

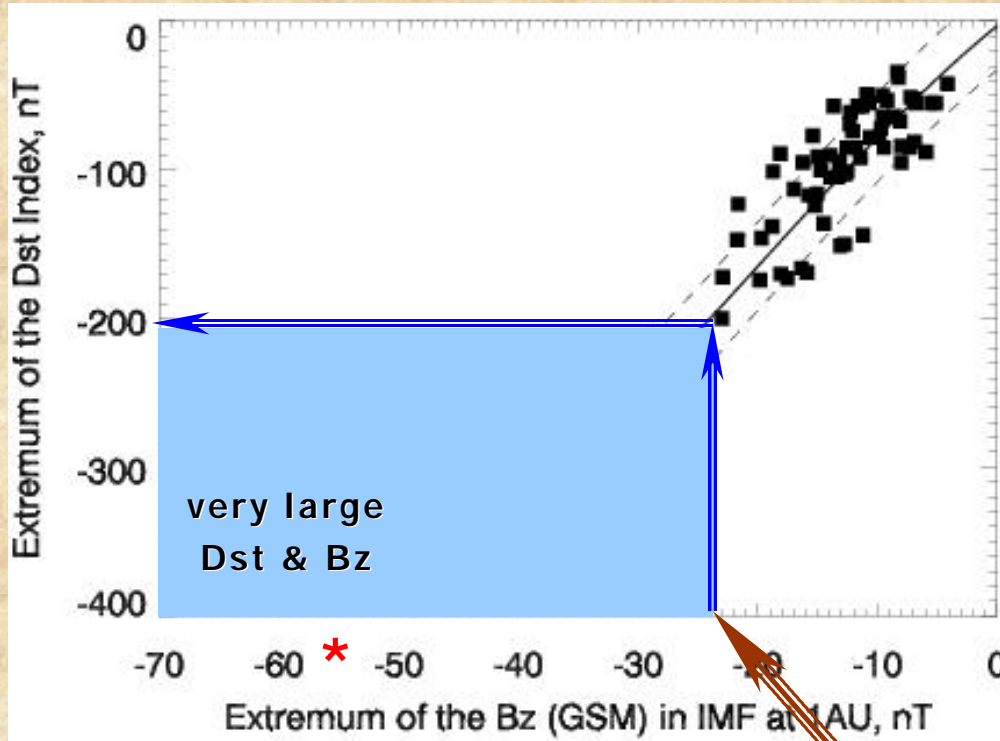


Photospheric Sources of Very Fast (>1100 km/sec) CMEs

Vasyl Yurchyshyn

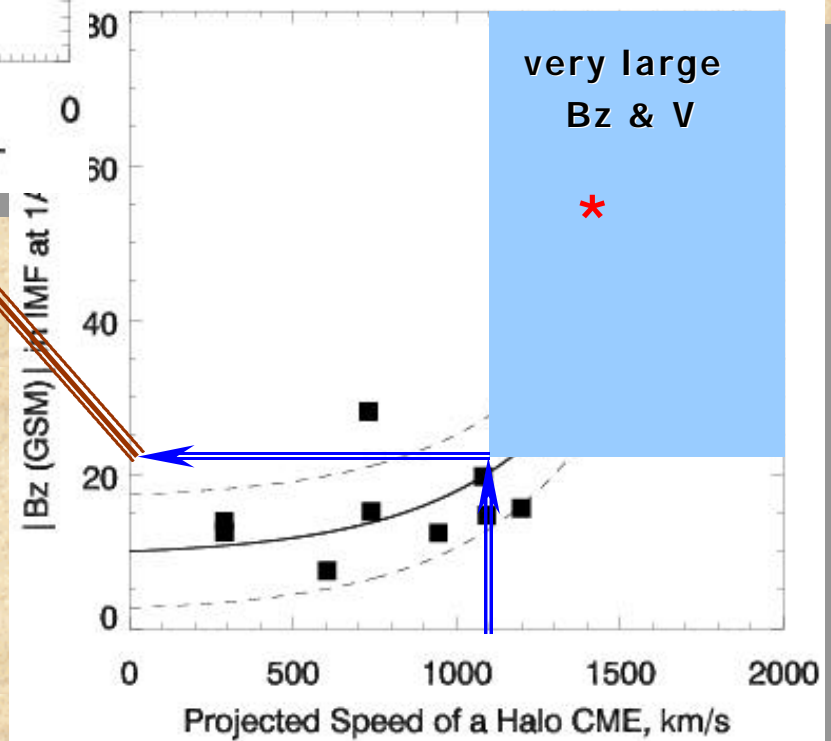
*Big Bear Solar Observatory,
40386 North Shore Lane, Big Bear City, CA 92314*

