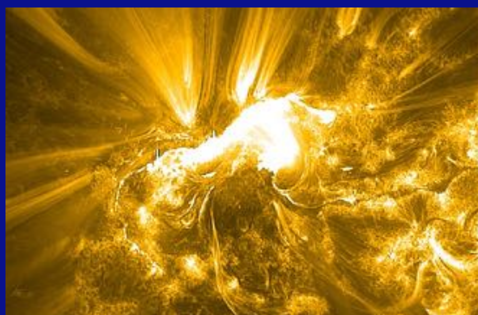
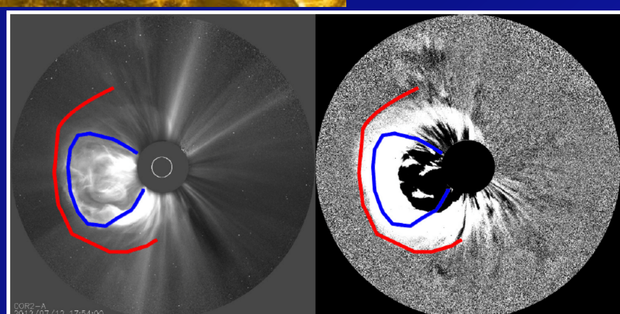
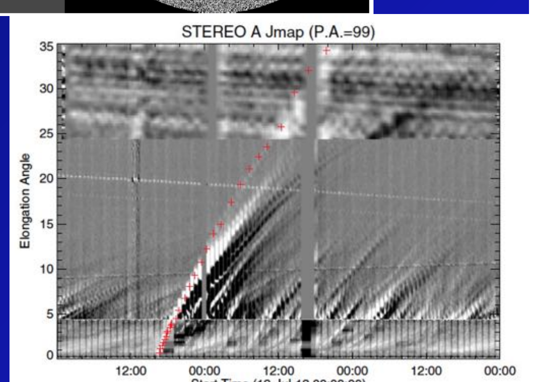
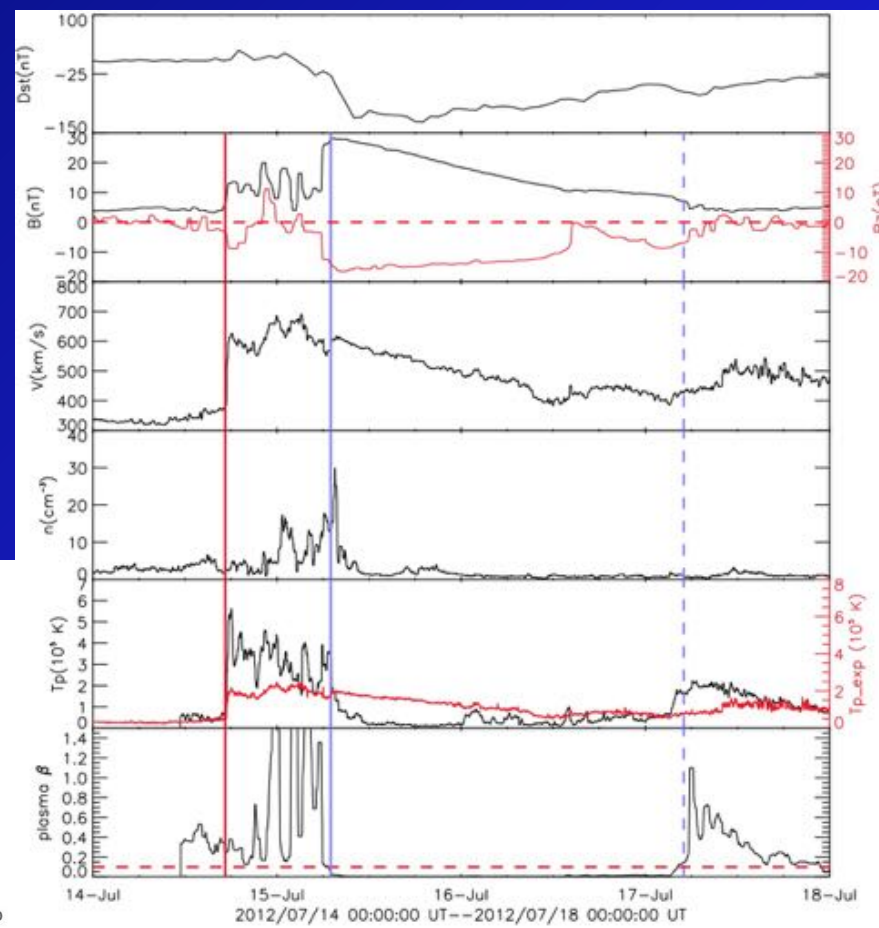
ISEST WG1 Summary: Data Group









