AS 786: The Sun and Heliosphere Course Perspective and Syllabus Fall 2014

Instructor: Professor Merav Opher
Office: CAS Rm 514F; tel: 8-6385, e-mail; mopher@bu.edu
Time: Tuesdays 11:00-12:30 and Thursday, 11:00-12:30
Place: Room CAS 502
Office Hours: Monday 3-4pm; Thursday's 3-4pm or by appointment.
Text: A guide textbook is. I will follow mostly articles/papers that I will give in class.
1. Heliophysics: Space Storms and Radiation: Causes and Effects ; Cambridge University Press. Edited by: Carolus Schriver and George L. Siscoe, Boston University [web link for that:
http://www.cambridge.org/gb/knowledge/isbn/item2713616/?site_locale=en_GB]

Books in Library Reserve:

2. Introduction to Plasma Physics with Space and Laboratory Applications" by Donald A. Gurnett and Amitava Bhattacharjee

3. Principles of Magnetohydrodynamics" by Hans Goedbloed and Stefaan Poedts

4. "Plasma Physics for Astrophysics" by R. M. Kulsrud

Course Objectives and Scope: The Sun and the Heliosphere is a centerpiece of astronomy and our nearest star and its wind available for detailed study. We have developed a detailed understanding the solar interior and nucleosynthesis, and we have an emerging but spotty understanding of the solar dynamo, the 11-year solar cycle, the energy sources and acceleration of solar wind, the evolution of solar magnetic fields, release of coronal mass ejections, and acceleration of flares and other energetic particles accelerated at shocks near the Sun and in the interplanetary medium. We have begun the process of connecting our remote observations of the Sun with *in situ* measurements from spacecraft on orbits in geospace and throughout the solar system. The coming decades promise to continue our rapid advances in understanding the Sun, generation of solar wind and transient events, its influence over geospace and the planetary environments, and our solar wind's interaction with the local part of the galactic medium that surrounds our solar system.

AS786 covers the fundamentals of Solar and Heliospheric Physics. The way that this course will be tailed will be to overview some important aspects of the solar and heliospheric such as reconnection; acceleration and transport of particles; and shocks. These concepts will be studied with application to solar and heliospheric phenomena such as coronal mass ejections; flares and interplanetary shocks. The course will cover several aspects in plasma physics with application to the Sun and Heliosphere. Solar topics include the Sun's atmosphere, corona, magnetic fields, solar wind sources, flares and coronal mass ejections. Heliospheric topics include solar wind acceleration and composition, turbulence, shocks, particle acceleration, solar energetic particles, the termination shock, anomalous and galactic cosmic rays. The course also makes the connection from the Sun to other stars, and from the heliosphere to other astrospheres.

Evaluation will consist on problems sets that will test the quantitative understanding of the concepts and a research proposal to be developed throughout the course (explained bellow).

Course Requirements
Attend all lectures
Complete problem sets

Complete group project proposal on a topic of your choice, approved by instructor

1. Write an Announcement of Opportunity (AO) (Due October 02) (due by all in the class)
2. Group Project pre-proposal: a brief description of the topic, with an initial annotated bibliography of the relevant literature, and references to appropriate models (Due October 23)
3. Group Research proposal (Due Date TBD)
4. Group Project may utilize models run with the CCMC
5. Class presentation (Date TBD)

Course Credits and Grading:

Write-up of the AO	5%
Project Pre-Proposal	5%
Presentation	25%
Final Research Proposal	30%
Homework Sets	35%

Course Outline

*note that we will miss classes: Sept 9/11/25;

Note Oct 14: is official BU Monday no class

We will make up for these classes on date TBD – we will discuss it during the first class

Planned *Sc**hedule***		*Reading*
Week 1 (Sep 2/4)	Corona Coronal Magnetic Fields Coronal Heating and Solar Wind Sources	*Selected reading*
Week 2 (Sep 16/18)	Flares Observations of solar and stellar eruptions, flares and jets	*Ch. 5 [space storms..]*
Week 3 (Sep 23)	Coronal Mass Ejections; Theoretical Models	*Ch. 6 [space storms..]*
Week 4 Sep 30/Oct 2	Coronal Mass Ejections; Theoretical Models	*Ch. 6 [space storms..]*
Week 5 Oct 7/Oct 9	Shocks – review major aspects; Rankine Hugoniot conditions; Acceleration in Shocks	*Ch. 7 [space storms..];* *Ch. 7 [Intr. Plasma Ph..]*
Week 6 Oct 16	Shocks – review major aspects; Rankine Hugoniot conditions; Acceleration in Shocks	*Ch. 7 [space storms..];* *Ch. 7 [Intr. Plasma Ph..]*
Week 7 Oct 21/Oct 23	Acceleration in Parallel Shocks Acceleration in Perpendicular Shocks	*Ch. 7 [Intr. Plasma Ph..]*
Week 8 Oct 28/Oct 30	Applications of particle Acceleration: Shocks near the Sun, Interplanetary Shocks, Outer heliosphere	*Ch. 8 [space storms..]*
Week 9 Nov 4/Nov 6	Energetic particle Transport with applications	*Ch. 9 [space storms..]*
Week 10 Nov 11/Nov 13	Reconnection	*Selected Reading*
Week 11 Nov 18/Nov 20	Reconnection – application to CMEs; Outer Heliosphere	*Selected Reading*
Week 12 Nov 25	The Interstellar Interaction Galactic Cosmic Rays	*Selected Reading*
Week 13 Dec 02/Dec 04	The Termination Shock Anomalous Cosmic Rays	*Selected Reading*
Week 14 Dec 9/Dec 11	Group Presentations (2 per class)	*Selected Reading*

NOTES

Group Presentations:

All groups and students must present their proposal to the class. These are either group or individual projects so each student should present a different part of the project. Students should include background, design, rationale and justification for funding of their study. Students must meet briefly with the instructor prior to the submission of their pre-proposal to ensure that the topic is appropriate for the course.

Proposals:

Each group or individual will prepare a research proposal and submit the proposal to the class. During the class we will discuss proposals and several examples will be provided. There may be opportunities to submit these proposals to NSF or NASA for funding, if there is interest in pursuing the projects after the course. Therefore, some thought should be given to the proposal team, funding opportunities and the afterlife of the project. The final project should include one or more of the following topics that will be covered in class: (a) Coronal Mass Ejections; (b) Acceleration of Particles; (c) Transport of Particles; (d) Reconnection; (e) Outer Heliosphere

Proposal Review:

Toward the end of the semester (likely during finals week), we will meet in a group to discuss and evaluate the class proposals. We will organize this as a mock review panel. Before that I will distribute criteria as panels in NSF/NASA review proposals. Members of a project/proposal team will be dismissed from the panel during the discussion of their proposal.

Lectures:

Lectures are designed to introduce the import concepts in solar and space physics, and help clarify information presented in the text and supplementary readings. Failure to attend regular and guest lectures will seriously compromise opportunities for gaining the full benefits of this course and will likely affect student performance on exams.

Problems Sets:

The problem sets will be given approximately every two weeks (on Tuesday) due the following Tuesday when the solutions will be given. The problems sets should be solved in the same group as chosen for the proposal review. Students from each group will be chosen randomly by the professor to present in the first 10 minutes of the class the rational for the solution of the problem.

Late Policy

Late homework will not be accepted.

Notes: Monday, September 15: Last day to add a class. Earlier "add" deadlines for some courses—e.g., foreign languages—are noted in the University Course Schedule.
Monday, October 6: Last day to drop a course without a W.
Friday, November 7: Last day to drop a course with a W. After this date, students may not drop your course.