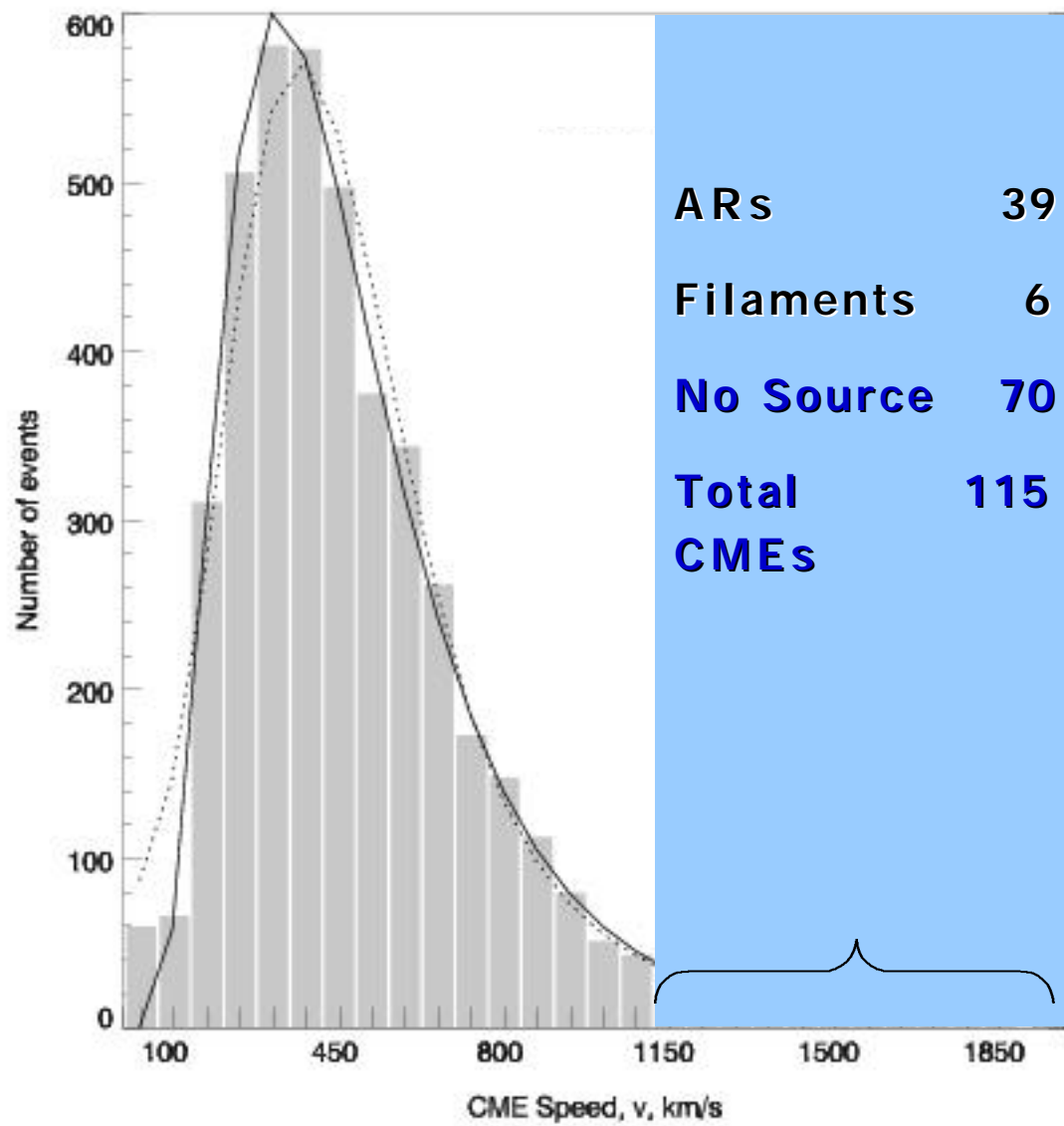
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**Why very fast CMEs
with $V > 1100$ km/s?**