WG1 Tasks

1. Identify all Earth-affecting solar transient events, CMEs and CIRs, during the STEREO era (2007 - 2017)

2. For selected events, fully measure, characterize and quantify their evolutional properties from the Sun to the Earth

Summary of Talks

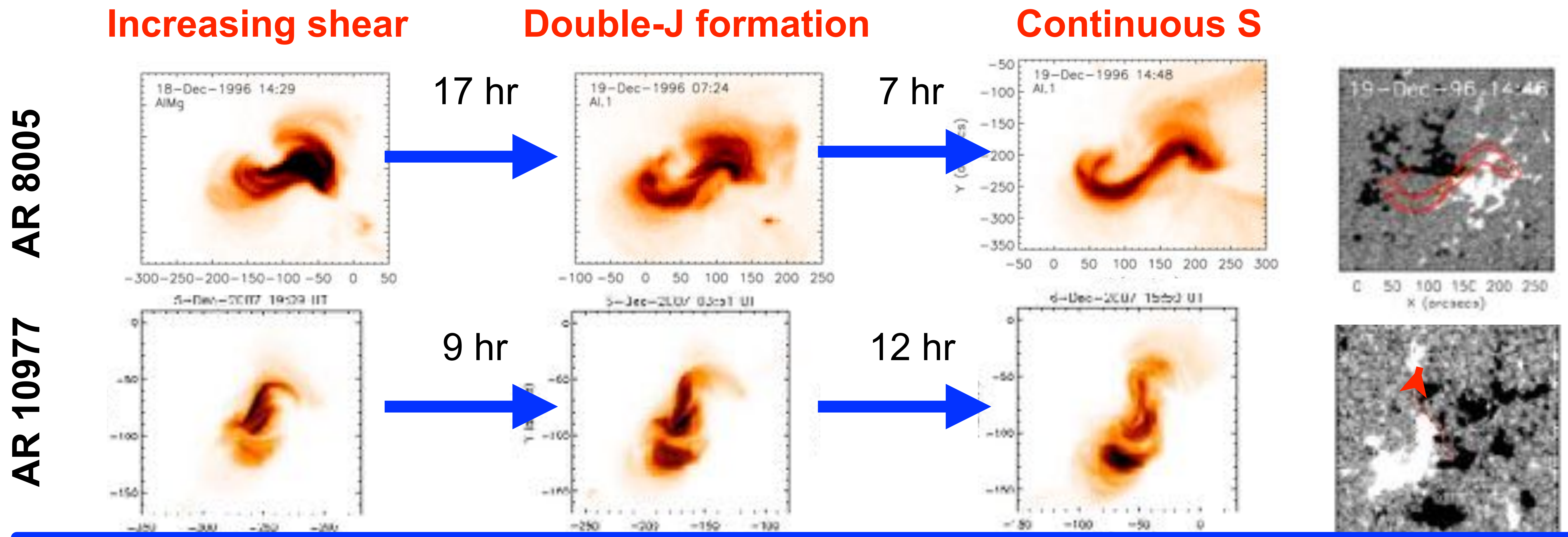
- Invitation talks by
  1. L. Green on magnetic flux ropes in the solar atmosphere,
  2. T. Nieves-Chinchilla on magnetic configuration of ICMEs,
  3. P. Hess on preparing for future of heliospheric observations.
- Six other talks on various issues

Observations of magnetic flux ropes in the solar atmosphere: what next?

Lucie Green
Mullard Space Science Laboratory, UCL

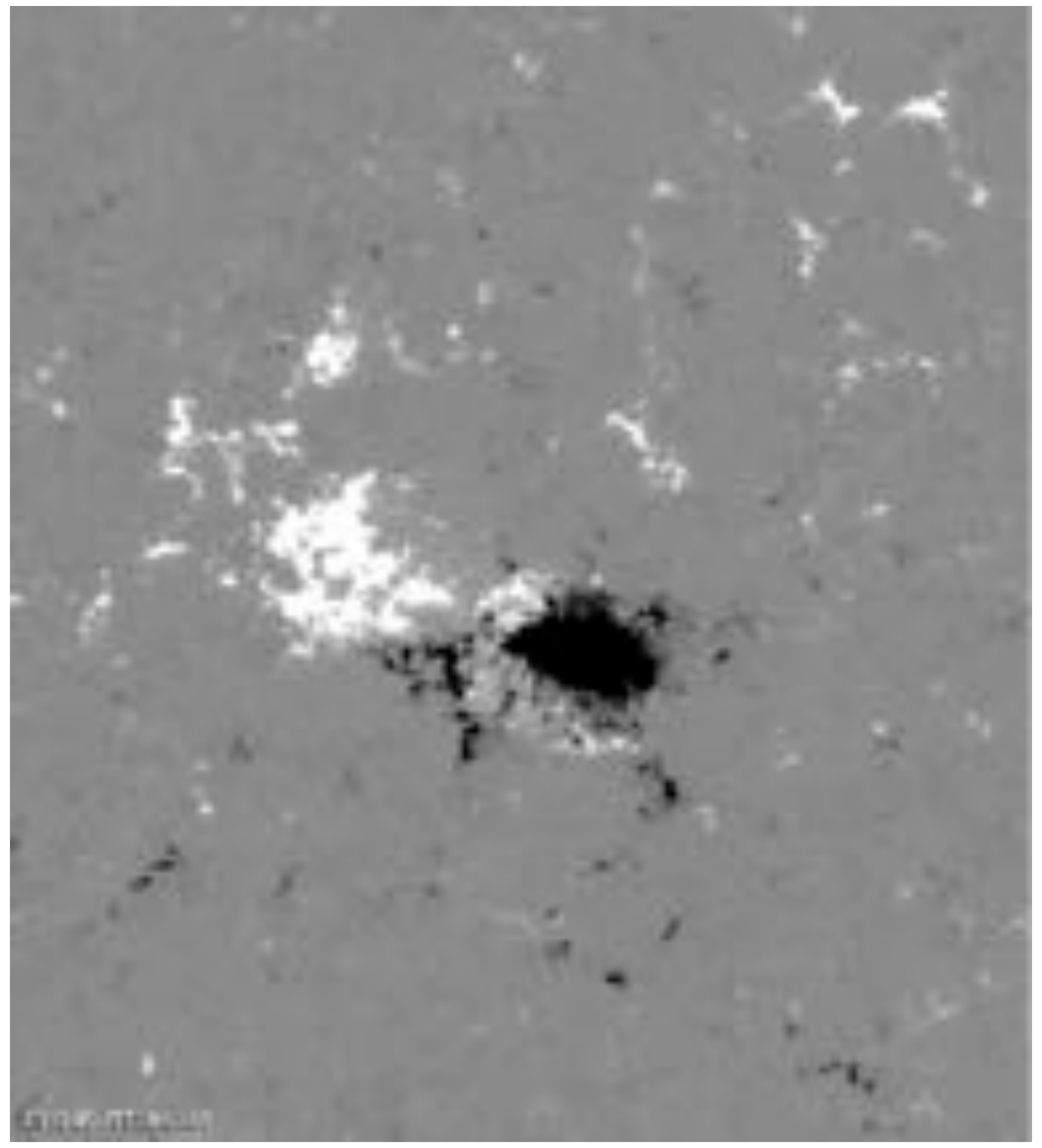
Flux rope formation: flux cancellation & observations

- Evolutionary stages in isolated bipolar regions
- Driven by photospheric field evolution

