

On the Initiation of Coronal Mass Ejections, Their Evolution, and Propagation into the Heliosphere: Recent Progress and Outstanding Questions

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Work supported by

NASA SR&T NNX08AH54G, AFOSR YIP FA9550-11-1-0048, and NASA HTP NNX11AJ65G

Introduction / Outline

1. Obs and Sims of CME Dynamics Very Early On, Low Corona

- **Example: CME Rotation During Eruption**
- **QUESTION: Can These Signatures Differentiate Between Models?**

2. Obs and Sims Of Interconnectedness, Coronal *Topological & Magnetic Connectivity* and Consequences

- **Example: Coupled/Sympathetic CME**
- **QUESTION: What Role Does Reconnection Play in CME Initiation?**

3. SDO/AIA Obs of Source Region Evolution During Eruptive Flares

- **Example: Flare Plasma Temperature as Signature of Mag Eng. Release**
- **QUESTION: Can We Constrain CME/rxn Modeling w Obs?**

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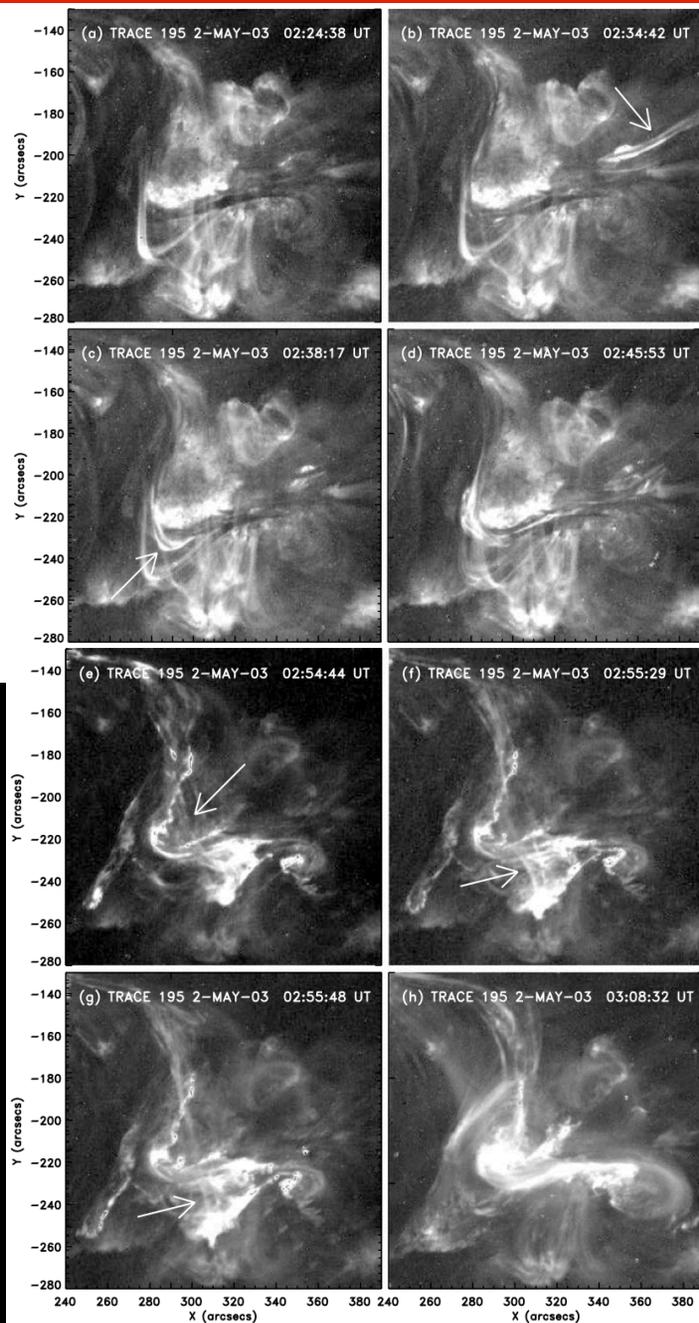
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CME Rotation During Eruption