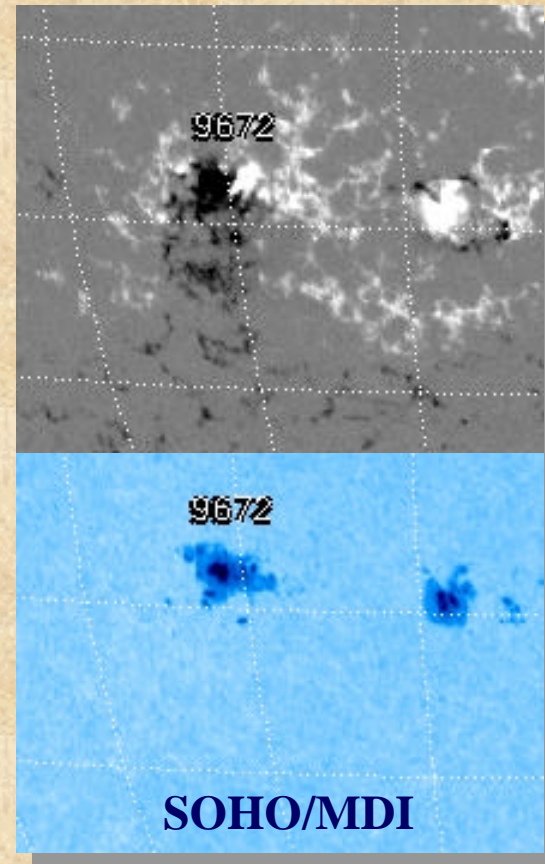
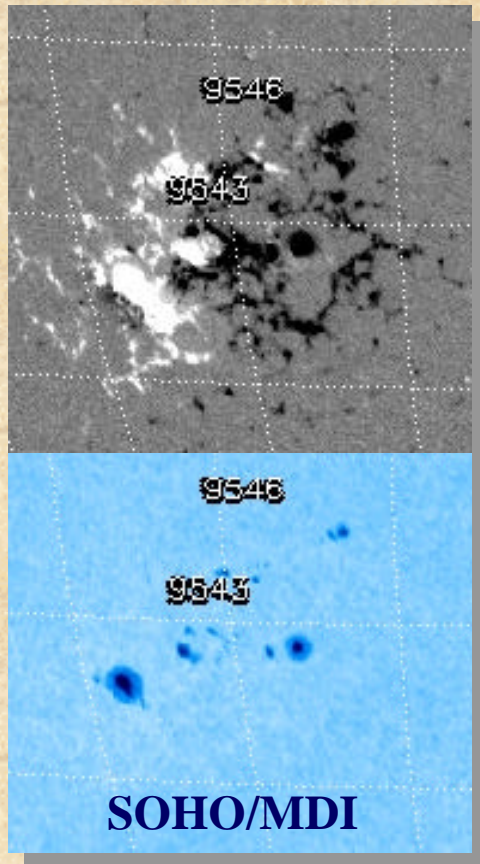
**CMEs with $V > 1100$ km/s
are capable of causing
geomagnetic storms with
the Dst index < -200 nT.**





**39 active region associated CMEs
originated in the following magnetic
configurations:**

1. Magnetic Complexes: 10 eruptions accompanied with one X, eight M and one C class flares



The Magnetic Complexes are extended magnetic regions which consist of two adjacent decaying active regions or a new magnetic region emerging inside a decaying active region

