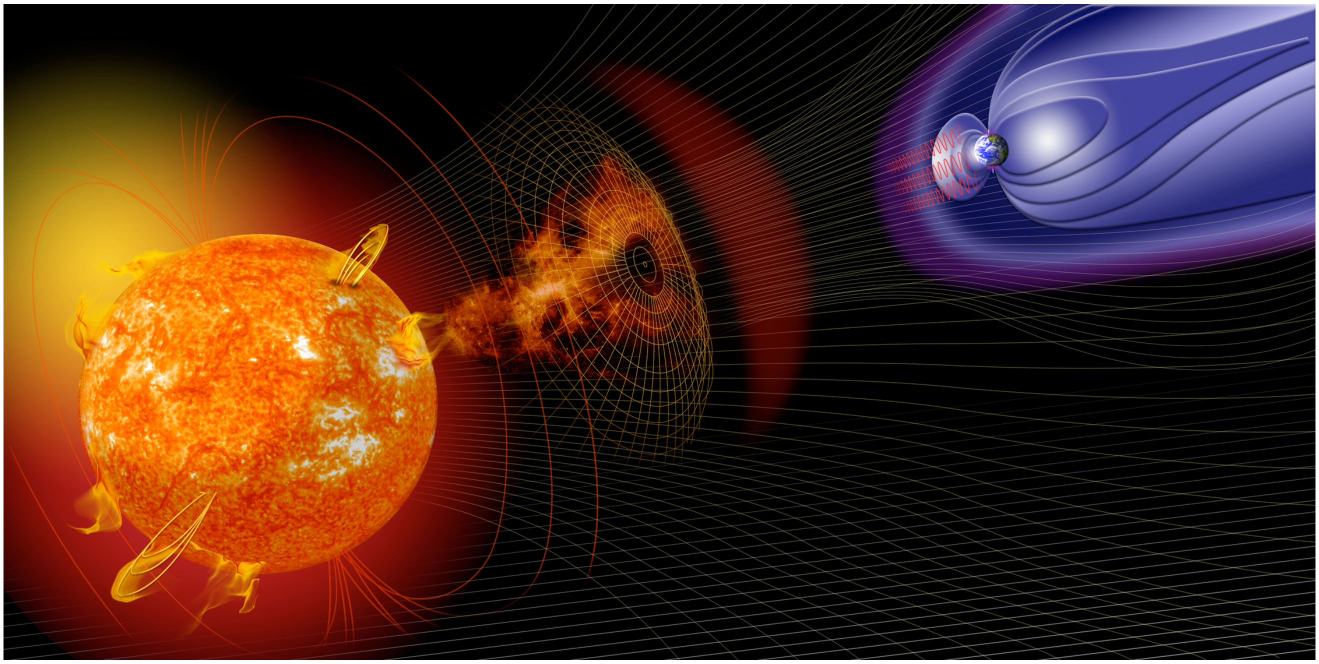
ASTR 670: Heliophysics
(also cross-listed as PHYS-597)



Overview

The heliosphere is defined as everything from the Sun's core beyond the planets, to its outer realms, as it was, it is, and ever will be. We'll not aim for such as lofty a goal as explaining all of that; instead we will focus on a few key concepts which will assist you in developing an understanding of the heliospheric structures and their temporal evolution. We'll do everything in a generalized format, so although this course will be directly useful to any graduate student thinking about research in solar physics, stellar physics, planetary science or exoplanets, the concepts will also directly useful to graduate students studying any astrophysical plasmas and using concepts of magnetohydrodyamics,

Much of this work will be investigated by active learning. So bring a pencil, a piece of paper and your brain. Indeed, as in all graduate courses, you'll find that the skills you will practice to do the learning objectives will probably become the most useful and transferrable skills you may obtain during your PhD.

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Learning Objectives

By the end of this course you will be able to

• Manipulate the equations of electromagnetism for any astrophysical plasma, and thereby predict the behavior of any plasma under specific conditions.

• Use the equations of electromagnetism to explain temporal and spatial size scales throughout the heliosphere.

• Interpret the role magnetism plays in both the storage and release of energy in plasmas.

• Analyze the effect and impact of solar particles and radiation on Earth, and at other planets.

• Design image processing and feature recognition algorithms to extract features from solar data, and justify the data-driven approach to science.

• Design effective exam questions of your own.

Topics

This course will consist of a series of 4 units - Solar Plasmas, Active Regions, Magnetic Structures, and Data-Driven Science. The first three units will be approximately 3 week blocks and will be taught in an active learning style. This will involve a lot of in-class activity, working in pairs, and as a group. The final unit is project based, where I will present an overview of simple image processing and feature recognition tools we use in solar physics and provide time in-class for you to design and implement a tool of your own.

For each Unit I will provide you with a list of Unit objectives - these are specific 'doing' tasks that you should be able to accomplish by the end of the Unit. The lecture notes I give you, and the mid term and final exams, will be closely aligned to these Unit objectives.