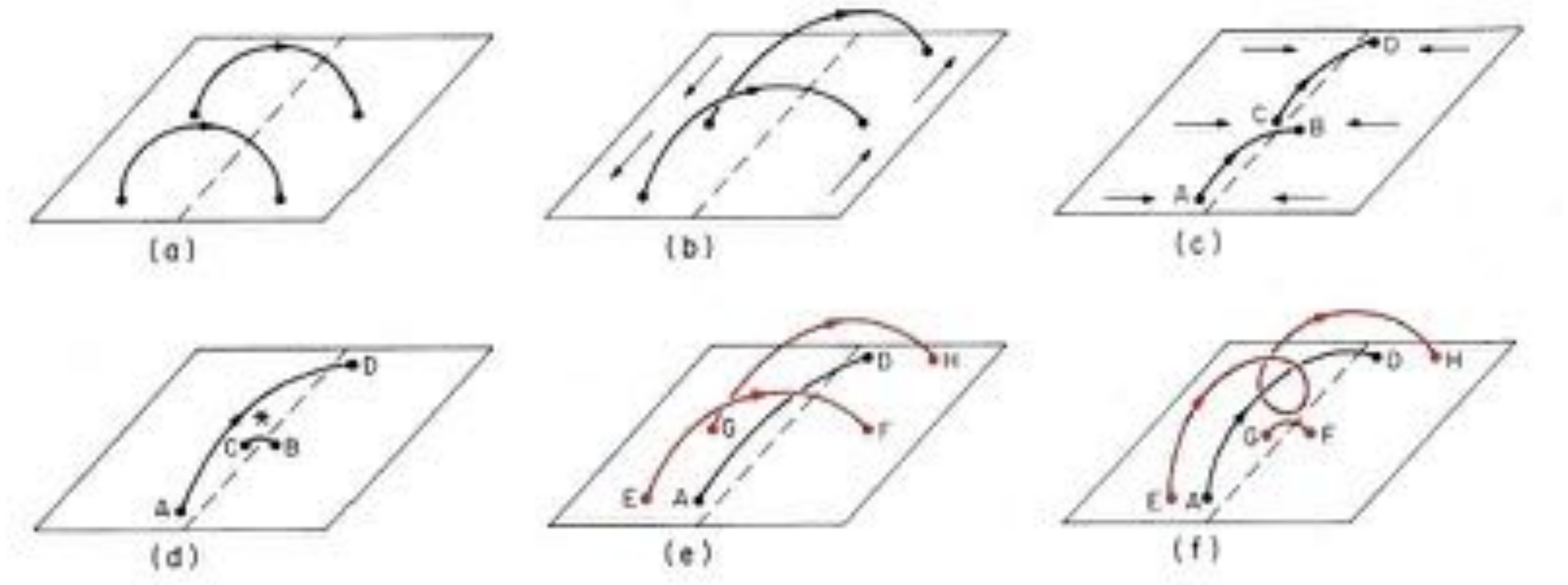


Observations show these flux ropes form on a timescale of ~ few days up to 14 hours prior to their eruption. But sigmoids are only observed in a sub-set of eruptive active regions.

Flux rope formation: flux cancellation

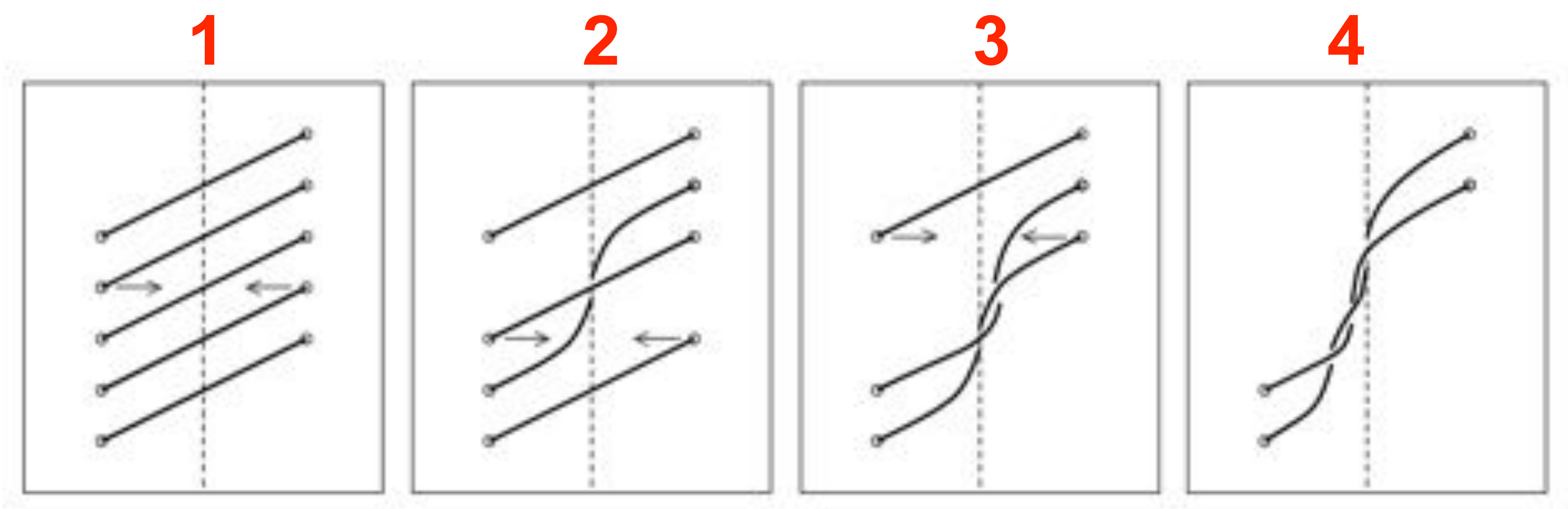


- van Ballegooijen & Martens, 1989
- Slow & ongoing tether-cutting-like photospheric reconnection
- A key mechanism for pre-CME flux rope formation
- The most robustly tested model for flux rope formation?



Modified from van Ballegooijen & Martens, 1989

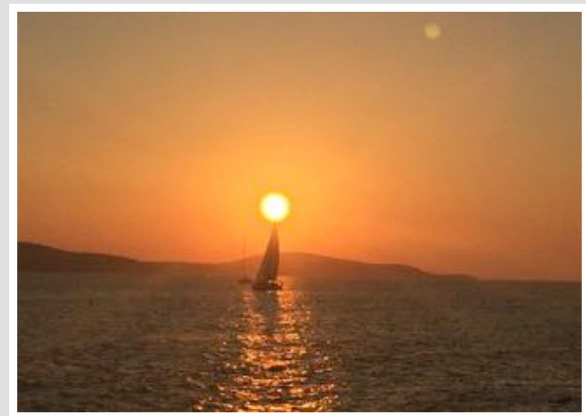
“Added value” of the flux cancellation process



Green, Kliem, Wallace (2011)

- But: cancellation can only create a flux rope from sheared fields, in fact it is concentrating free energy along the PIL (Welsch, 2006).
- The above example shows that only 2/3 cancellations were forming a flux rope out of the sheared arcade.
- Flux in **the flux ropes** amounts to about **60%-70% of the cancelled flux** (Savcheva et al., 2012).