Average CME speed in this group is 1445 km/s

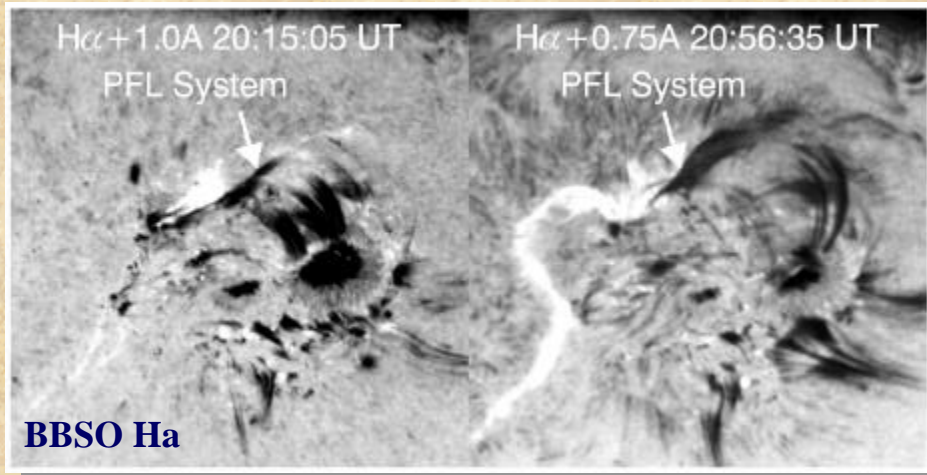
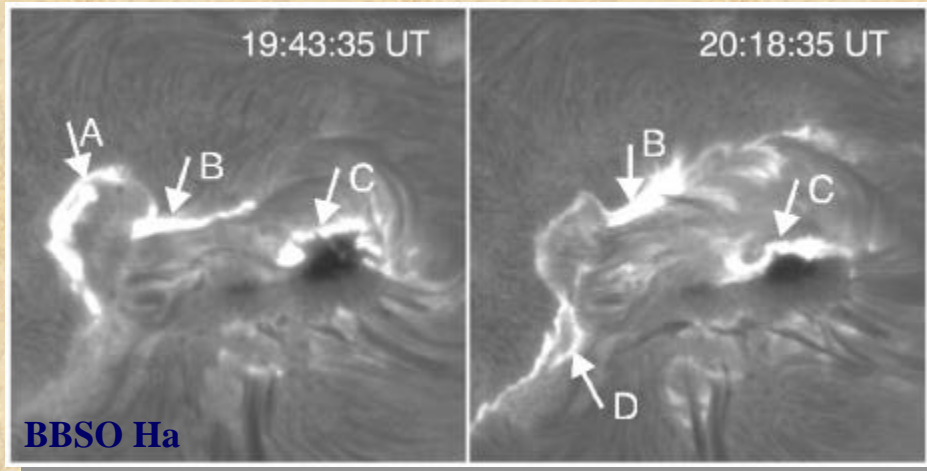
Maximum CME speed in this group is 1813 km/s

**39 active region associated CMEs
originated in the following magnetic
configurations:**

1. Magnetic Complexes: 10 eruptions accompanied with one X, eight M and one C class flares
2. "Tadpole"- Shaped sunspots: 8 eruptions associated with two X, five M and one C class flares

AR 8357 on Nov 4, 1998

BBSO DMG



Typical features:

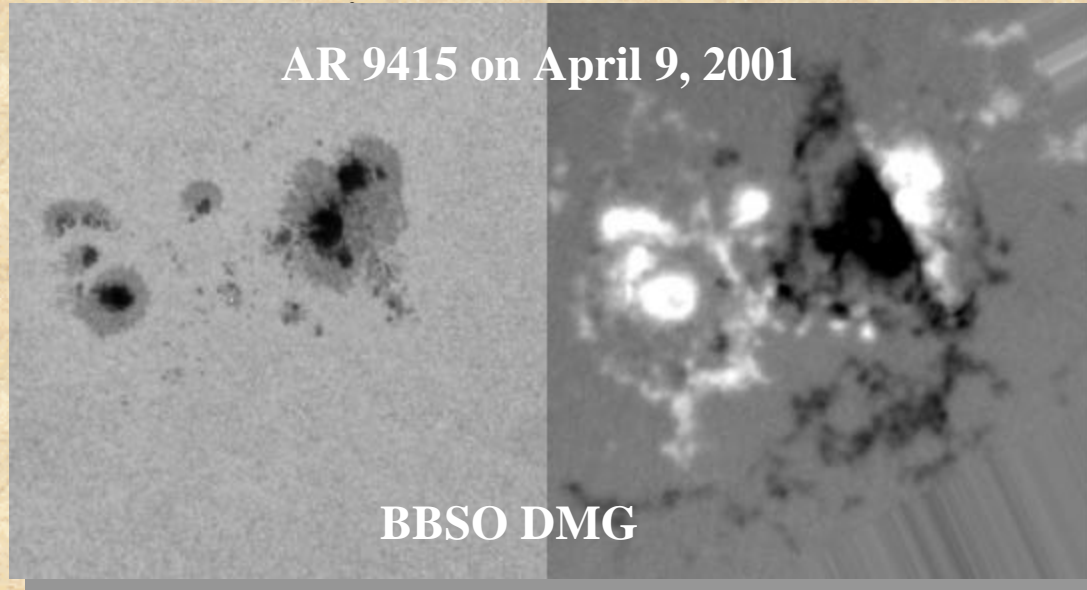
- a large sunspot w/ many small satellites
- highly twisted magnetic field
- strong magnetic shear
- well pronounced moat structure

