Summary of VarSITI/ISEST-MinMax24 WG5

The Bs challenge Group
2015 ISEST WORKSHOP
October 26-30, 2015, Mexico City

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http://solar.gmu.edu/heliophysics/index.php/Working_Group_5

The Bs challenge: Statement of the WG

The presence of **southward** magnetic fields in ICMEs are
the most important factor in producing **geomagnetic storms**.

The challenge is that direct observations of magnetic fields near the Sun
are extremely limited: currently possible only in the
photosphere/chromosphere
at the solar end and by in-situ observations at 1 AU.

WG5 aims to understand and reconstruct the possible flux
rope **magnetic structure**
of CMEs/ICMEs from observations and models. It also aims to
predict the **intensity** and the duration of the **Bs** in ICMEs
upon arriving at the Earth.

Breakdown of the problem

We need to predict Bs at 1 AU → **magnitude & orientation of B at 1 AU**

The problem consists of 4 basic steps:

(1) ***Deduce near-Sun |B| of CMEs***

(2) Deduce near-Sun orientations of CMEs

(3) **Extrapolate** ***near-Sun |B| to 1 AU***

(4) Extrapolate **near-Sun orientation to 1 AU**

List of WG5 presentations during ISEST WS 2015

Simplified solutions to predicting the magnetic vectors within CMEs :
Neel Savani* (Invited Talk)

Measuring Coronal Magnetic Fields With Shocks Driven by Coronal Mass Ejections, Bemporad Alessandro*, R. Susino, F. Bacchini, G. Lapenta

Radio Emission Before, During and After the Interaction Between Two Coronal Mass Ejections in the Interplanetary Medium, Tatiana Niembro Hernández*, A. Lara, R. González Domínguez, A. Raga

Kinematics and Consequence of Interacting CMEs Observed by STEREO/HI, Nandita Srivastava*, W. Mishra, T. Singh

Identification of Solar Origins of Several Geoeffective ICMEs by Modeling of Their Ion Composition --- by Vladimir Slemzin*, Y. Shugay, F. Goryaev, P. Pagano, D. Rodkin, I. Veselovsky

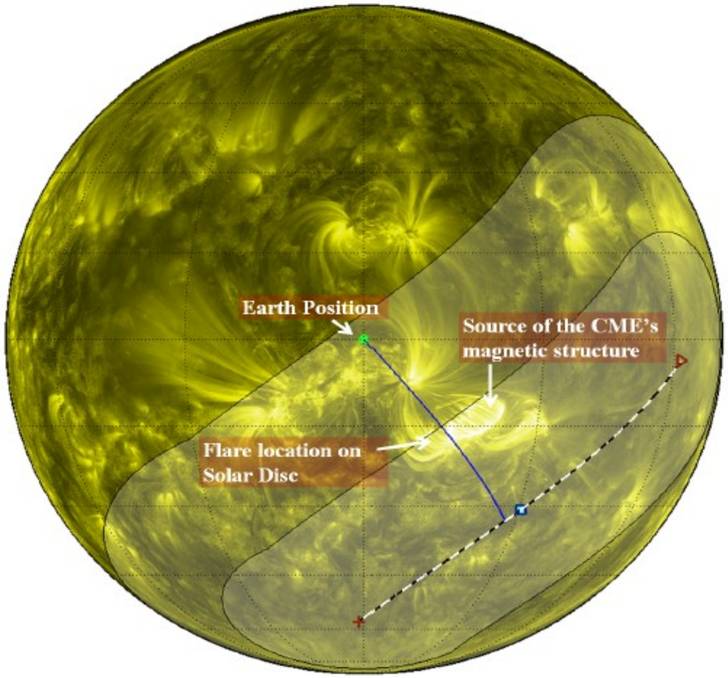
Simplified solutions to predicting the magnetic vectors within CMEs, Sanani : Methods