UNRAVELING THE INTERNAL MAGNETIC CONFIGURATION OF THE ICMES



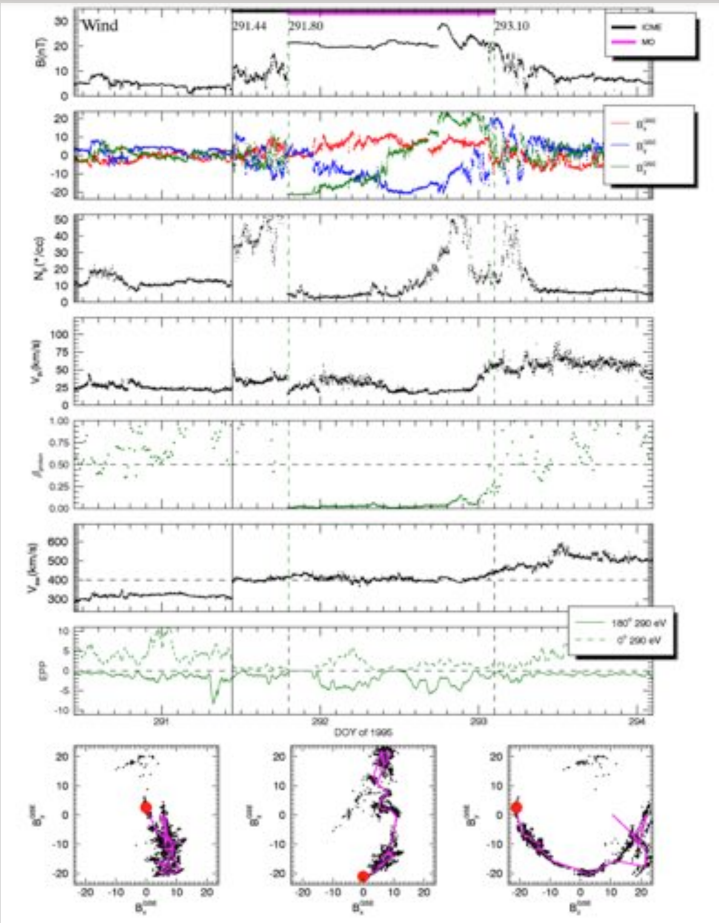
'my annual dose of mediterraneo'
Sunset, Sunday Sept 23 (2018)
Picture by me

Teresa Nieves-Chinchilla
(GSFC-NASA/CUA)

ISEST workshop, September 24-28, 2018. Hvar, Croatia.

Collaborators: L. Jian (NASA-GSFC), L. Balmaceda (GMU/GSFC, A. Vourlidas (JHU-ApL), M. Linton (NRL), N. Savani (UMBC/GSFC), M.A. Hidalgo (UAH)

INTERNAL STRUCTURE WITHIN THE ICMES



Magnetic Obstacles (MOs) vs. Magnetic Clouds (MCs)

Magnetic clouds – flux ropes

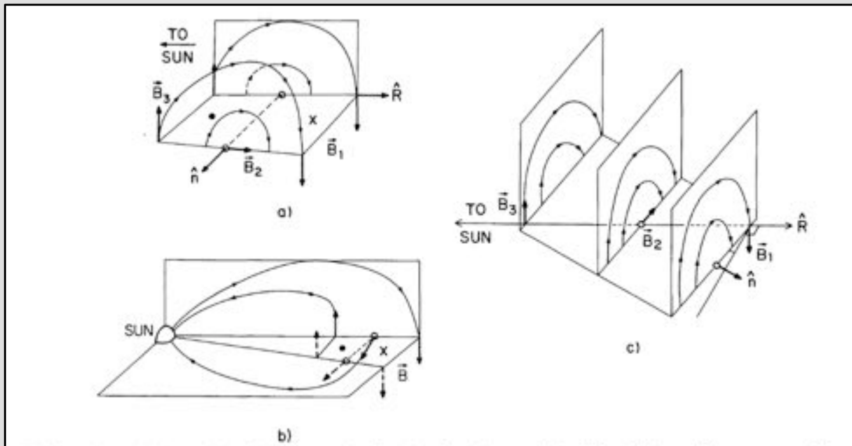


Fig. 8. (a) and (c) possible field geometries for detached 'magnetic bubbles'; (b) possible geometry for extended loops attached to the Sun. The configuration (a) is not admissible because it requires a normal direction and a field orientation that are not consistent with observations (see text).

Burlaga & Behannon, Sol. Phy. 1982.

TAKE-AWAYS

1. **Not every thing that glitters is a flux rope!!**
   - Flux ropes have a solar cycle (SC) dependence.
   - ~80% of the ICME-MOs are flux ropes but just ~45% display signatures of ‘pure’ flux rope.
   - Complex structures and Ejecta occurrence increases during the maximum.
2. **The ICMEs configuration have a solar cycle dependence.**
   - The occurrence of the events with perpendicular axis to the observer increases during the rising phase of the SC.
   - The occurrence of the events highly inclined increases during maximum and declining phase.
3. **The flux rope polarity is not binary but diverse.**
   - Between the Bipolar [NS, SN] and Unipolar configurations there are Hybrid configurations [NSN, NSS, SNN,SNS] that we quantify and describe based on the longitude and tilt.
   - There is a cyclic reversal of the bipolar magnetic field flux rope configuration.