Average CME speed in this group is 1445 km/s, maximum CME speed is 2519 km/s

39 active region associated CMEs originated in the following magnetic configurations:

1. Magnetic Complexes: 10 eruptions accompanied with one X, eight M and one C class flares
2. "Tadpole"- Shaped sunspots: 8 eruptions associated with two X, five M and one C class flares
3. Complex Delta Spots: 21 eruptions accompanied with eleven X, eight M and two C class flares

D
AR 9415 on April 9, 2001



Typical features:

- two opposite polarity sunspots located in the same penumbra
- large magnitude of the magnetic field and high horizontal gradients
- highly twisted magnetic fields
- strong magnetic shear

Average CME speed in this group is 1523 km/s, maximum CME speed is 2604 km/s.

	# of CMEs	Max Speed
Complexes	10	1803 km/s
"Tadpole" Sunspots	8	2519 km/s
Delta - sunspots	21	2604 km/s

Origin of delta-configurations is not well understood yet:

delta-sunspots were proposed to be formed due to emergence of a large twisted loop (Fan et al. 1999) and they are believed to be connected above the photosphere.

However, according to Zirin & Liggett (1987), Shi & Wang (1993) and Liu & Zhang (1999) delta-sunspots are formed by

1. Emergence as a cluster of sunspots
2. Emergence of a satellite sunspot
3. Collision of two bipolar magnetic features.

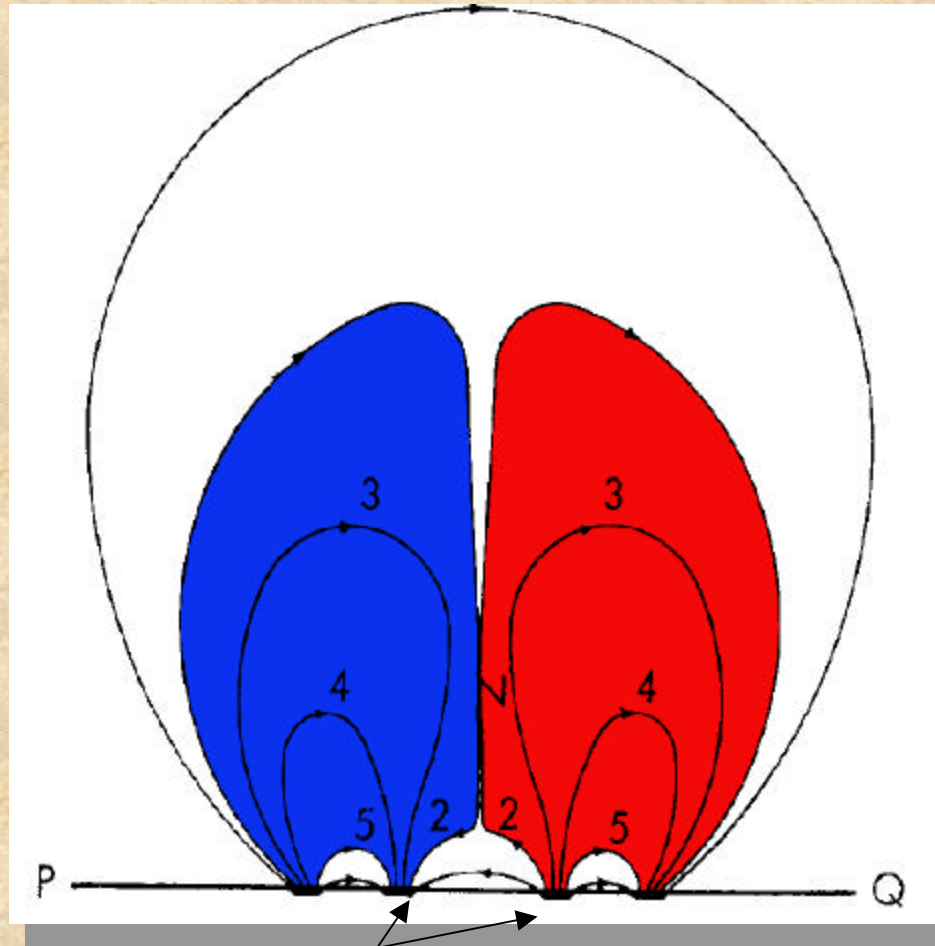
Also, direct magnetic connections (short & direct loops) between the two delta-sunspots occurs only as they decay (Zirin & Liggett 1987),



