CSI 662 / PHYS 660
Introduction to Space Weather
Syllabus

Fall 2009

Prerequisites: permission of instructor
Credits: 3

Date: Thursday
Time: 4:30 PM to 7:10 PM
Place: Robinson Hall, room B224

Instructors: Jie Zhang

Contact Info: (703)993-1998 (phone), jzhang7@gmu.edu (e-mail)

Office Hour: 2:00 PM to 3:00 PM, Thursday, or by appointment

Office: Room 351, Research Bldg 1

Class URL: http://solar.gmu.edu/teaching/2009_CSI662/index.html

Description: Space Weather is a relatively new interdisciplinary science that addresses the physical processes and their predictions in the space environment between the Sun and the Earth. The practical importance of space weather is to mitigate its adverse effects on critical human technological systems, including satellites (systems and orbits), communications, navigations, electric power grids, and also the safety of astronauts. This course begins with an overview of the space weather systems involving the **Sun, Heliosphere, Magnetosphere and Ionosphere**. It presents the basic structure of the Sun, the solar magnetic field and configuration, the physical bases of flares and coronal mass ejections, and particle acceleration mechanisms. It describes the physics controlling the formation and dynamics of the solar wind and interplanetary magnetic field. The physical processes that govern the magnetosphere's behavior and its interaction with the atmosphere are covered. These include electric fields and particle acceleration that can produce geomagnetic storms. The fundamental equations of state that dictate atmospheric equilibrium and the creation of the ionosphere will be presented. Basic processes include neutral gas dynamics, ionospheric motions, and photochemical processes. The space weather effects on technological systems are discussed.

This introductory course is intended for graduate students and senior-level undergraduate students with academic background in introductory physics.

Content:

- Overview of Space Weather Systems (Sun, Heliosphere, Magnetosphere, Ionosphere)
- Solar interior, solar magnetism, structure of solar atmosphere
- Solar Activity: Flares, Coronal Mass Ejections and Solar Energetic Particles
- Solar Wind Formation and Acceleration, Heliospheric Structure
- Magnetospheric structure, magnetospheric storms and substorms
- Ionospheric Structure and dynamics
- Space Weather Effects on Technological Systems

Homework: 4-6 homework to reinforce the understanding of physical processes

Project: There are two projects. One project is on the observations and basic understandings of one specific severe space weather event. The study shall cover the whole chain activities through the Sun, heliosphere, magnetosphere and ionosphere. The other project is on theories and numerical simulations. Students are required to have an in-depth study of one of the space weather models available at NASA Community Coordinated Modeling Center (CCMC at http://ccmc.gsfc.nasa.gov/)

Exams: one midterm and one final exam

Grades: Homework (20%), Project (30%), Midterm (20%), Final Exam (30%)

Text Book (required): "Space Physics: An Introduction to Plasma and Particles in the Heliosphere and Magnetosphere", third edition, 2004, by May-Britt Kallenrode, Springer (ISBN: 3-540-20617-5)

Supplement Reference Books (not required):

"Physics of the Solar Corona", 2006, by Markus J. Aschwanden, Praxis Publishing (ISBN: 3-540-30765-6) --- supplement on solar atmosphere, solar magnetism, flares and CMEs; graduate level

"Physics of the Earth's Space Environment: An Introduction", 2002, by Gerd W. Prölss, Springer (ISBN: 3-540-21426-7) --- A good supplement on magnetosphere and ionosphere; graduate entry level

"Introduction to Plasma Physics: With Space and Laboratory Applications", 2005, by Donald A. Gurnett and Amitava Bhattahcarjee, Cambridge (ISBN: 0-521-36483-3) --- supplement on plasma physics and magnetohydrodynamics; graduate entry level

"Physics of Space Environment", 1998, by Tamas I. Gombosi, Cambridge University Press (ISBN: 0-521-59264-X) --- supplement on advanced theoretical aspect; graduate advanced level

"Space Weather: Physics and Effects", 2007, by Volker Bothmer and Ioannis A. Daglis, Springer (ISBN: 3-540-23907-3) --- supplement on the state-of-the-art research on the space weather science.

"Introduction to Space Environment", 1994, by Thomas F. Tascione, Krieger Publishing Company (ISBN: 0-89464-044-5) --- contents organized in a similar way as Kallenrode, but somewhat not up-to-date; senior undergraduate level

"The Sun from Space", 2nd edition, 2009, by Kenneth R. Lang, Springer (ISBN: 978-3-540-76952-1) --- supplement on conceptual understanding of the space weather with an emphasis on the Sun; undergraduate level

"Space Weather, Environment and Societies", 2006, by J. Lilensten and J. Bornarel, Springer (ISBN: 1-4020-4331-7) --- supplement on entry level understanding of the space weather and its effect on society; undergraduate level

"An Introduction to Space Weather", 2008, by Mark Moldwin, Cambridge (ISBN: 978-0-521-86149-6) --- supplement on conceptual understanding of the space weather, short summaries; undergraduate level, non-science major