Topic: Magnetic Flux Ropes from the Sun to the Heliosphere

Project Title:
Formation, Evolution, and Eruption of Solar Filaments for a Full Cycle: Simulations Verified by Observations

PI Name: Petrus Martens
PI Email: martens@physics.montana.edu
Affiliation: Montana State University-Bozeman
CO-I(s):
- Anthony R Yeates (Durham University)
- Duncan Hendry Mackay (University of St. Andrews)

Project Information:
We propose to simulate the formation, and evolution up to eruption of solar filaments for the entire solar cycle 23 and the beginning of cycle 24, drive our simulations by magnetogram observations, and compare the results with recently obtained filament metadata.

The novel aspect of this proposal is that we compare our results with systematic filament observations over the same period carried out by the filament detection module AAFDCC further developed by Pietro Bernasconi as part of the SDO Feature Finding Team, headed by PI Martens. This code not only detects, locates and tracks filaments, but also measures their chirality decisively for about half the cases. The filament module has produced filament metadata for the entire cycle 23 and cycle 24 up to now, and we have the most recent version of these metadata available. We will analyze and verify these data in detail.

We will then try to reproduce these results with the flux transport and non-potential coronal magnetic field simulation code developed by Co-I's Mackay and Yeates. This code has been well tested and already reproduces key aspects of filament evolution varying with the solar cycle. In particular it has already yielded a surprising weakening of the hemispheric chirality rule in the descending phase of the cycle, which seems to be borne out by the filament metadata as well.

The scientific relevance of this project is three-fold. First, with the simulations successfully reproducing the formation, chirality, evolution, and eruption of filaments over a cycle we will have made a decisive step towards physical understanding of the filament formation mechanism. Second, the correct moment and location of eruptions together with the magnetic structure are the necessary initial conditions for simulations of the evolution of interplanetary flux ropes, including Earth-directed CME's, and third, successful reproduction of an entire cycle of filament life-cycles from magnetogram data provides a solid basis for future predictive simulations based upon real-time magnetograms, e.g. from HMI.

ROSES ID: NNH13ZDA001N
Duration: 4 years
Selection Year: 2013
Program Element: Focused Science Topic

Citations:

Summary: no summary

Citation: Martens, Petrus C.; Yeates, Anthony R.; Pillai, Karthik G.; (2014), Hemispheric Patterns in Filament Chirality and Sigmoid Shape over the Solar Cycle, Nature of Prominences and their role in Space Weather. Edited by Brigitte Schmieder, Jean-Marie Malherbe and S.T Wu. Proceedings of the International Astronomical Union, IAU Symposium, Volume 300, pp. 135-138, doi: 10.1017/S1743921313010867

Summary: no summary

Citation: Schuh, M. A.; Banda, J. M.; Bernasconi, P. N.; Angryk, R. A.; Martens, P. C. H.; (2014), A Comparative Evaluation of Automated Solar Filament Detection, Solar Physics, Volume 289, Issue 7, pp.2503-2524, doi: 10.1007/s11207-014-0495-9