CSI 769 - 001
Solar and Heliospheric Physics

Syllabus

Fall 2010
Prerequisites: Classical Mechanics (PHYS 303), Electromagnetic Theory (PHYS 305), Analytical Geometry and Calculus (MATH 213), or permission of instructor
Credits: 3

Date: Thursday
Time: 4:30 PM to 7:10 PM
Place: Research Bldg 1, room 301

Instructors: **Prof. Jie Zhang**
Contact Info: (703)993-1998 (phone), jzhang7@gmu.edu (e-mail)
Office Hour: 3:00 PM to 4:00 PM, Thursday, or by appointment
Office: Room 351, Research Bldg 1

Description: This course provides an advanced understanding of physics processes that govern space plasma, with a focus on understanding the structure and dynamics of Sun's atmosphere. The topics include magnetic field (3-D extrapolation, helicity, nullpoint and separator), magnetohydrodynamics (MHD), magnetic reconnection, flare dynamics, coronal mass ejections, shock and particle acceleration, and solar wind. After taking this course, students should (1) have a deep understanding of magnetism and MHD physics, (2) understand the physical mechanisms leading to energetic eruptions, (3) learn state-of-the-art computational tools to model physical processes and compare with observations. This course is intended for graduate students who are interested in space science and astrophysics.

Content:

- Introduction/Overview: Solar Physic and Space Weather
- Maxwell and MHD Equations
- Magnetic Field 1: potential and force free field, helicity
- Magnetic field 2: 3-D morphology, null points, separators
- Magnetic reconnection 1: current sheet
- Magnetic reconnection 2: Magnetic annihilation
- Magnetic reconnection 3: Steady reconnection
- Magnetic reconnection 4: unsteady reconnection
- Solar application 1: classic models of flares and CMEs
- Solar application 2: state-of-the-art models of flares and CMEs
- Heliosphere and solar wind
- Shock and particle acceleration
- ICMEs and magnetic clouds

Homework: There will be weekly assignments.

Project: Students are required to conduct two research projects that involves in-depth physics, advanced data analysis, intensive computation and literature study. The following two projects are

suggested: (1) calculating coronal magnetic field using PFSS model, and (2) CME tracking based on STEREO observations and 3-D magnetic field configuration

Exams: one midterm and one comprehensive final exam

Grades: Homework (25%), Projects (25%), Midterm (25%), Final Exam (25%)

Class URL: http://solar.gmu.edu/teaching/2010_CSI769/

Text Book (required):

- "Magnetic Reconnection – MHD Theory and Applications", Eric Priest and Terry Forbes, Cambridge University Press, ISBN 0-521-03394-2, 2000

Supplement Reference Books:

- "Physics of the Solar Corona", Markus J. Aschwanden, Praxis Publishing, ISBN 3-540-30765-6, 2006
- "An Introduction to Plasmas and Particles in the Heliosphere and Magnetospheres", May-Britt Kallenrode, 2004
- Online resources

Computational Tools:

- IDL programming language, SSW software package, PFSS model, and GCS model
- NASA Community Coordinated Modeling Center: http://ccmc.gsfc.nasa.gov/