delta-sunspots may represent two topologically independent magnetic fluxes with high field strength and large magnetic shear

2D Sweet Configuration

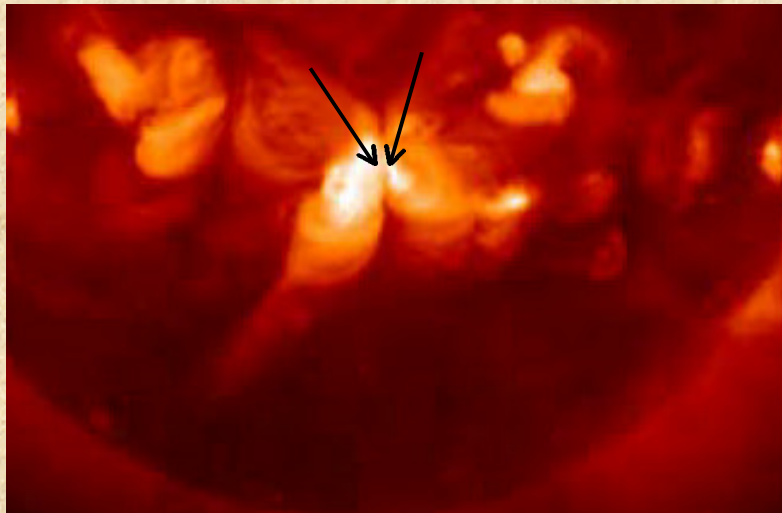
Sweet P.A., 1958, Proc. IAU Symp. 6, Cambridge, p.123



delta - sunspots

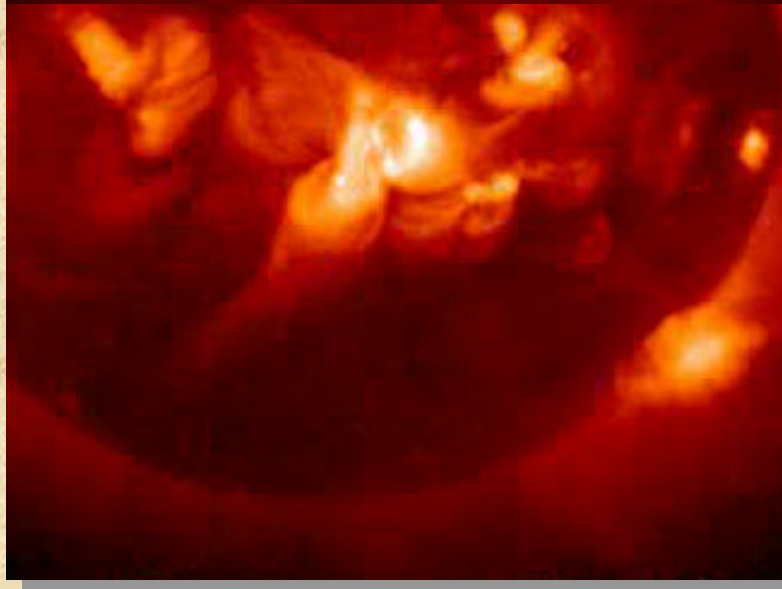
YOHKOH/SXT AR9415 April 9, 2001

15:09 UT (before flare)

