CSI 662 / PHYS 660
Introduction to Space Weather
Syllabus

SPRING 2012

Prerequisites: permission of instructor
Credits: 3

Date: Thursday
Time: 4:30 PM to 7:10 PM
Place: Research Hall, room 302

Instructors: Dr. 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 Hall

Class URL: http://solar.gmu.edu/teaching/2012_CSI662/index.html

Description: Space Weather is an interdisciplinary science that addresses the physical processes 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 upper-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: Weekly homework to reinforce the understanding of various physical processes in the space environment

Projects: There are multiple projects based on data analysis and numerical simulation models. All data are available in various space science websites, and numerical models are mainly from the NASA Community Coordinated Modeling Center (CCMC at http://ccmc.gsfc.nasa.gov/)

Exams: one midterm and one final exam

Grades: Homework (25%), Project (35%), Midterm (15%), Final Exam (25%)

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 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 level

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

“Heliophysics: Plasma Physics of the Local Cosmos”, 2009, by Carolus J. Schrijver & George L. Siscoe --- research oriented book, advanced graduate level

“Heliophysics: Space Storms and Radiation: Causes and Effects”, 2010, by Carolus J. Schrijver & George L. Siscoe --- research oriented book, advanced graduate level

“Heliophysics: Evolving Solar Activty and the Climates of Space and Earth”, 2010, by Carolus J. Schrijver & George L. Siscoe -- --- research oriented book, advanced graduate level

“Understanding Space Weather and the Physics Behind it”, 2011, by Delores Knipp, McGraw Hill Company (ISBN-13: 978-0-07-340890-3   -- Supplement on space weather concepts; upper undergraduate level

“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 at upper 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; lower undergraduate level

“Space Weather, Environment and Societies”, 2006, by J. Lilensten and J. Bornarel, Springer (ISBN: 1-4020-4331-7) --- supplement on basic understanding of the space weather and its effect on society; lower 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; lower undergraduate level, non-science major