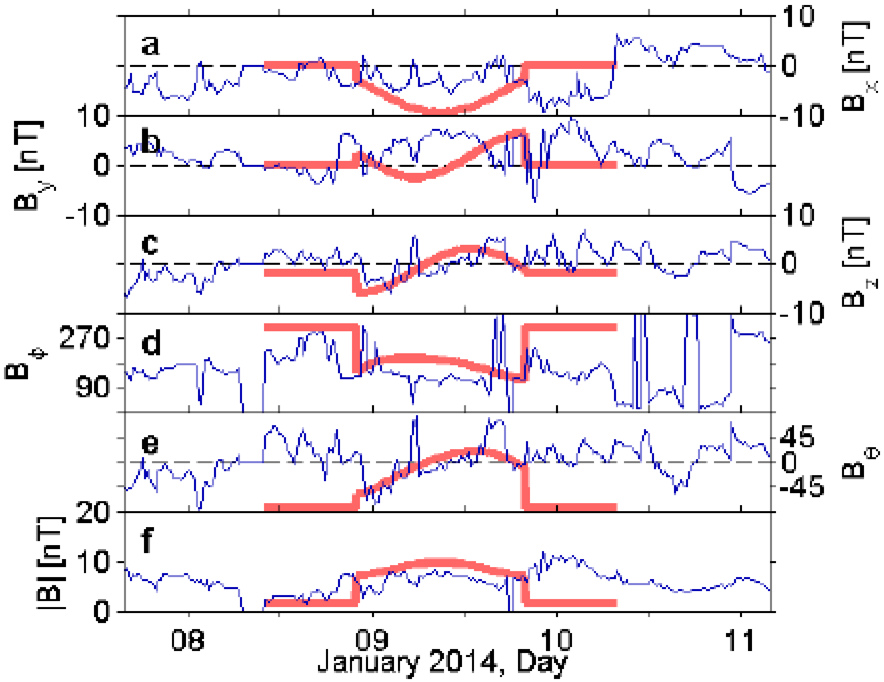
(1) Use Hm sign & tilt (Bothmer&Schwenn scheme)
of solar source region & determine volume
of influence of the CME-ICME in the heliosphere →
ICME orientation & impact parameter at 1 AU

