics, including synchrotron radiation, charged-particle acceleration, and the creation and destruction of magnetic fields, though dynamos and reconnection.

COURSE SCHEDULE

TOPIC (and most relevant text Chapters)	# of Lectures
Nature of Plasmas on Earth and in Space (1)	1
Motion of Charged Particles in Electromagnetic Fields (2,3,4)	4
Waves in Plasmas (5,6,9,10)	5
Instabilities in Plasmas (7,11)	4
Midterm Exam (probable date, 8 October)	1
Transport Processes (8,10)	5
Radio Galaxies: Synchrotron Emission (9)	3
Cosmic Rays: Particle Acceleration (12)	2
Plantary, Stellar and Galactic Dynamos: Production of Magnetic Fields (13)	3
Solar Corona: Magnetic Reconnection (14)	2

Final Examination: due Wednesday, December 5th, at 10:45 AM.

Special Dates: No classes on 3 Sept. (Labor Day) and 21 Nov. (Thanksgiving) which are university holidays; the semester midpoint (last day to drop with W) is 15 Oct. Also note that I will be out of town on 19 Nov. and that missed class will be made up on one Friday, most likely 21 Sept.; if I must miss any other classes, I will do my best to make them up.

Of course, modifications to the above schedule may be necessary.

SOME USEFUL INFORMATION:

This syllabus and all assignments will be posted on my web-site:

www.chara.gsu.edu/∼wiita/teaching.html

I plan to post the notes to that site, most likely within a day or two after the lecture in which they are presented. Thus, if you have too much difficulty in simultaneously taking notes and understanding the material being presented, you should concentrate on the latter and then download the notes later to go over them at your leisure. But you will be wise to take notes on material discussed that is not presented on overheads, since that stuff is unlikely to be posted on the web-site.

RESPONSIBILITIES AND GRADING:

The assignments will consist of 3 or 4 problems per week, usually grouped into bi-weekly problem sets. At least one assignment will involve a computer project, and at least one will incorporate a short written paper. There will be an in-class, closed book, midterm exam accounting for 25% of the course grade. The assignments will account for 50%, while the take-home final exam will comprise the other 25% of the course grade.

An average above 90% will earn an A, less than that, but above 85%, an A−, above 80% a B+, above 75% a B, above 70% a B−, above 65% a C+, above 60% a C, above 55% a C−, above 50% a D and below 50% an F.

Students are expected to abide by the Policy on Academic Honesty (see the on-line **Graduate Catalog**). In particular, unless explicitly instructed otherwise, there is to be no collaboration on assignments; only by working the most of the problems by yourself are you likely to learn this material. Therefore, all questions concerning assignments are to be directed to me, unless I let you know that working together is acceptable on a particular assignment or part thereof.

This syllabus may be revised if necessary.