Assessment

Your final grade will be based on the following elements
Exams: 50%
Three written mid terms during regular class time, one exam for each unit and each worth 10%.
One final comprehensive exam worth 20% (may be oral).
Class reviews tests: 10%
At the start of most classes we will have a short multiple choice review test on the material from the previous day (2-3 minutes, 2-3 questions). You will do this as both an individual and then as a class. Your grade will be 5% your individual component, and 5% your peer-weighted class score.
Projects: 40%
Four projects, one for each unit and each worth 10%

At the end of each of Units 1, 2, and 3 you will select a paper from ApJ, ApJL, A&A, Solar Physics, Nature, or Science published in the previous 5 years which addresses any of the topics discussed in that Unit. Using this you will prepare a short report detailing

1 typed page
(i) The question being studied in the paper,
(ii) The proposed data and method of study,
(iii) The main result of this paper (or, the most relevant result)
1 typed page
(iv) A typical analytical CUME question using this paper, and your proposed solution and grading scheme.

Dates of project submission will be annoyed in class and on canvas and will become part of this syllabus. We will discuss and agree on a grading rubric at the end of Unit 1. Half of the marks awarded will be my grading on your individual project using this rubric. You will also all grade each other's CUME question using the rubric, and the other half of your marks will be the average of the grades you get from the other students.

Unit 4 will consist of a discussion of image processing and feature recognition as applied to solar physics data. We will then discuss several types of solar physics problems which require a data-driven scientific approach and you will select one topic to answer. You will then design and write the code to answer the science question using your personal choice of programming language.

This Unit project report will consist of an oral report (15 minutes) detailing
(i) The science question you are trying to study
(ii) Why it requires image processing and feature recognition
(iii) Your results from your code,
(iv) The interpretation of your results

You will also print out your code, which should be adequately commented such that a fellow graduate student will be able to follow the code even if they do not know the programming language. We will discuss and agree on a grading rubric for this project at start of Unit 4. Half of the marks awarded will be my grading on your individual project using this rubric. You will also all grade each other's work using the rubric, and the other half of your marks will be the average of the grades you get from the other students.

Final Grades

The final grades will be awarded using this following grade system.

A+:	> 97%	A:	90%-96.9%	A- / B+:	88%-89.9%
		B:	80%-87.9%	B-/ C+:	78%-79.9%
		C:	70%-77.9%	C- / D+:	68%-69.9%
		D:	60-67.9%		
		F:	less than 60%		

If your grade falls into one of the overlapping areas (e.g., A- / B+), your grade will be determined by the final exam. An 'I' grade is only possible if the student is unable to complete the course due to circumstances beyond the student's control that develop after the last day to withdraw from the course.

Other Details:

1 Calculators

Calculators are making our society dumber and dumber. You are always welcome to use calculators to check your answer, but all our in-class activities will be worked out without a calculator. This also applies in exams, where an answer graded as and A will provide ample evidence that a calculator was not used in the solution.

2 Prerequisites

You will be able to recognize Maxwell's equations and apply div, curl, grad notation. Some programming language skills are preferred. Communication and listening skills are an essential requirement for this class.

3 Materials

I will draw on material from 'Heliophysics: Plasma Physics of the Local Cosmos: Schrijver and Siscoe', 'Physics of the Solar Corona: Aschwanden' , 'Solar Astrophysics, Foukal', and 'Physics of the Sun, Mullan'. *There is no assigned textbook* and I do not expect you to buy any of these. Feel free to borrow my copies at any time if you would like to. I do not use reading assignments, but I expect you to review the previous day's notes before coming to each class. I will make all the lecture material and class notes available on Canvas.

4 Time and Location

Classes are 3:30 to 4:45 on Monday and Wednesday in Astronomy 119. The first day of class is Wednesday 20th January. Official hours are Wednesday afternoon, 01:30pm to 3:30pm but email me or speak to me after class to ensure I will be in the office at a specific time. Most likely we'll go to a coffee shop for a chat.

5 Policies

Course policies regarding attendance, work load, late work, plagiarism, and time expectations will be agreed on with your input as a class on the first day. A document detailing these will then become part of this syllabus.

Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act Amendments Act (ADAAA) covers issues relating to disability and accommodations. If a student has questions or needs an accommodation in the classroom (all medical information is treated confidentially), contact: Trudy Luken, DirectorStudent Accessibility Services (SAS) - Corbett Center, Rm. 208Phone: (575) 646-6840 E-mail: sas@nmsu.eduWebsite: http://sas.nmsu.edu/

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For more information on discrimination issues, Title IX, Campus SaVE Act, NMSU Policy Chapter 3.25, NMSU's complaint process, or to file a complaint contact: Gerard Nevarez, Title IX CoordinatorAgustin Diaz, Title IX Deputy CoordinatorOffice of Institutional Equity (OIE) - O'Loughlin House, 1130 University AvenuePhone: (575) 646-3635 E-mail: equity@nmsu.edu Website: http://www.nmsu.edu/~eeo/