(2)Use GCS model to drive ENLIL → ICME |B| at 1 AU

(1)+(2) → ICME B vector at 1 AU

Simplified solutions to predicting the magnetic vectors within CMEs: Results



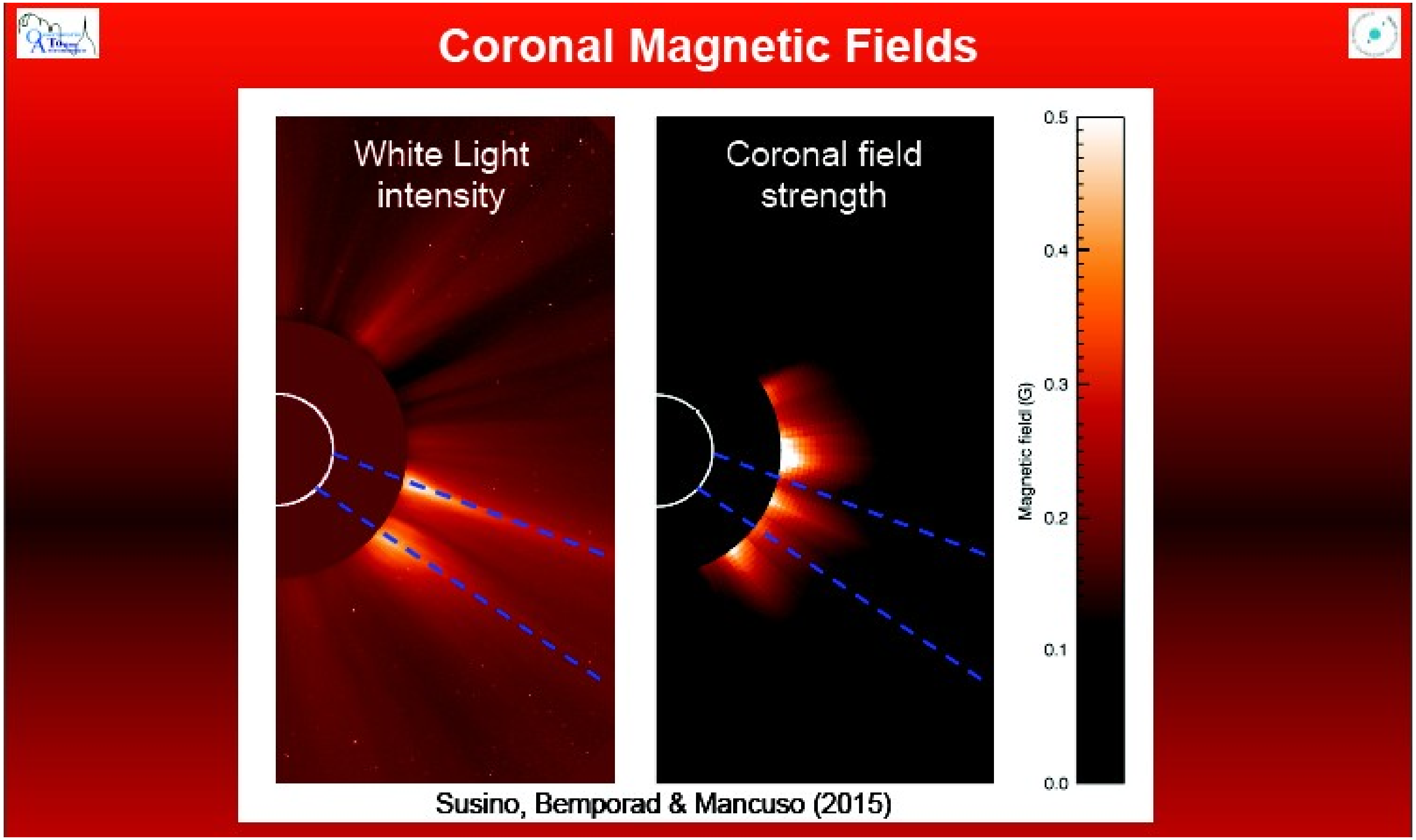


Predict the magnetic field vectors & Kp index for several CMEs

Measuring Coronal Magnetic Fields With Shocks Driven by Coronal Mass Ejections, Bemporad et al.: Methods

Apply MHD jump conditions to EUV/WL shock observations & deduce pre/post-shock magnetic field

Measuring Coronal Magnetic Fields With Shocks Driven by Coronal Mass Ejections: Results



2D magnetic field map up to 12 Rs

Radio Emission Before, During and After the Interaction Between Two Coronal Mass Ejections in the Interplanetary Medium, Niembro Hernández: Methods

ANALITIC MODEL OF ICME – ICME INTERACTION (HYDRODYNAMICALLY)

- Predicition of time and distance in which the interaction takes place and a ***merged region*** is formed
- Prediction of arrival time and velocity of the ***merged region*** at 1 AU

NUMERICAL SIMULATION OF ICME – ICME INTERACTION (YGUÁZU-A CODE) (CONSIDERING TERMAL PRESSURE)

- Predicition of time and distance in which the interaction takes place
- Prediction of arrival time and velocity of the ***merged region*** at 1 AU
- Profiles of density and velocity as function of distance at a fixed time

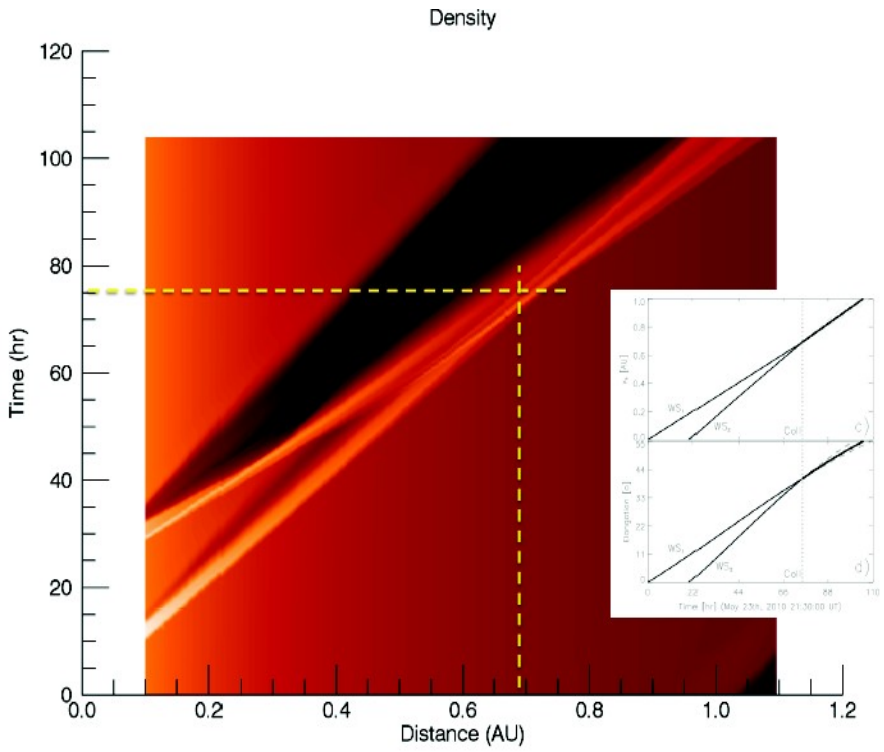
  THE EVOLUTION OF EACH STRUCTURE INVOLVED
- Profiles of density and velocity as function of time at a fixed distance