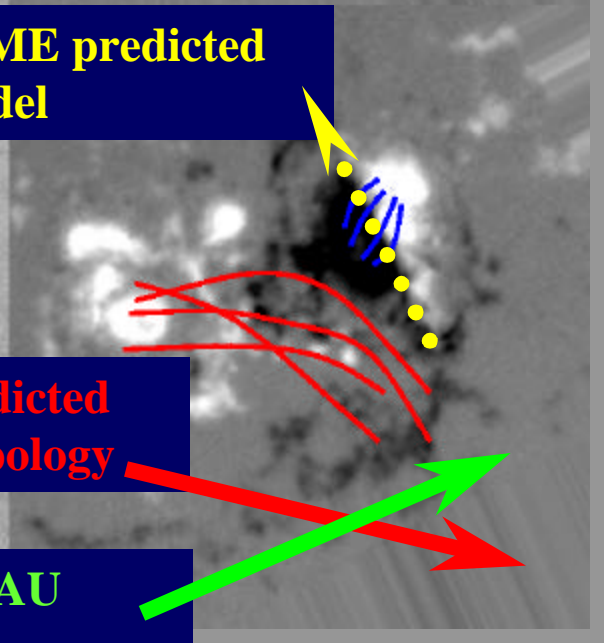
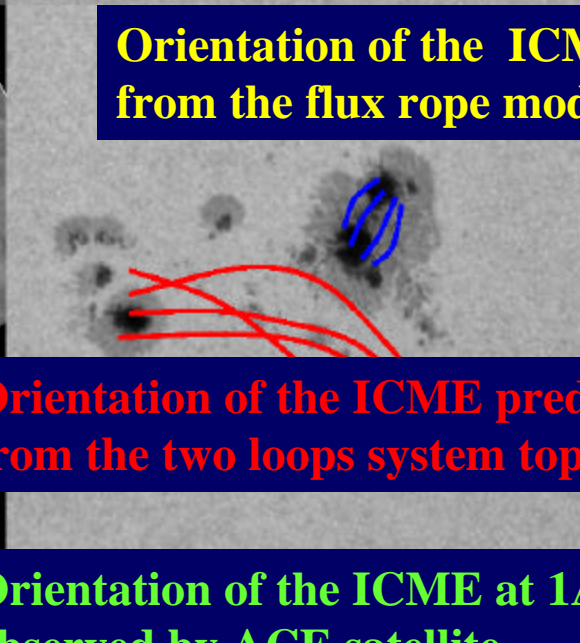
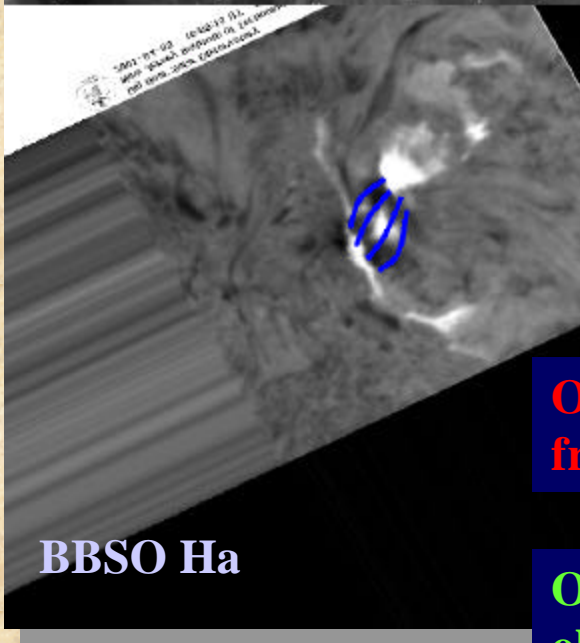
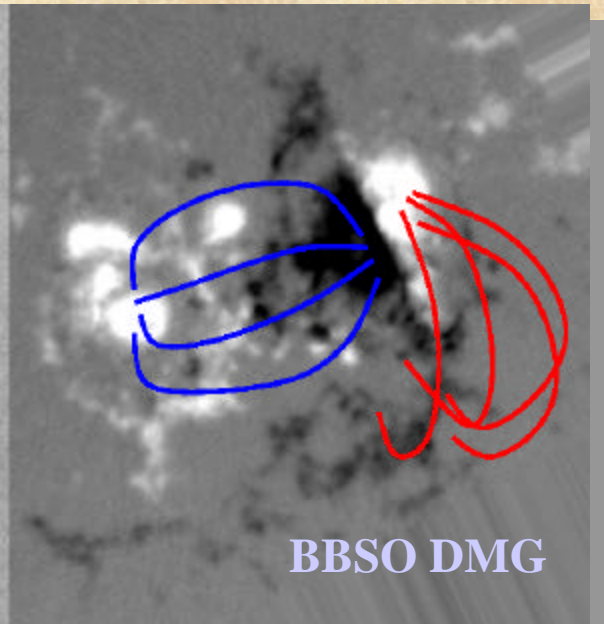
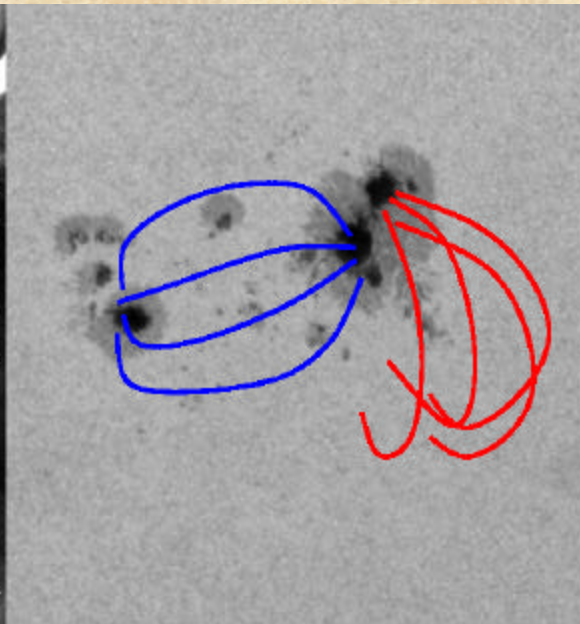
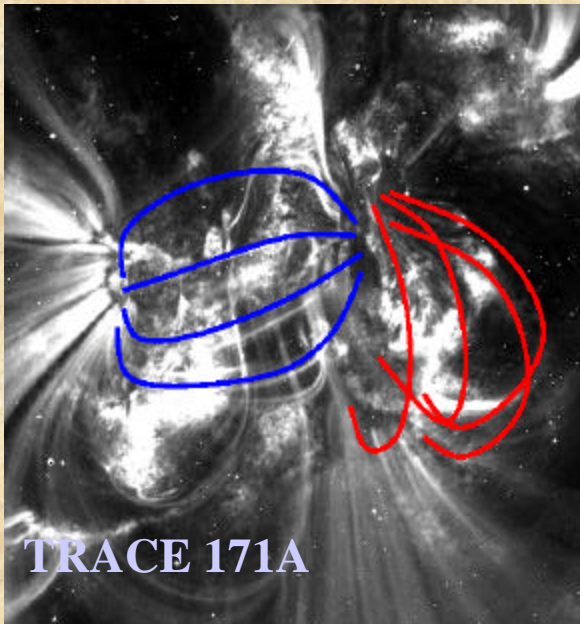


M7.9 flare 15:20UT

21:25 UT (after flare)



AR 9415 delta-sunspots are not connected



Orientation of the ICME predicted from the flux rope model

Orientation of the ICME predicted from the two loops system topology

Orientation of the ICME at 1AU observed by ACE satellite

Cont

Possible application of the results

- Space Weather applications: Majority of the geoeffective, very fast CMEs originate in 4 distinct magnetic regions:
 - ✓ delta-configurations (46%)
 - ✓ magnetic Complexes (22%)
 - ✓ "tadpole" - shaped sunspots (17%)
 - ✓ quiescent filaments located near active regions (15%)
- 3D Modeling: delta-sunspots may be disconnected and the magnetic field above them could be represented by two topologically independent magnetic systems
- Eruption: Reconnection between the two magnetic systems may form:
 - (i) an unstable flux tube, which erupts into the interplanetary space
 - and
 - (ii) the post flare loop system, which ties the previously disconnected delta-sunspots