Preparing for the Future of Heliospheric Observations

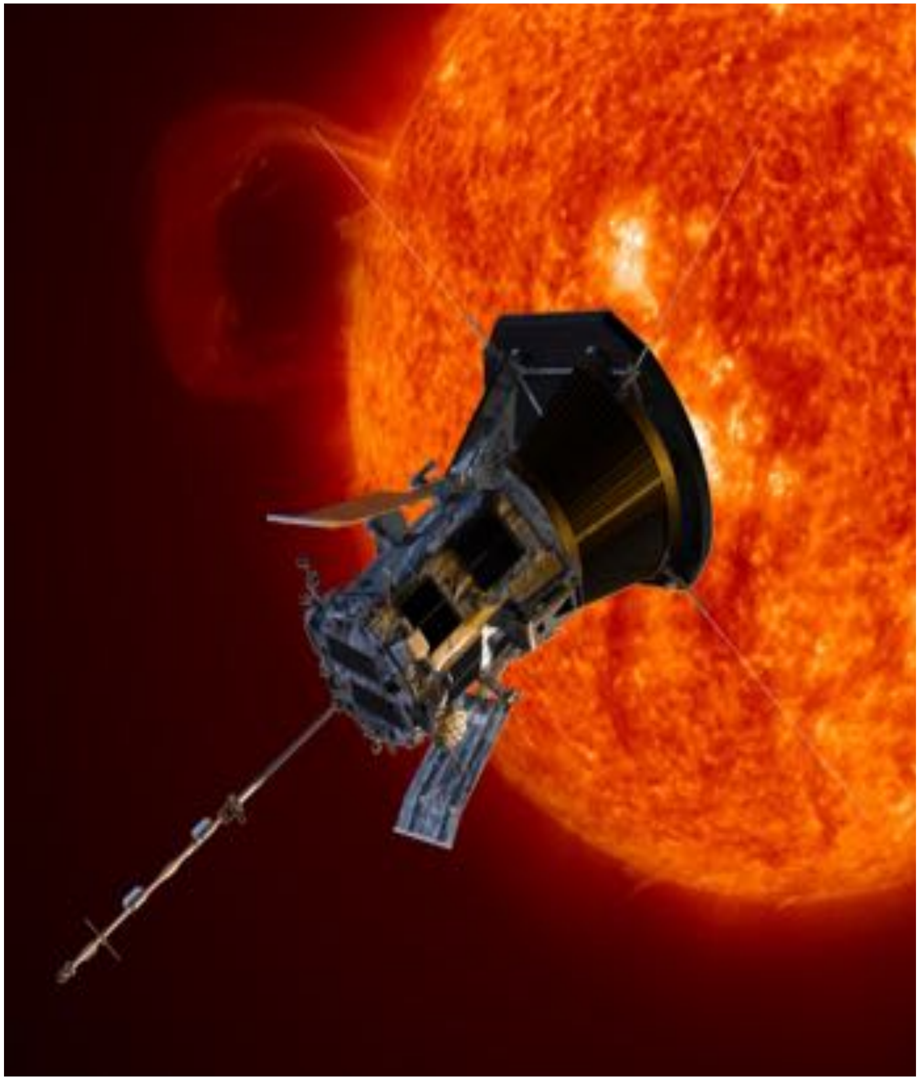
Phillip Hess
NRC Postdoctoral Associate
U.S. Naval Research Laboratory, Washington, D.C.

U.S. NAVAL RESEARCH LABORATORY

DATA IN CYCLE 25

- With the combination of STEREO and SDO, Solar Cycle 24 provided unprecedented remote sensing coverage of the heliosphere
- Multiple viewpoints, extending from the low corona to beyond 1 A.U. allowed for the better imaging of CMEs than ever before
- The upcoming solar cycle will feature far less optimal data availability
- How will this impact our ability to measure CMEs in the heliosphere?

UPCOMING MISSIONS

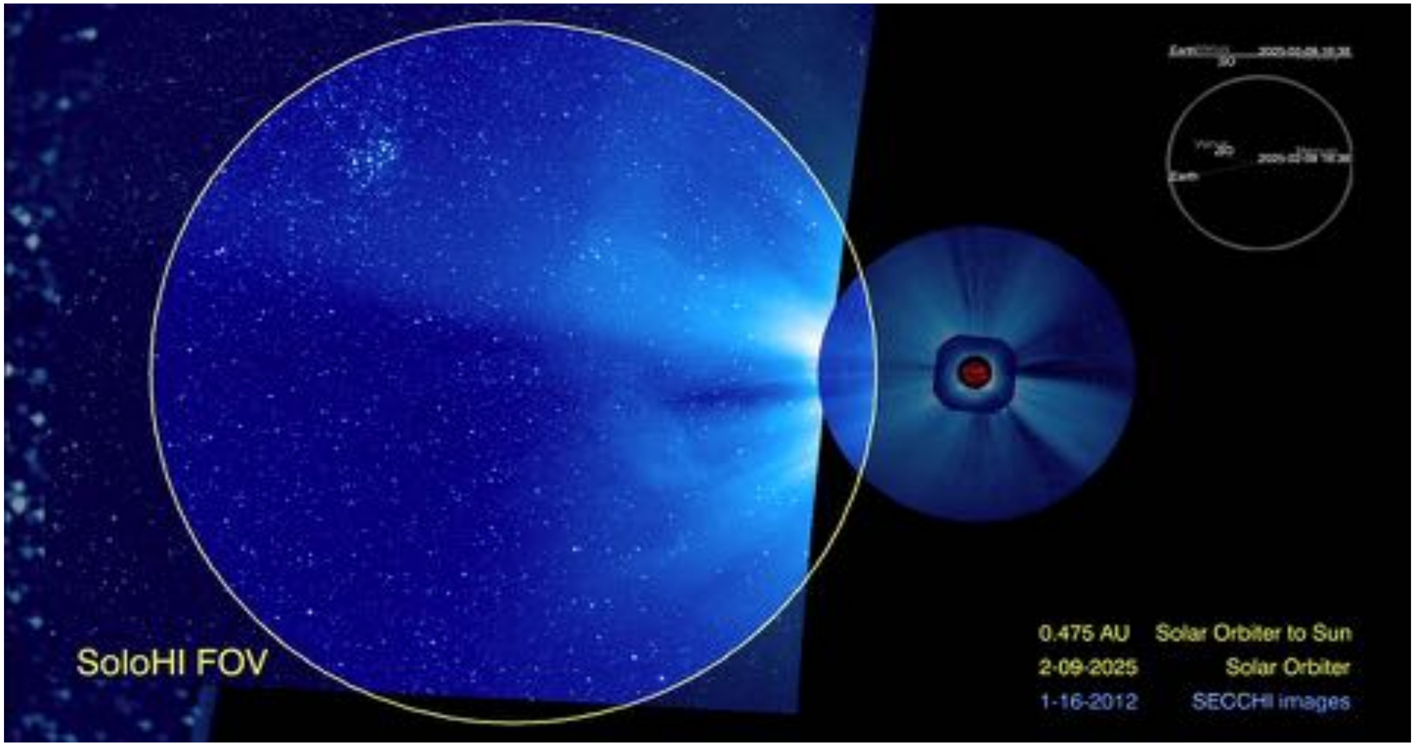


Credit: NASA/Johns Hopkins APL/Steve Gribben

- PSP and Solar Orbiter are going to be extremely illuminating missions for solar and heliophysics
- However, these are encounter missions that will not provide a synoptic viewpoint of CMEs that lends itself to statistical studies
- Much of the WISPR data from PSP will be taken on the backside of the Sun, where any CME that is seen will likely not observed particularly well by any other satellite