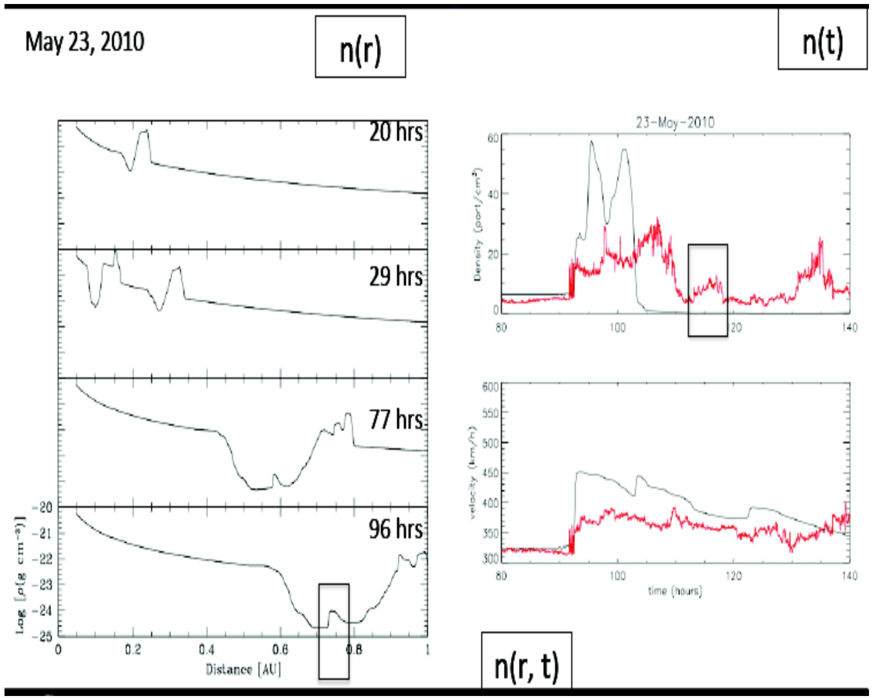
  COMPARISON WITH IN SITU DATA

RADIO EMISSION

- Searching for signatures in the interplanetary medium related to the ICME-ICME interaction

Radio Emission Before, During and After the Interaction Between Two Coronal Mass Ejections in the Interplanetary Medium: Results