(Green et al., 2007)



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L.M. Green *et al.*

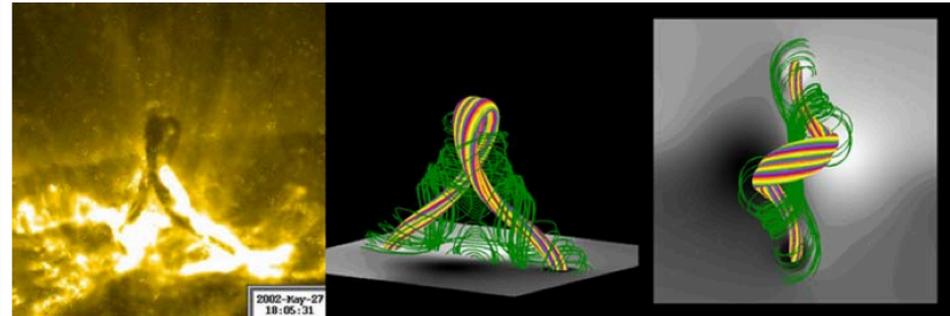


Figure 14 Comparison of the filament eruption on 27 May 2002 with the numerical simulation of Török and Kliem (2005). The coloured field lines outline the core of the kink-unstable flux rope. Additional field lines below the flux rope core are shown in green. The “magnetogram” of the normal component of the magnetic field in the bottom plane of the simulation box is included. The plot on the right shows a view from above at the same time as the plot in the middle.

