To: Kazunari Shibata
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Subject: Summary of the CAWSES-II TG 3 meeting organized on July 15, 2010 by B. V. Jackson

Below is my summary of the meeting. Any error, imprecision is purely my fault.

The meeting focused on techniques to derive 3-D properties from observations of CMEs. Brigitte Schmieder, Pascal Démoulin, Noé Lugaz, Munetoshi Tokumaru (by Bernard Jackson), Bernard Jackson and Cristina Mandrini presented their works and that of their collaborators.

1) B. Schmieder discussed the ejections of November 20, 2003, in fact 2 homologous/sympathetic flares and ejections and a filament ejection. There is some in-situ data on November 22, 2003 at 1 AU, which might correspond to a magnetic cloud (MC) but it is of very short duration (1 hour) and might either be associated with the sheath or with a different structure. She presented 3-D IPS reconstruction on November 23 made by P. Manoharan. These seem to show a loop-like structure propagating North of the ecliptic approximatively towards Earth. Discussion focused on whether or not this was associated with the November 20 flares and CMEs. LASCO images show a south-eastern deflection of these 2 CMEs on the 20. This appears to indicate that the IPS reconstruction corresponds to another ejection, possibly a disk centered ejection from November 19, which was deflected to the North-East (some work in preparation and some work published in Kumar et al., ApJ, 710, 2010)

2) P. Démoulin presented his work done in collaboration with S. Dasso about MC expansion. The expansion is found to be controlled by the drop with distance of the solar wind pressure. He emphasized the difference between isolated CMEs and CMEs which have been/had been overtaken by a fast stream or another CME. The expansion is found to be around 0.7 (i.e. the size of the cloud is proportional to distance to the power 0.7) for isolated CMEs based on theoretical work and the analysis of Helios and Ulysses data. For overtaken CMEs, there is, at first, a lower expansion (smaller index, in 4 cases, even negative, corresponding to contraction) followed when the shock has exited the MC by a faster expansion (up to values of 2). 2.5-D MHD simulations by Xiong et al (JGR, 2006 & 2007) were presented, showing similar results. It is possible, in particular, to compare an isolated CME, with the same exact CME overtaken by a shock at different stages of its interaction. For the simulation, the over-pressure of the sheath must be taken into account because the CME is added out-of-equilibrium at 0.1 AU, but once this is done, the results are consistent with the previous analysis. No shock strength information is available because of the limited spatial resolution (work published in Gulisano et al, A & A, 509, 2010 & Démoulin & Dasso, A & A, 498, 2009)

3) N. Lugaz presented work to use 3-D MHD simulations to test analysis methods. An example was given for CME mass which can be derived from coronagraphic observations. Using a simulation and producing synthetic coronagraphic images taking into account the Thomson scattering, it was found that the mass can be underestimated up to a factor of 2

in C3 field-of-view for a limb CME. Then, the example of the January 24-25, 2007 CMEs was presented. STEREO had a 20-hour data gap and a 3-D MHD numerical simulation was used to determine the origin of 3 tracks observed in HI-2 after the gap. Techniques to present results (running difference, J-mapping) must be carefully understood because of the possible loss of information. Line-of-sight integration can result in multiple density structures contributing to the signal from the same pixel, especially during CME-CME interaction. Discussion focused on the simulation procedure, the deformation of CME fronts and whether or not there is good agreement between the simulation and the observation. Vignetting issues in LASCO images must also be kept in mind (work published in Lugaz et al., ApJ, 627, 2005 and Lugaz et al., ApJL, 684, 2008)

4) B. Jackson presented M. Tokumaru's IPS reconstruction technique. He explained the basics of the method: about 40 radio sources, here at 327 MHz, are observed, and it allows us to measure the density perturbation at different locations in the sky. Then, different CME shapes can be fitted to these observations to give the CME 3-D structure. This technique has been developed 15 years ago and is still being fine-tuned, and many CMEs have been analyzed. Examples of different CME shapes (shell and loop) were shown for different observations. For one particular CME, comparison with SMEI reconstruction is indicative of very consistent results between the 2 techniques. Discussion focused on the use of different frequencies (80 MHz may have some contribution from the ionosphere), the number of available radio sources to observe, the scale-length of the density fluctuations being measured and the possibility the density change comes from other structures than CMEs (solar wind, etc...) (work published in Tokumaru et al., 105, JGR, 2000 and Tokumaru et al., JGR, 112, 2007).

5) B. Jackson presented work based on 3-D reconstruction of CMEs from SMEI data. SMEI onboard Coriolis was launched on 2003 and has observed 100s of CMEs. The satellite's design is such that a map of the whole sky is done about every 100 minutes by the 3 cameras. 3-D reconstruction of the density and the speed were presented. The CME 3-D mass can also be estimated from the reconstruction. Discussion focused on one event were the speed enhancement appeared to be ahead of the density enhancement. It was also debated whether a mass enhancement of a factor of 3 between LASCO mass and SMEI mass was expected or whether even more mass enhancement due to pile-up would be expected. (shorter summary due to absence for coffee break). (work published in Jackson et al. JGR, 111, 2006 and in Jackson et al. Advances in Geosciences, 21, 2008 and Jensen et al, Solar Phys., 2010)

6) Cristina Mandrini presented work done in collaboration with Sergio Dasso, B. Schmieder and P. Demoulin about MC reconstruction from in-situ data. Particular focus was on the determination of the MC helicity from different techniques. For a given choice of MC boundaries, all different methods (force-free, non-linear force-free, etc...) give very similar results. A method to derive the helicity without using any model (but assuming circular cross-section and invariance along the cloud axis) was presented and it gives results in very good agreement with the other techniques. Finally, the magnetic flux can be estimated from solar observations and from in-situ measurements and good agreement is found. It is usually also consistent with the flux from dimming regions.

Discussion focused on whether the cloud curvature should be taken into account. The curvature is expected since the flux rope is still attached at the Sun. It was decided that the effect should be minor (especially compared to other factors). One issue with reconstruction from in-situ data is the choice of boundaries. More quantitative methods were briefly discussed (conservation of the axial flux, constraint of divB = 0) to determine these boundaries. In the one instance when the length of a field line inside the MC was derived, it was found to be 2.4 (from the Sun back to the Sun). (work published in 17 papers included Dasso et al., A & A, 455, 2006 and Mandrini, IAU, 264, 2010)

I hope this reflects more or less what was presented today,

Best,

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