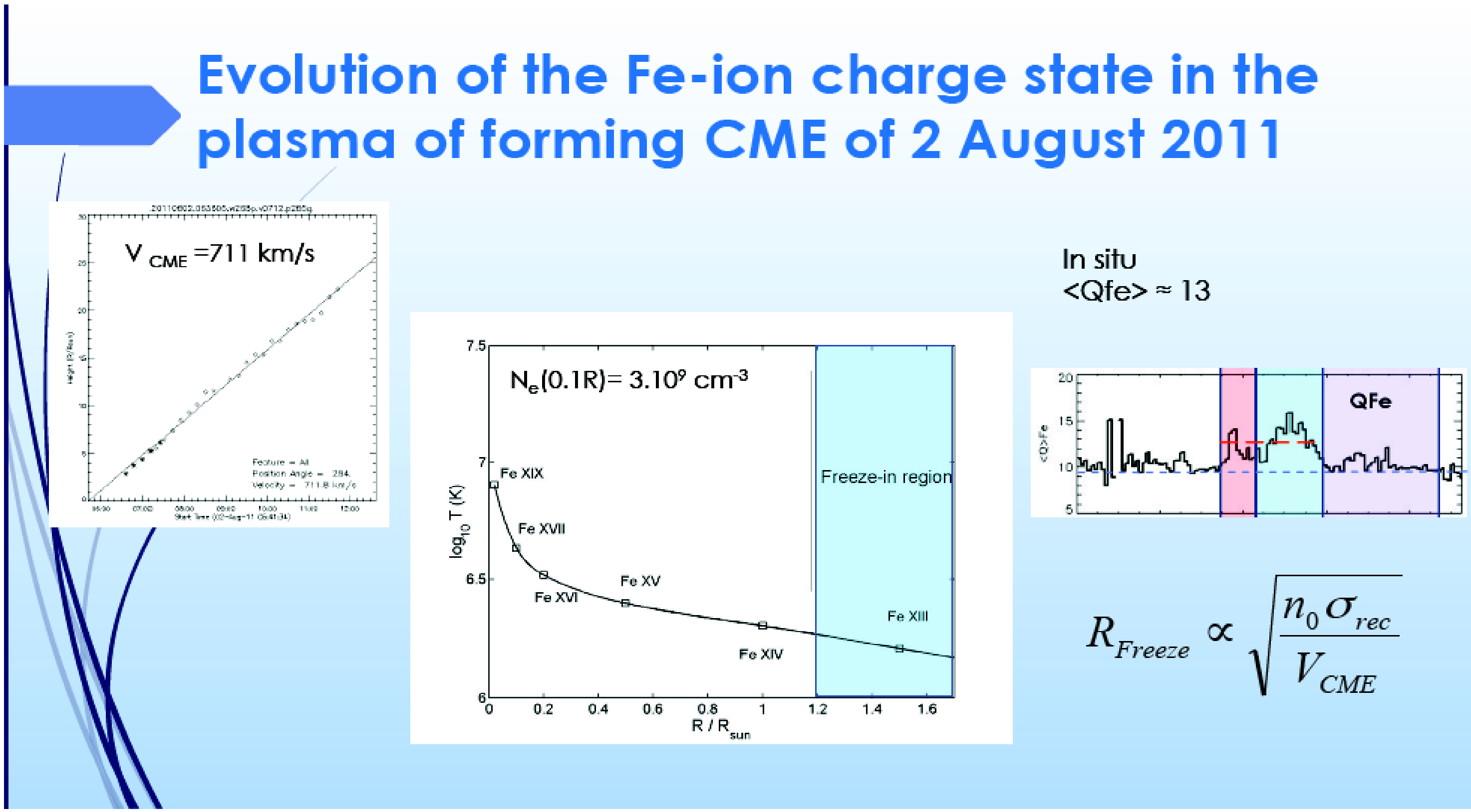


Predict interaction time(distance) of two CMEs as well as arrival time, v & n of composite structure at 1 AU

Identification of Solar Origins of Several Geoeffective ICMEs by Modeling of Their Ion Composition, Slemzin et al.: Methods

Study the link between measured “in situ” ion composition of geoeffective ICMEs and parameters of plasma in the supposed coronal sources, taking into account evolution of the SW plasma from the solar origin to the Earth

Identification of Solar Origins of Several Geoeffective ICMEs by Modeling of Their Ion Composition:Results



Kinematics and Consequence of Interacting CMEs Observed by STEREO/HI, Srivastava et al.: Methods

Use kinematics & masses of interacting CMEs to infer the nature of their interaction