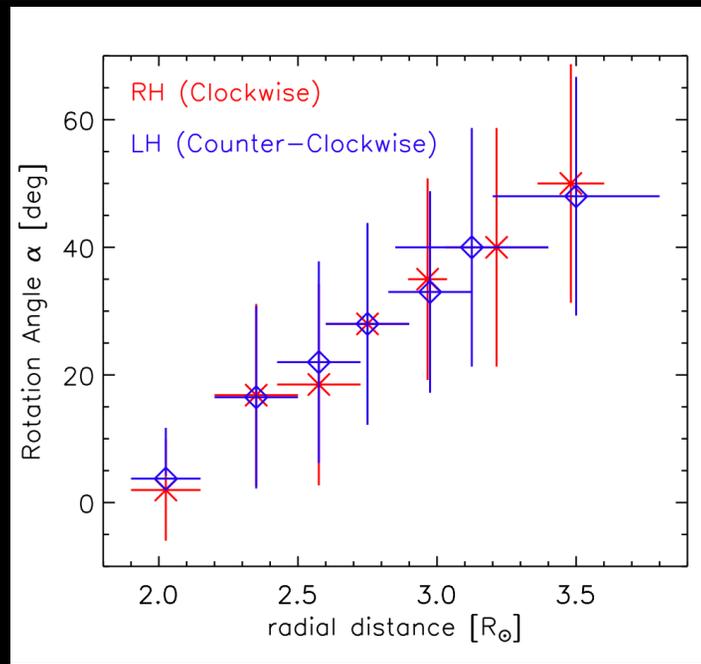
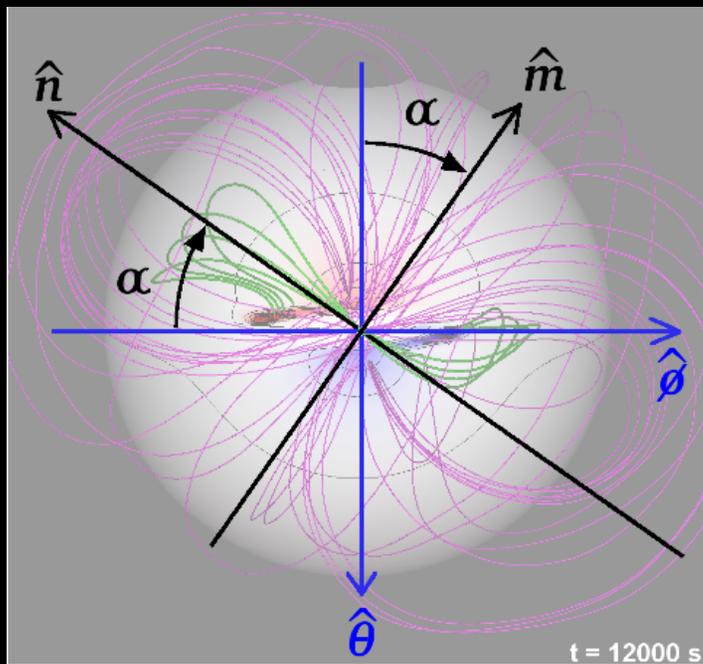
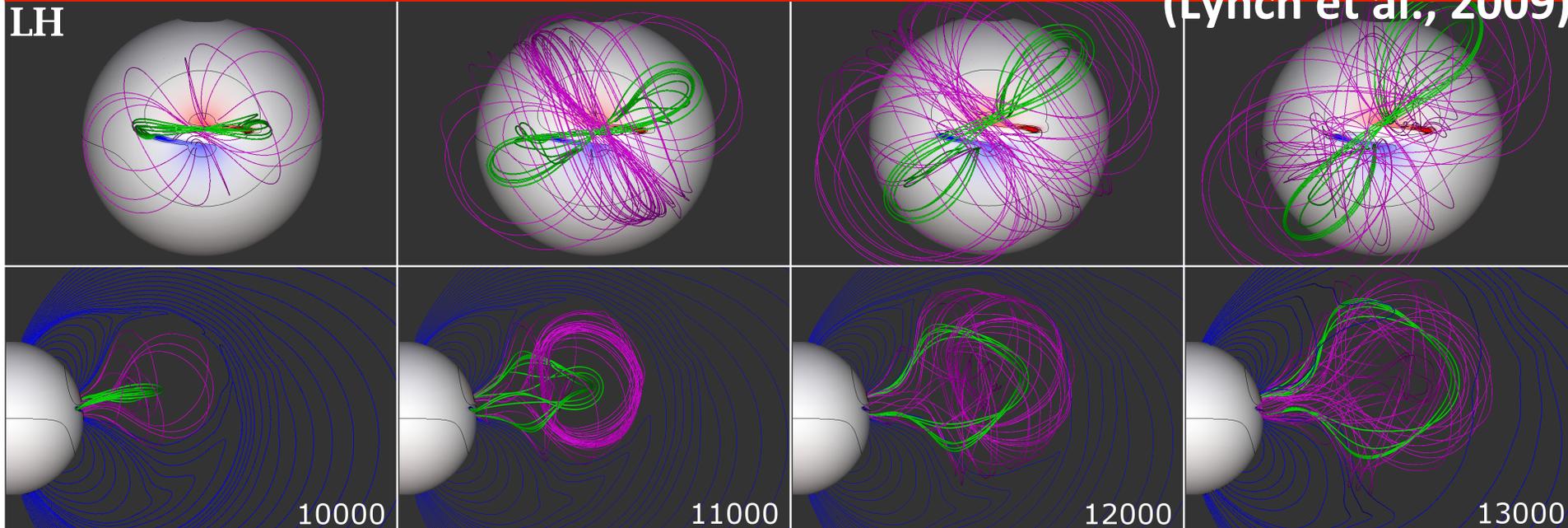
Table 2 Summary table showing the results from each active region. “S” indicates a forward-S sigmoid and “Z” indicates a reverse-S sigmoid. The observations used for determining the helicity sign of the erupting field are listed in column 2 and the direction of rotation of the filament is shown in the last column. CW indicates a clockwise rotation and CCW indicates a counterclockwise rotation.

