

Notes on the April 4, 2007, Meeting of the NESSC, BU, 10.30 am to 2.00 pm

Nancy Crooker opened the meeting with a review of papers and authors (listed below) and noted a few changes: the addition of Kelly Koreck to current sheet acceleration paper 4, the merging of papers 7 and 8, the cancellation of paper 9 to be replaced with new paper 13.

1. Comparative reconnection as it bears on the relative roles of microscale and macroscale determinants of local and global reconnection rates: BHATTACHARJEE, Raeder, Dorelli, Korreck. DEFINITION STAGE
2. Proton-electron asymmetry in post-eruption plasmas in the corona and magnetosphere: SPENCE, Schwadron--WRITING STAGE
3. Shock heating and particle accelerations: KORRECK, Raymond, Lee, Moebius, Kahler--DEFINITION STAGE
4. Reconnection and current sheet acceleration: CHEN (Bhattacharjee), Korreck, Chupp, Moebius—LATE DEFINITION STAGE
5. Cooling of plasma in ICMEs and plasmoids: HUGHES and SISCOE (Elliott), Raymond (UVCS), Smith--DEFINITION STAGE
6. CME-plasmoid acceleration and propagation: WU (SCHWADRON), Forbes, Reeves, Siscoe--FINAL RESEARCH STAGE
7. Pre-eruption and eruption processes (e.g., flux cancellation for CMEs and "build-up" or growth phase for substorms) REEVES, Forbes, Lin, Spence, Hughes--DEFINITION STAGE (2nd go around)
8. Post-eruption processes sunward or earthward of the eruption site (flares and auroras, particle heating/energization and injection into closed-field-line volumes): RAYMOND, Korreck, Golub, Spence, Hughes, Reeves, Webb--DEFINITION STAGE
9. Post-eruption presence of magnetic reconnection (ICMEs and plasmoids): CROOKER and HUGHES, Farrugia, Owens, Goodrich, Raeder—CANCELED, replaced by 13.
10. Post eruption current sheets and "blobs": LIN, Cranmer, Raymond, Crooker, Goodrich, Hughes--DEFINITION STAGE (2nd go around--need to include magnetospheric current sheet)
11. Turbulence, waves, fields and plasma structure in ICME and terrestrial magnetosheaths: SMITH, Farrugia, Richardson--DEFINITION STAGE
12. Magnetosheath accretion and ICME shock standoff distance as a function of radial distance: SISCOE, Isenberg, Hughes, Webb, Richardson--WRITING STAGE
13. Flux transport by interchange reconnection in the magnetosphere: Merkin, Crooker, Lyon--NEW, RESEARCH STAGE
14. From AGU special session (so far): Mark Moldwin and Mark Linton; Mihir Desai and David Burgess--?

The following are highlights of discussions of various papers:

3. Heating by shocks and reconnection: Christina Prested will look at electron distribution functions associated with reconnection events identified with Cluster observations to see if they exhibit a unique diagnostic signature to distinguish them from shock acceleration. Steve Kahler noted that even if there is a distinguishing signature, in the solar flare case, it might be lost in the post acceleration transit to 1 AU. Prested will report on progress at next meeting.

4. Reconnection and current sheet acceleration. Message from Li-Jen Chen "Kelly Korreck has agreed to combine HINODE and RHESSI data to look into the question of whether there are energetic electrons within magnetic islands at the Sun (called "tadpoles") during solar flares. If she finds positive results, our paper would be ready to enter the writing stage."

5. Cooling of plasma in ICMEs and plasmoids: Siscoe reported that a paper by Liu et al. already covers the ICME case. Jeff Hughes has provided papers on the earth plasmoid density and temperature. Siscoe needs to convert these into statements about entropy for comparison with the ICME case.

6. CME-plasmoid acceleration and propagation: The simple analytical comparison of acceleration and motion between ICMEs and plasmoids is done. Pin Wu is going to do for the plasmoid case an analysis of forces and acceleration like she did for the ICME case.

7. Pre-eruption and eruption processes to be combined with 8. Post-eruption processes sunward or earthward of the eruption site: Siscoe suggested applying the following set of principles and categories for separating mechanisms into different types.

1. A universalization principle—if a mechanism cannot be applied to both situations (terrestrial and solar) we do not consider it. Our project is to investigate mechanisms that have a potential to account for macro-scale eruptions (or explosive energy conversions) in solar-system plasmas generally.