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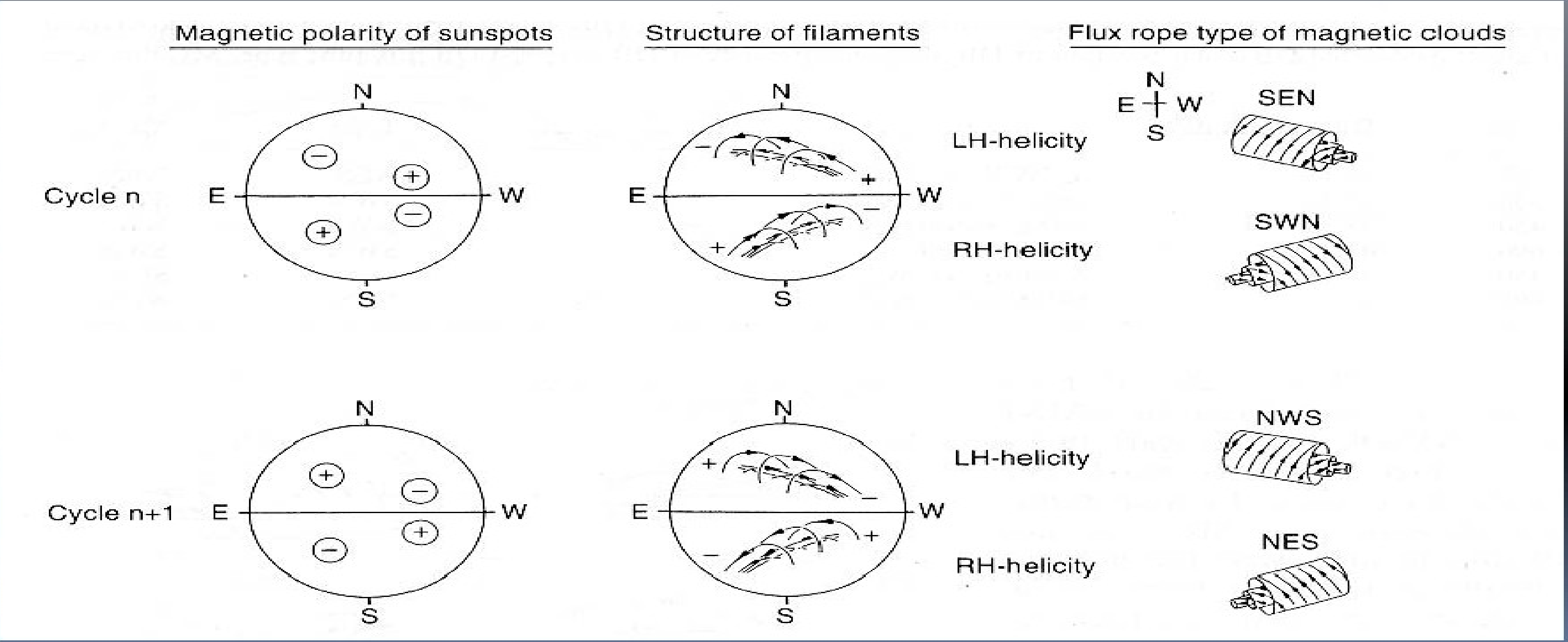
Use kinematics & masses of interacting CMEs to infer the nature of their interaction

Forecasting the Magnetic Field Configurations of CMEs, V. Bothmer, WG1-invited: Determine MC configuration from solar source region

Scheme of the Dependence of CME Magnetic Cloud Configurations on the Solar Cycle



No consideration of quadrupolar fields

Bothmer & Schwenn, 1998

Forecasting the Magnetic Field Configurations of CMEs:Conclusions

Conclusions

1. The magnetic field configuration of CMEs can be predicted from solar magnetograms based on the B&S scheme
2. Complexity of magnetic field structure arises from different sources: SR photospheric field complexity, lateral expansion, deflection (e.g., January 2014 CME), non force-free evolution
3. I think we often luckily miss CME cores – likeliness of a Carrington event may even be independent of threshold estimates
4. However, all of this is not too different from problems of terrestrial weather forecasts and natural hazard occurrences
5. These aspects are challenges for upcoming projects and offer bright perspectives for collaborative research

Future Work

1. Find suitable datasets for near-Sun |B| field calculations applicable to as many of the available methods as possible --- **start with events already analyzed by the various team members** - & populate list @ http://solar.gmu.edu/heliophysics/index.php/List_of_CMEs_for_WG5_Analysis ---> compare the predictions of various methods

2. Perform parametric studies of the various methods of CME-ICME magnetic field determination ---> assess the full range of anticipated magnetic fields from the various methods

3 Cordinate with other WGs (data/modeling&theory/campaign)
as well as with other teams/projects
on the topic (e.g., CCMC, LWS, HELCATS, SUSANOO)