Date	Helicity indicator	Helicity sign	Sigmoid shape	Filament rot.
07 Apr 97	“sinistral” filament; flare ribbons; magnetic tongues	> 0	S	CW
12 May 97	“dextral” filament; flare ribbons	< 0	Z	CCW
06 Jun 00	filament threads; “dextral” filament; $\alpha(x, y)$	< 0	Z	CCW
19 Jul 00	filament threads; flare ribbons; α_{best}	< 0	Z	CCW
15 Jun 01	“dextral” filament; flare ribbons	< 0	Z	CCW
02 May 03	filament threads; “sinistral” filament	> 0	S	CW

CME Rotation During Eruption

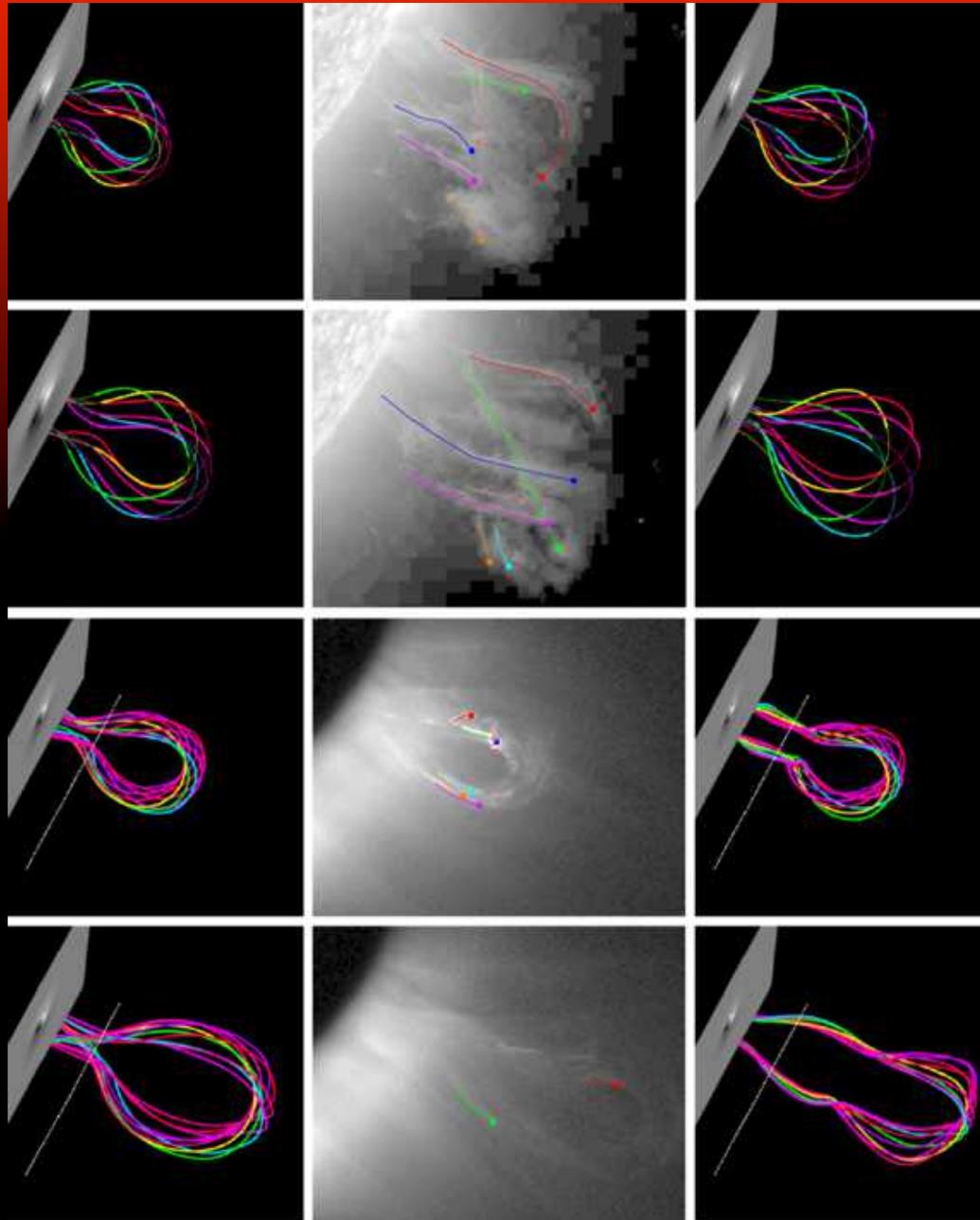
(Lynch et al., 2009)