SOLAR ORBITER

- The SoloHI instrument onboard Solar Orbiter has similar limitations, but does have the ability to provide an out of ecliptic constraint on the CME longitude



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CONCLUSIONS

- Solar Cycle 25 will almost assuredly have less optimal data for observing CMEs in the heliosphere
- We may be able to do rough approximations of similar techniques used in cycle 24, but this will likely not lead to any real, new insight. At best we will be treading water
- The only way to push our understanding of CMEs forward is to do more with the data we already have
- Better image processing, better models (both for structure and for propagation) can achieve this
- It is important to use the right tool for the right job
- The alignment of spacecraft should allow for a better understanding of CME coherence based on comparison of different in-situ signatures

Evolution of Coronal Cavities leading to CMEs

Ranadeep Sarkar and Nandita Srivastava

[1] Udaipur Solar Observatory, Physical Research Laboratory, Udaipur, India

In collaboration with

Marilena Mierla[2], Matt West[2] and Elke D'Huys[2]

[2]Royal Observatory of Belgium, Brussels, Belgium

Results

We have studied the morphological evolution of an erupting coronal cavity starting from its initiation in the lower corona up to the LASCO C2/C3 field-of-view.

- The height-time profiles for the top of the prominence material and the lower-most part of the cavity almost coincide.
- Up to almost 1.3 solar radii in SWAP field-of-view, the cavity exhibits non-radial motion. After approx. 1.3 solar radii, it maintains same position angle (270^0).
- Up to almost 4 Rsun (LASCO-C2), the cavity morphology is best fitted with an ellipse. In LASCO C3 field-of-view the cavity morphology attains almost circular shape.
- After near about 2 solar radii, the cavity maintains a constant value of aspect ratio (approx. 0.25) and thus exhibits self-similar expansion.
- In the quiescent phase, the cavity centroid height slowly rises from 1.10 to 1.23 R_S during its passage on the visible solar disc from May 30 to June 13, 2010 and its initial circular shaped morphology gradually expanded and evolved into elliptical shape prior to the eruption from the western solar limb.
- The cavity centroid undergoes acceleration after crossing the critical decay index value.

THANKS!!

Identifying the Source Complexity of a Complex Ejecta

Arun K. Awasthi[1], **Rui Liu[1*]**, Haimin Wang[2], Yuming Wang[1], Chenglong Shen[1]

[1]University of Science and Technology of China

[2]New Jersey Institute of Technology

ISEST 2018 workshop, Sep. 24 - 28, 2018, Hvar, Croatia

Conclusion

- Complex ejecta may **inherit complexity** from the source

- Time to start thinking about **internal structure and reconnection** if we are to understand CMEs and to predict their geoeffects.

Awasthi, Liu*, et al. 2018, ApJ

Which factors of an Active Region determine whether a flare will be CME-associated or not?

Christian Baumgartner, Julia K. Thalmann,
Astrid M. Veronig

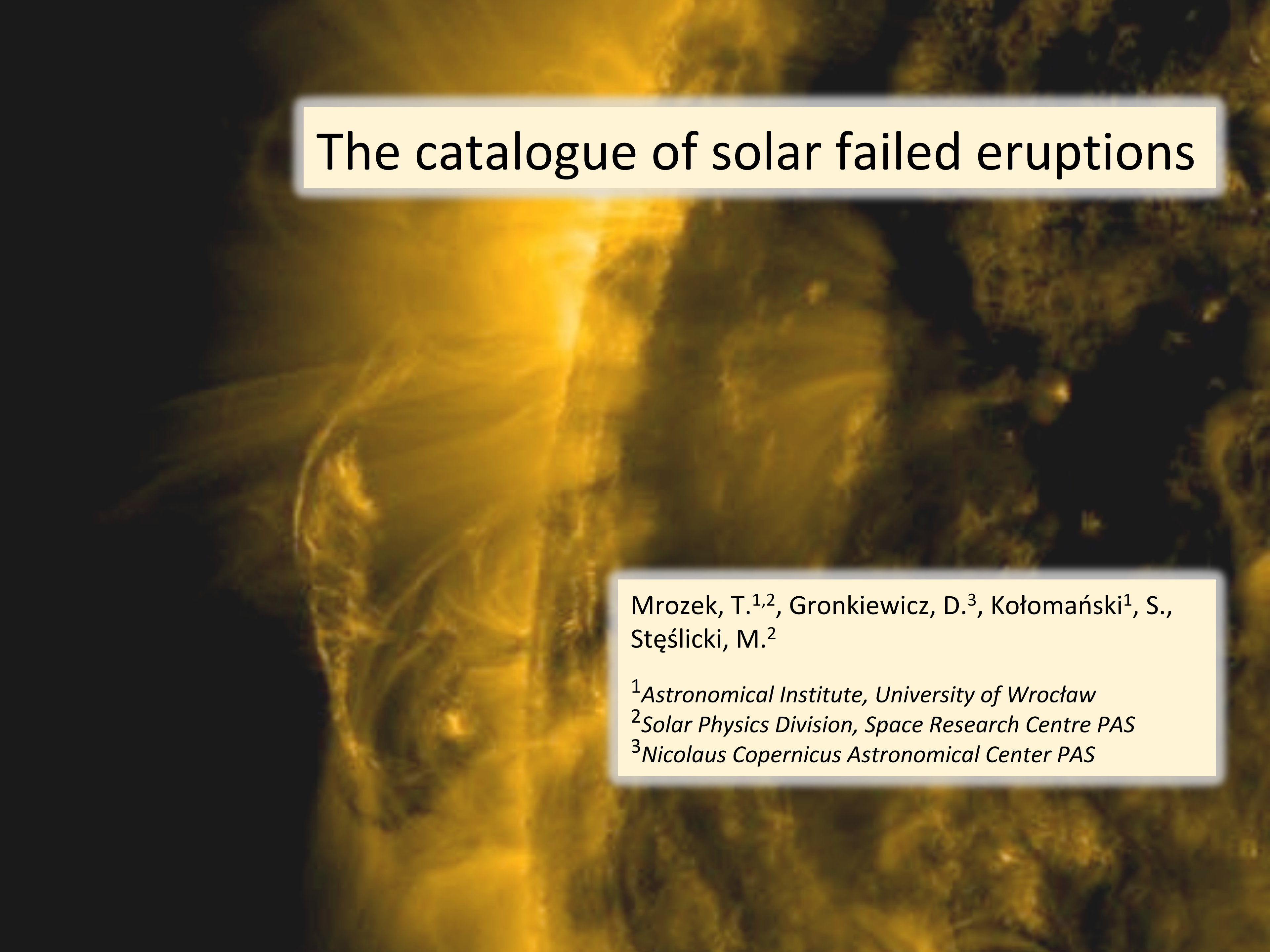
Institute of Physics & Kanzelhöhe Observatory, University of Graz, Austria

