# Milestone 10
# (month 14)
# On line Report

### Magnetic helicity trend in active regions generating CMEs

- CNRS developed **new methods for the estimation of errors on helicity and energy** due to violation of the solenoidal property in numerical discretizations of magnetic fields. This topic is of general interest for numerical simulations, in particular also for nonlinear extrapolations that are used to estimate the free energy available for coronal activity (flares and CMEs).

- CNRS, UCT and KU-Leuven worked on a collaborative project on **helicity calculations based on nonlinear extrapolation**. The goal is to identify a CME with an associated magnetic cloud that would be suitable for helicity depletion studies. To this aim, a number of candidates have been considered, but the definite target has not been identified yet, due to the several requirements that the event needs to meet for a proper and reliable analysis. A meeting at Leuven between CNRS and KU-Leuven was useful to make progress on this topic.

- CNRS, KULeuven, INAF, UCL, UCT studied the **variation of the accumulated coronal helicity** derived from the magnetic helicity flux through the photosphere in AR NOAA 10365, where several large flares and CMEs occurred. Full-disk line-of-sight magnetograms taken by MDI/ SOHO were used to measure the helicity flux, and the integral of GOES X-ray flux was used as a proxy of the coronal energy variations due to flares/CMEs. **Using the linear force-free model, the accumulated helicity flux was transformed into a time evolution of the force-free parameter alpha** taking into account flares/CMEs via the proxy derived from GOES observations. This method can be used to determine the value of alpha at different times in the evolution, and it is a possible alternative to the usual matching of field lines with EUV images. The results indicate an inverse correlation between the released energy and the coronal helicity, namely that the higher is the value of the accumulated

coronal helicity, the smaller is the force-free parameter variation required to produce the same decrease in the free energy during the CMEs.

- INAF and UCT investigated the **amount of magnetic helicity injected into the corona through the photosphere in a sample of active regions (ARs)** during their passage across the solar disk. This parameter was measured by inferring the apparent motion of photospheric footpoints of magnetic field lines from a time series of HMI/SDO full-disk line- of-sight magnetograms. The temporal variation of the maps of magnetic helicity flux was analysed by measuring the fragmentation of the patches that were characterized by the flux of magnetic helicity. The results indicate that not only the accumulation of magnetic helicity in the corona, but also its **positive and negative fragmentation and distribution should be taken into account to provide a more confident indication of AR complexity and flare/CME productivity**.

- UCT, INAF, CNRS and KULeuven have collaborated in **reviewing** the most recent papers on **the role played by magnetic helicity accumulation in** the phases that preceed and follow eruptive events such as **flares and CMEs**. The state of the art and the main issues of this topic have been described in the framework of the effects that eruptive events might have on Space Weather.

- UCT, INAF, KULeuven and ROB investigated the **trend of magnetic helicity flux during the phases of formation and successive eruption of flux ropes**. Two active regions were selected (NOAA 11318 and NOAA 11675), observed by HMI/SDO and AIA/SDO since their appearance on the solar disc. Each active region showed a different magnetic field configuration and evolution, leading to the formation of flux ropes visible in the EUV images. Measuring the magnetic helicity flux from the longitudinal magnetic field components in the two active regions, a different behaviour in the accumulation of the magnetic helicity flux, depending on the location of the flux ropes in the active regions, was detected.

Refereed papers

1) Valori, G.; Démoulin, P.; Pariat, E. 2012, Comparing Values of the Relative Magnetic Helicity in Finite Volumes, Solar Physics, 278, Issue 2, pp.347-366, DOI: 10.1007/s11207-012-9951-6

2) Valori, G.; Demoulin, P.; Pariat, E.; Masson, S. 2012, Accuracy of Magnetic Energy Computations, A&A 553, A38

3) Zuccarello, F., Balmaceda, L., Cessateur, G., Cremades, H. et al., 2013, Solar activity across the corona: recent advances, Journal of Space Weather Space Clim. 3, A18

4) Ermolli I., Giorgi, F., Romano, P., Zuccarello, F., Criscuoli, S., Stangalini, M. 2013, Active region magnetic configurations as flare precursors: a case study based on SOHO/MDI and SDO/HMI simultaneous observations, accepted in Solar Physics

5) Valori, G.; Romano, P.; Ermolli, I; Giorgi, F.; Steed, K.; van Driel-Gesztely, L.; Zuccarello, F.; Malherbe, J. M.; 2013, Time evolution of force-free parameter and free magnetic energy in the Active Region 10365, in preparation

6) Romano, P.; Zuccarello, F. 2013, On the role played by the spatial distribution of the magnetic helicity flux, in preparation

Contributions at meetings:

1) Romano, P.; Valori, G.; Ermolli, I.; Giorgi, F.; Steed,K.; van Driel-Gesztely, L.; Zuccarello, F., 2012, Comparison between coronal relative magnetic Helicity and photospheric Helicity Flux in an active Region, poster session 2, ESWW9, Brussels, 5-9.11.2012

2) Romano, P.; Zuccarello, F., 2013, Spatial distribution of the magnetic helicity flux measured with SDO/HMI in active regions hosting flares and CMEs, MemSAIt, 84, 363

3) Ermolli, I., Giorgi, F., Romano, P., Zuccarello, F., Criscuoli, S., Stangalini, M. 2013, Active region magnetic configurations as flare precursors: a case study based on SOHO/MDI and SDO/HMI simultaneous observations, SOHe 2013, Catania

4) Romano, P., Zuccarello, F. 2013, Spatial distribution of the magnetic helicity flux in a flare site, ESWW10, Antwerpein

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