

CSI 769 Fall 2010

Solar and Heliospheric Physics

Project: Toward Understanding the Physical Mechanism of CME

Assignment date: Nov. 24, 2010

Project Due Time: 1 PM, Dec. 09, 2010

Presentation: In class, Dec. 09, 2010

1. Introduction

A CME, as observed in a coronagraph, is a large scale structure ejected from the Sun and propagating into the interplanetary space. It originates in the lower corona of the Sun. If the CME happens to pass through the Earth orbit, it may cause severe space weather that disrupt critical human technological systems in space. It is now generally believed that, following the eruption, a CME has the form of flux rope magnetic structure. It is also believed that the kinetic energy of CME comes from the energy released from current-carrying magnetic fields in the eruption region.

However, the physical mechanism of CME remains elusive. What is the pre-eruption magnetic structure of the CME? What is the cause of the onset of the CME eruption? What is the role of ideal MHD instability, such as torus instability and kink instability? What is the role of magnetic reconnection? Following the onset, how does a CME accelerate into a high speed? What about the transformation of the magnetic structure inside a CME during the acceleration phase? What is the relationship between CME and flare? One can further raise many other questions. There are no consensus answer for most of these questions in the scientific community.

2. Description

In this project, you are required to study one scientific paper on the subject of CME and present the paper in class. I am suggesting the following papers for you. I find that these papers are well written and widely referred, and become "classical". Nevertheless, You are free to choose any paper you prefer, as long as the main subject of the paper concerns CMEs.

- **“Disruption of Coronal Magnetic Field Arcades” by Mikic, Z., Linker, J., Astrophysical Journal, Vol. 430, 898-912, 1994**
- **“A Model for Solar Coronal Mass Ejections” by Antiochos, S.K. et al., Astrophysical Journal, Vol. 510, pp. 485-493, 1999**
- **“Onset of the Magnetic Explosion in Solar Flares and Coronal Mass Ejections” by Moore, R. L. et al., Astrophysical Journal, Vol. 552, Issue 2, pp. 833-848, 2001**
- **“Basic Topology of Twisted Magnetic Configurations in Solar Flares” by Titov, V.S., Demoulin P., Astronomy and Astrophysics, Vol. 351, P. 707-720, 1999**
- **“A Three-dimensional Line-Tied Magnetic Field Model for Solar Eruptions” by Isenberg, P.A., Forbes, T. G., Astrophysical Journal, Vol. 670, Issue 2, pp. 1453-1466, 2007**

- **“Onset of Coronal Mass Ejections Due to Loss of Confinement of Coronal Flux Rope”** by Fan, Y., Gibson, S.E., *Astrophysical Journal*, Vol. 668, Issue 2, pp. 1232-1245, 2007
- **“Coronal Mass Ejection: Initiation, Magnetic Helicity, and Flux Ropes. I. Boundary Motion-Driven Evolution”** by Amari, T. et al., *Astrophysical Journal*, Vol. 585, pp. 1073-1086, 2003
- **“Partial Torus Instability”** by Olmedo, O., Zhang, J., *Astrophysical Journal*, Vol. 718, Issue 1, PP. 433-440, 2010

I recommend you read the abstracts of all these papers and choose the one you think best fit your interest.

3. Requirement

The requirement of this project is to make a powerpoint presentation on the scientific paper you choose to study. You need to study the paper thoroughly. During the reading, you may keep the following questions in mind: (1) what does the author(s) try to address (the big picture)? (2) what is the method or approach? (3) how to use the method to make the intended study? what is the main result of the study? (4) what are the limitation of results? For instance, any assumption used in the work, and any caveats resulting from the assumption? (5) what is your personal opinion on the method and the result? (6) Does the work presented in the paper inspire you to make further exploration?

You are required to write a PPT file of the presentation. You need to send me the PPT file by e-mail no later than 1 PM, Dec. 9, 2010.

Your oral presentation is limited to 15 minutes, similar to the duration of a typical conference presentation. Please keep your talking time less than 12 minutes, and leave 3 minutes for discussion. Since there is no enough time to cover every aspect of the paper, you try to limit yourself to the key points of the paper, and make the key points understood to the audience. For a 12-minute talk, the number of PPT slide is about 10.

The grading is based on the clarity of the presentation and the quality of the PPT file.