Summary and Conclusions

Determining factors for large eruptive vs. confined flares are:

- Vertical decay of the host AR magnetic field above flare PIL: in confined flares, magnetic field decays more slowly (h_{crit} is higher)
- Orientation of flare-relevant PIL as function of height: confined events → quicker adjustment with respect to global AR field
- Flare location within AR:
  Large flares occurring in AR periphery → tend to be eruptive
  Large confined flares: predominatly located close to AR center, below the „dipole field“ of large ARs (consistent with Wang & Zhang 2007)

Study published in: Baumgartner, Thalmann, Veronig, ApJ 853, 105 (2018)

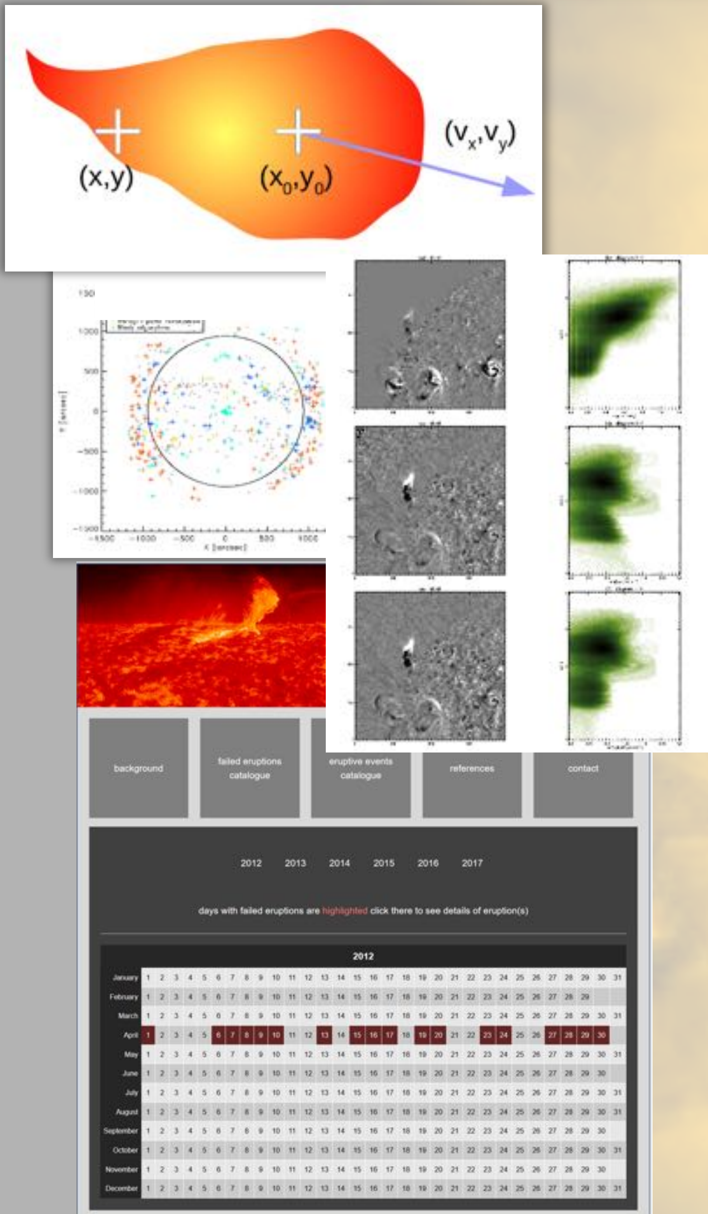


The catalogue of solar failed eruptions

Mrozek, T.[1,2], Gronkiewicz, D.[3], Kołomański[1], S., Stęślicki, M.[2]

[1]*Astronomical Institute, University of Wrocław*
[2]*Solar Physics Division, Space Research Centre PAS*
[3]*Nicolaus Copernicus Astronomical Center PAS*

Final remarks



- SDO/AIA data base for time period 2012 – 2016 have been searched for eruptive events with an automatic algorithm **(~10000 events, ~1000 full eruptions, ~800 failed eruptions**). Until the end of 2018 we will look over the entire data base.

- Found events (1 APR 2012 – 1 APR 2013) have been classified and collected in the catalogue. The failed eruption class is investigated with more details.

- Problems:
  - we have to abandon (restrict?) working with full resolution data (problems with server connection, huge amount of data to download)
  - a lot of events that need to be classified by hand (all found: 2000+/year, failed eruptions: 200+/year)

- The first version of catalogue will be available on September/October 2018 (www.eruptivesun.com)

XVI HVAR Astrophysical Colloqium, ISEST 2018 Workshop, 24-28 September 2018 Hvar, Croatia

Can superflares occur on the Sun?