2. A prioritization principle—a mechanism that happens automatically in both situations (terrestrial and solar) has priority over a mechanism in which a crucial piece required for its operation must be supplied by different process at the two places because of differences in environmental parameters.

3. A Newtonian requirement: an acceptable mechanism must explicitly identify the force that expels the CME or plasmoid, and by principle 1, it should be the same in both cases

4. Classification based on the role of (rapid) reconnection—cause or consequence

5. Classification based on the mode of operation—macroscale instability or microscale instability

6. Classification based on role of external processes—e.g. the breakout model for CMEs and triggering for substorms.

These were presented as preliminary thoughts, but principle 2 would seem to rule out mechanisms that operate by a microscale instability since these usually require specific thresholds at which the instability initiates and such thresholds depend on solar and

terrestrial environmental parameters, which are very different. It might be that two different micro-instabilities will kick in to initiate the eruptions that characterize the two places (CMEs and substorms), but a mechanism that can get by with the same instability operating in both places merits first attention. This puts top priority on macro-instability mechanisms. Principle 3 provides the obvious candidate—an instability in which a net outward force appears acting on an incipient CME or plasmoid. The work of Wu and Siscoe shows that once a net outward force appears, the subsequent dynamics can be explosive (but because of tethering does not have to be explosive). The flux-cancellation and flux buildup phases of CMEs and substorms provide contexts in which to embed the Newtonian requirement. Wu has shown that it operates in the CME case and she is studying the plasmoid case in connection with paper 6. Kathy Reeves could check to see whether the Newtonian requirement works in the Forbes et al. model. A significant test of Newtonian instability (to give it a name) as being the mechanism that accelerates plasmoids would be to see whether it happens under the condition that is known to trigger substorms—a northward turning of the IMF after sufficient flux buildup. The issues were discussed as leading to things to do before the next meeting.

10. Post eruption current sheets and "blobs": John Raymond reviewed the phenomenology of blobs in sheets trailing CMEs and noted that current thinking, developed in a recent paper by Lin et al., is that a tearing instability operates in the sheets to produce flux islands and these are the visible blobs. Chuck Goodrich suggested an alternative possibility of multiple mini-CMEs following the main one based on analogy with driven substorms in the magnetotail as simulated by the LFM global MHD code in which a series of plasma blobs follow a main substorm as long as strong driving continues. A movie of the phenomenon was shown. Raymond noted that some of the post-CME blobs appear to form in place like tearing islands, but others in which the plasma can be shown to be relatively cold might arise from low in the corona, like mini-CMEs. Goodrich agreed to pursue the analogy further by preparing more diagnostics on the mini-plasmoids. Raymond will try to find examples of blobs that might be of the mini-CME type.

11. Turbulence, waves, fields and plasma structure in ICME and terrestrial magnetosheaths: John Richardson reported that this group is going to meet on Tuesday, April 10, to discuss which of many possible topics they will pick to pursue as part of the joint NESSC project.

12. Magnetosheath accretion and ICME shock standoff distance as function of radial distance: Siscoe reported that the paper on this topic is well along. It will present the following three main results based on comparisons of MHD simulations of earth's magnetosheath and an ICME using the BATSRUS and ENLIL-CONE models at CCMC

1. The deflection speed is smaller than expected based on the speed of the leading edge of the ICME.
2. The deflection of the solar wind near the nose of the ICME is not enough to allow it to flow around the ICME; instead the solar wind there accretes along the face of the body as the ICME propagates out.

3. The ICME sheath is generally thinner than expected based on the radius of curvature of the ICME and the Mach number of the ICME relative to the solar wind.

Matt Owens warned that the smaller than expected deflection speed in the ICME sheath found with the CONE model might be an artifact of the low resolution of the model as implemented at CCMC. Since then Dusan Odstrcil has agreed to re-run the model with higher resolution. Results will be reported next time.

13. Flux transport by interchange reconnection in the magnetosphere: Slava Merkin used an LFM global magnetosphere simulation to show how interchange reconnection operating in earth's magnetosphere can cause open field lines to jump or "saltate" from one side of the polar cap to the other without moving across it. Discussion centered on how to make the demonstration of this interesting effect clearer. A meeting the next day of interested persons arrived at an idea of how to do this. Results will be presented next time.

The next meeting of the NESSC is tentatively set for Wednesday, May 2, at the Center For Astrophysics.

Submitted by  
George Siscoe