

**AS703**

**Introduction to Space Physics**

**Spring 2000**

**Instructor:** Professor Jeffrey Hughes

**Time:** 9:00-11:00 Mondays & Wednesdays

**Place:** The Astronomy and Space Physics Conference Room (Room CAS 500)

### **Purpose**

This course is designed to introduce space physics to incoming graduate students in astronomy and to all other graduate students interested in research in space physics. The goal is to provide students with sufficient background knowledge for them to begin to read research articles and understand research colloquia, as well as acquainting them with research opportunities in the field. For students in the graduate program in astronomy, this course is considered preparatory to the comprehensive examinations.

### **Level of Presentation and Prerequisites**

Consistent with the purpose of the course, students would normally take this course during their first two years of graduate study, ideally in their first year. As a result there are no formal prerequisites for this course, but graduate standing is required. The presentation will assume a good grasp of the principles encountered in undergraduate physics, particularly in electromagnetic theory, classical mechanics, and to a lesser extent in thermodynamics and statistical mechanics. No prior knowledge of space physics or astronomy will be assumed. Students not in the graduate program in astronomy are urged to discuss their participation in the course with the instructor.

### **Course Content**

The course is concerned primarily with phenomenology, and with the physical processes underlying this phenomenology. Each of the main regions of interest in space physics will be introduced in turn: the sun and solar wind; planetary atmospheres; planetary ionospheres; and planetary magnetospheres. In each case the basic morphology of the region will be described, and then the basic physical processes underlying this morphology will be addressed. Discussion of each topic will include a description of the major outstanding questions and of the type of research currently ongoing at the university.

### **Assessment and Grades**

Grades will be based on a combination of 5 or 6 problem sets and a final examination. Approximately two-thirds of the grade will be based on the problem sets and one-third of the grade on the final examination.

Since this course is also intended to help astronomy graduate students prepare for the comprehensive exam, the problem sets will emphasize problem solving abilities and will often include comprehensive exam-style questions.

**Primary Texts:**

*Introduction to Space Physics*, Margaret Kivelson and Christopher Russell, Cambridge Univ. Press, 1995.

This book is a collection of chapters based on a course of lectures given by 12 lecturers at UCLA several years ago and subsequently edited by Kivelson and Russell into a single text. The original lectures had the same basic goals as this course, but the emphasis is on the magnetosphere. The ionosphere and atmosphere get short shrift. The quality and level of the different chapters varies a lot. In spite of this, this is the best book that exists. We will not cover all chapters at the same level of detail, and some supplementary material on atmospheres and ionospheres may be needed.

*Physics of the Space Environment*, Tamas Gombosi, Cambridge Univ. Press, 1998.

**Other basic Space Physics Books:**

*Introduction to Ionospheric Physics*, Henry Rishbeth and Owen Garriott, Academic Press, 1969.

*The Earth's Ionosphere: Plasma Physics and Electrodynamics*, Michael C. Kelley, Academic Press, 1989.

*Physics and Chemistry of the Upper Atmosphere*, Manfred II. Rees, Cambridge Univ. Press, 1989.

*Physics of Space Plasmas: An Introduction*, George K. Parks, Addison Wesley, 1991.

*The Solar-Terrestrial Environment – An Introduction to Geospace: The Science of the Terrestrial Upper Atmosphere, Ionosphere and Magnetosphere*, J.K. Hargreaves, Cambridge Univ. Press, 1992.

*Introduction to the Space Environment*, Thomas F. Tascione, Orbit, 1988.

*Physics of Solar System Plasmas*, Thomas Cravens, Cambridge Univ. Press, 1997.

**Introduction:**

1. What is space physics?
2. Single Particle Motions and MHD

**Topic I: The Sun and Solar Wind**

1. The Solar Atmosphere and the Active Sun
2. The Steady State Solar Wind
3. The Heliosphere and Solar Wind Interaction with Planets
4. Interplanetary Shocks and Structures

**Topic II: Planetary Atmospheres**

1. Atmospheric Structure and Nomenclature
2. Hydrostatic Equilibrium
3. Atmospheric Escape and the Exosphere
4. Comparative Planetary Atmospheres

**Topic III: Planetary Ionospheres**

1. Ionospheric Structure and Nomenclature
2. Photochemical Processes – Chapman Layer Theory
3. Diffusion and Transport
4. Ionospheric Conductivity and Currents

**Topic IV: Planetary Magnetospheres**

1. Magnetospheric Structure and Nomenclature
2. Particle Motions and Plasma Populations
3. Magnetospheric Convection and Magnetic Reconnection
4. Magnetospheric Current Systems, M-I Coupling
5. Magnetospheric Substorms, Magnetic Storms, and Space Weather
6. Comparative Planetary Magnetospheres and Ionospheres