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Analysing Vector Magnetic Field Data from SDO Mission

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Project Title: Analysing Vector Magnetic field data from SDO mission

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Project Description:

The study of space weather becomes increasingly important in a modern society as scientists realize that our daily life can be much affected by processes occurring a hundred million miles away at the Sun. Indeed, the drivers of almost all space weather concerns can be identified as explosions at the solar surface – solar flares and coronal mass ejections (CMEs) are the two causes of space weather hazard.

At the solar surface, sunspots, which appear to be dark are places where strong magnetic fields reside. Flares and CMEs can erupt from these places. Scientist have been monitoring these spots using both white light and Extreme Ultraviolet (EUV) imaging, as well as measurement of magnetic field for the past several decades. It turns out that the magnetic field dominates the evolution of these spots and these spots can evolve for days before they erupt. Therefore to better understand the eruption, understanding its pre-eruption evolution is important. NASA's SDO mission has the capability to monitor the Sun's magnetic field continuously, therefore making the study of pre-eruption of solar magnetic field possible. **In this project, the student will learn how to analysis SDO vector magnetic field data. S/he will use pre-developed magnetogram Forecast (MAG4) code and other IDL codes to download vector magnetic imaging files, identify neutral line configuration, obtain magnetic field measure; s/he will then classify these results to different categories.**

![Figure 1](image.png)

**Figure 1** Left: Output from the MAG4 code, showing AR threat level (red high, yellow medium, and green low). Right: A deprojected vector magnetogram of an AR, where the positive (white) and negative (black) vertical field abuts, is the neutral line, flares and CMEs erupt from these neutral lines.

MAG4 (Magnetogram Forecast), is a joint UAH/MSFC project developed by Dr Falconer. It is a computer code that downloads vector magnetograms, deprojects vector magnetograms, and analyze magnetic measures, and makes forecast of probability that an active region (AR) will produce a major flare, CME, or Solar Proton Event (SPE). The forecasts are made in Near Real Time (NRT) as well as on
historic data. It creates a database of each AR evolution as it crosses the solar disk. Its data set will be used by the student. An example of MAG4 examination of an AR is shown in Figure 1.

**Student Duties, Contributions and Outcomes:**

The student duty is spelled out in the following steps. In the first week, s/he will meet with the mentors on a daily basis (with > hours per day), learning the data analysis method and get use to the code. Starting from the second week, s/he will perform the necessary data analysis. S/he is expected to meet Dr. Li and Dr. Falconer twice per week. Throughout the project, s/he will work alongside with a graduate student of Dr. Li.

1. Identify active regions of interest from solar flare lists.
2. Collect magnetic field data of these active regions from SDO.
3. Identify the periods of interests.
4. Determine the neutral line of the active regions.
5. Obtain measures of magnetic field (from MAG4 database).
6. Categorize events to different groups according to the measure of magnetic field and the configuration of neutral lines.

The outcome of the project will be a classification of the events based on the magnetic field measure and the neutral line configuration. The classification will be the main contribution of the student. Upon the completion of the project, a scientific publication may be produced from the project. Further continuation of the project into the Fall semester is possible. In which case, the student may be able to attend a conference such as the Fall American Geophysical Union (AGU) meeting.

**Faculty Requirements and Mentorship:**

The prospective student will be supervised by Prof. Gang Li and Dr. David Falconer, both work at CSPAR, UAH. The main supervisor is Prof. Gang Li. In the case the main advisor is absent for attending conferences/workshops or giving summer school lectures, Dr. Falconer will step in as the substitute mentor. One graduate student (Mr. Clayton Allison) will be available at the lab for help. In the first week, the student will closely interact with Prof. Li and Dr. Falconer on a daily basis to learn relevant data analysis procedures. From the second week, s/he is encouraged to talk to either advisors every other day. Every other week, s/he will prepare and present a 1-hour worth presentation to Prof. Li/Dr. Falconer reporting his/her progresses in the past two weeks. A final report is required at the end of the project.

Student Qualification: The project will require certain computer skills and a solid scientific background. Senior and Junior students with a science and/or technology major are encouraged to apply. There is no prerequisite courses the students must have taken. However, knowledge about Matlab, IDL, Python will be helpful.

Clear and careful documentation by the student is required.