D.Sokoloff, Moscow University and IZMIRAN, Russia
L.L.Kitchaonov, Irkutsk, Russia
M.M.Kazova, Moscow, Russia
D.Moss, Manchester, UK
I.Usoskin, Oulu, Finland

Parker Dynamo

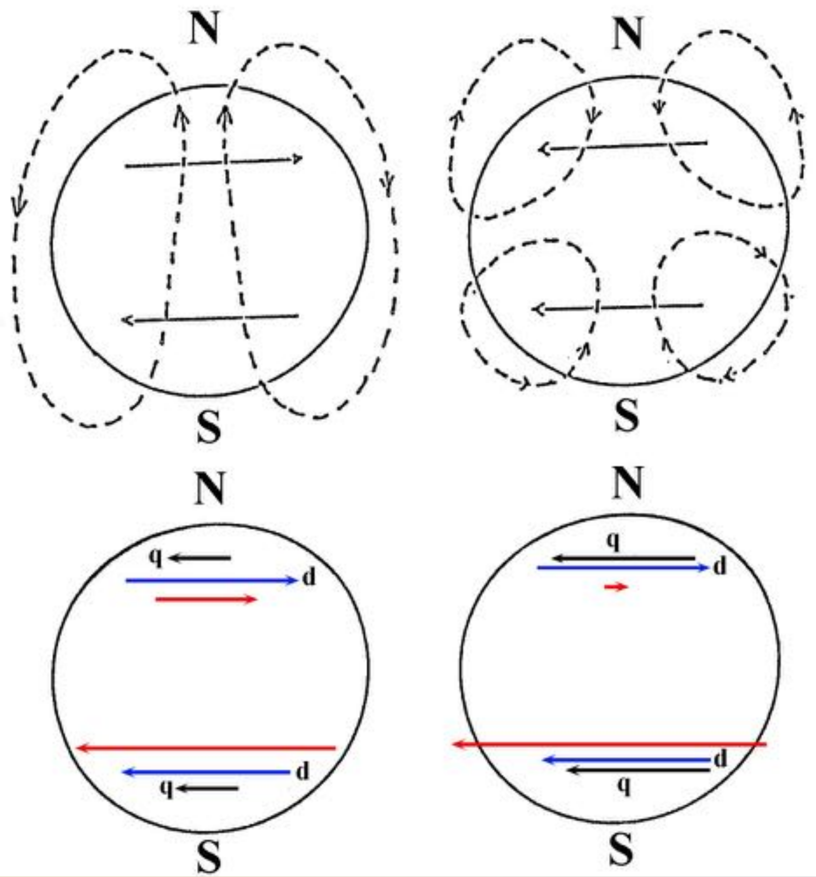
$$B_P \xrightarrow{\Omega} B_T$$

Differential rotation

$$B_T \xrightarrow{\alpha} B_P$$

Mirror asymmetry

Kitchatinov & Olemskoy 2016
From time to time alpha changes sign.



Our suggestion:

Antisolar differential rotation

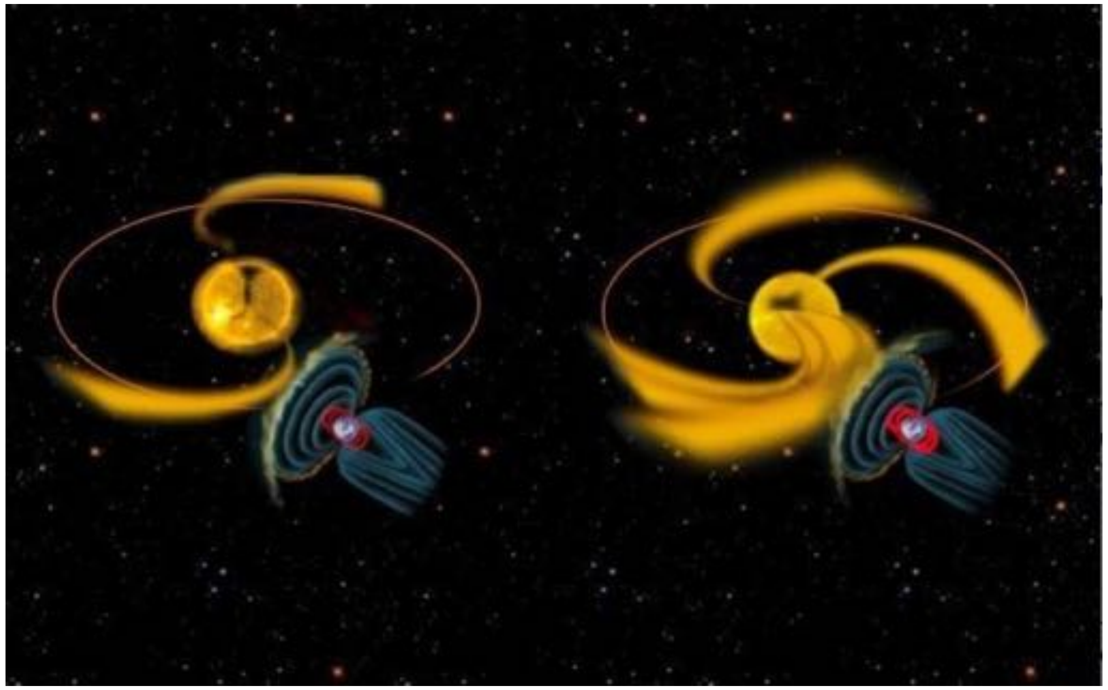
KARL-FRANZENS-UNIVERSITÄT GRAZ
UNIVERSITY OF GRAZ

The dependence of the peak velocities of HSS on the co-latitudes of their source CHs

S. Hofmeister[1], A. Veronig[1], M. Temmer[1], S.Vennerstrom[2], Bojan Vrsnak[3], And Bernd Heber[4]

1: University of Graz, Austria
2: DTU Space, Denmark
3: Hvar Observatory, Croatia
4: University of Kiel, Germany

Summary:



- Strong dependence of the peak velocity measured on the position of the measuring satellite within the HSS
  - increases cc from 0.40 to 0.72
  - HSS arising from φ_{co} > 60° have a high chance to not reach the ecliptic
  - Forecast: co-latitude as input parameter

- Shapes the interplanetary space.
- Pre-conditions the interplanetery space for subsequent CMEs.

- This is only one of many ways on how to investigate the co-latitudinal dependence.

  We do not need to wait for Solar Orbiter, we have all the data we need to derive the latitudinal profile of HSS. Let‘s start.