LH



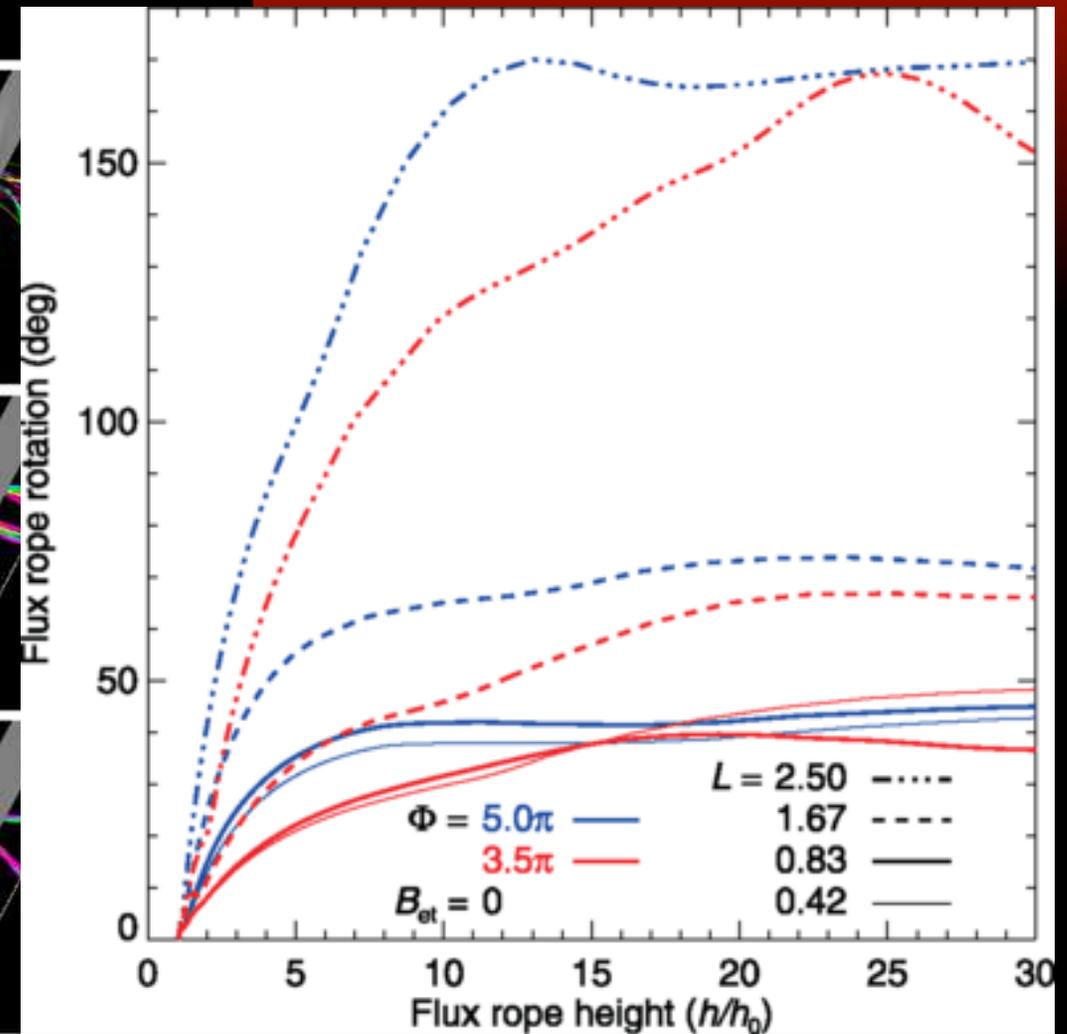
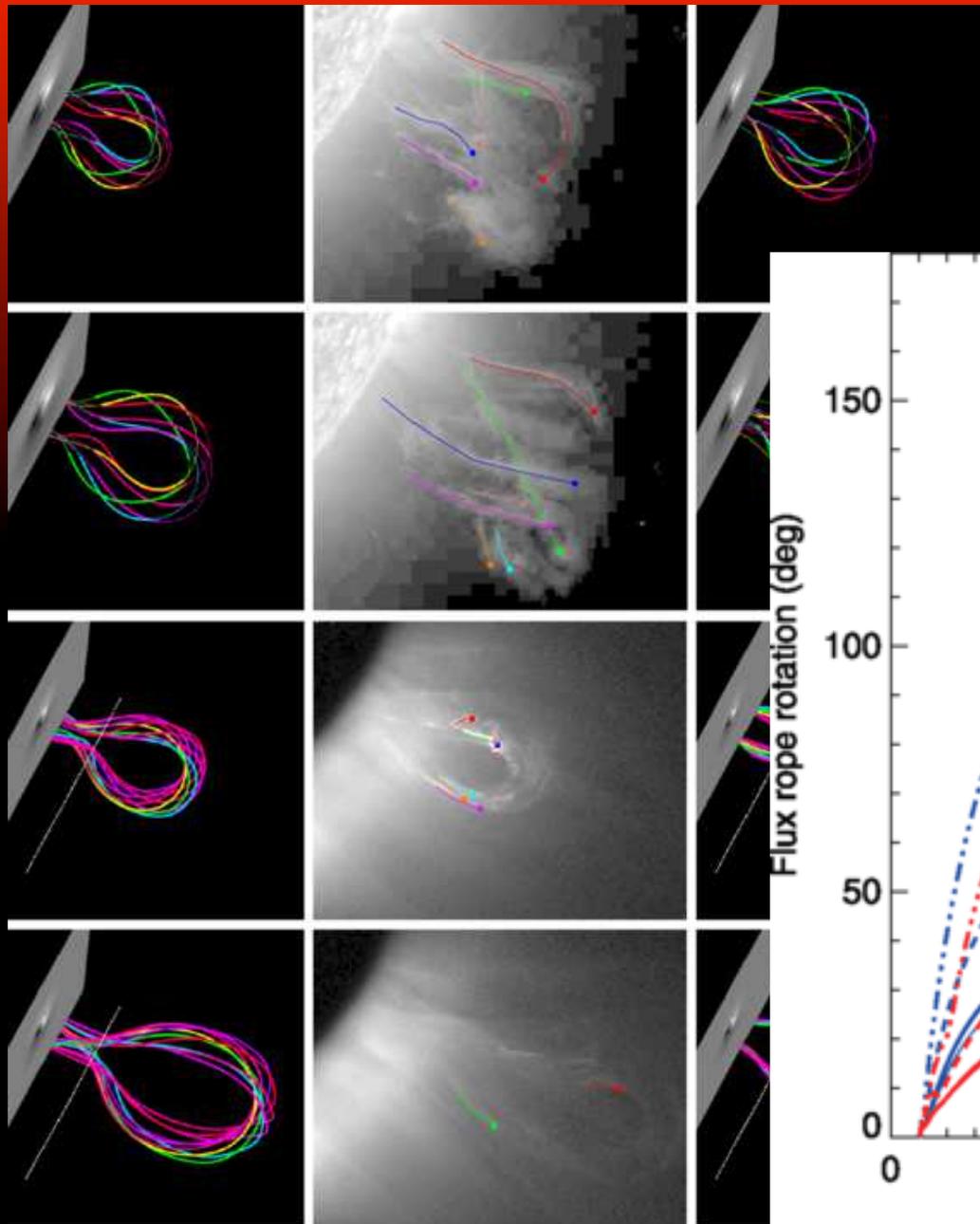
CME Rotation During Eruption

(Kliem et al., 2012)



CME Rotation During Eruption

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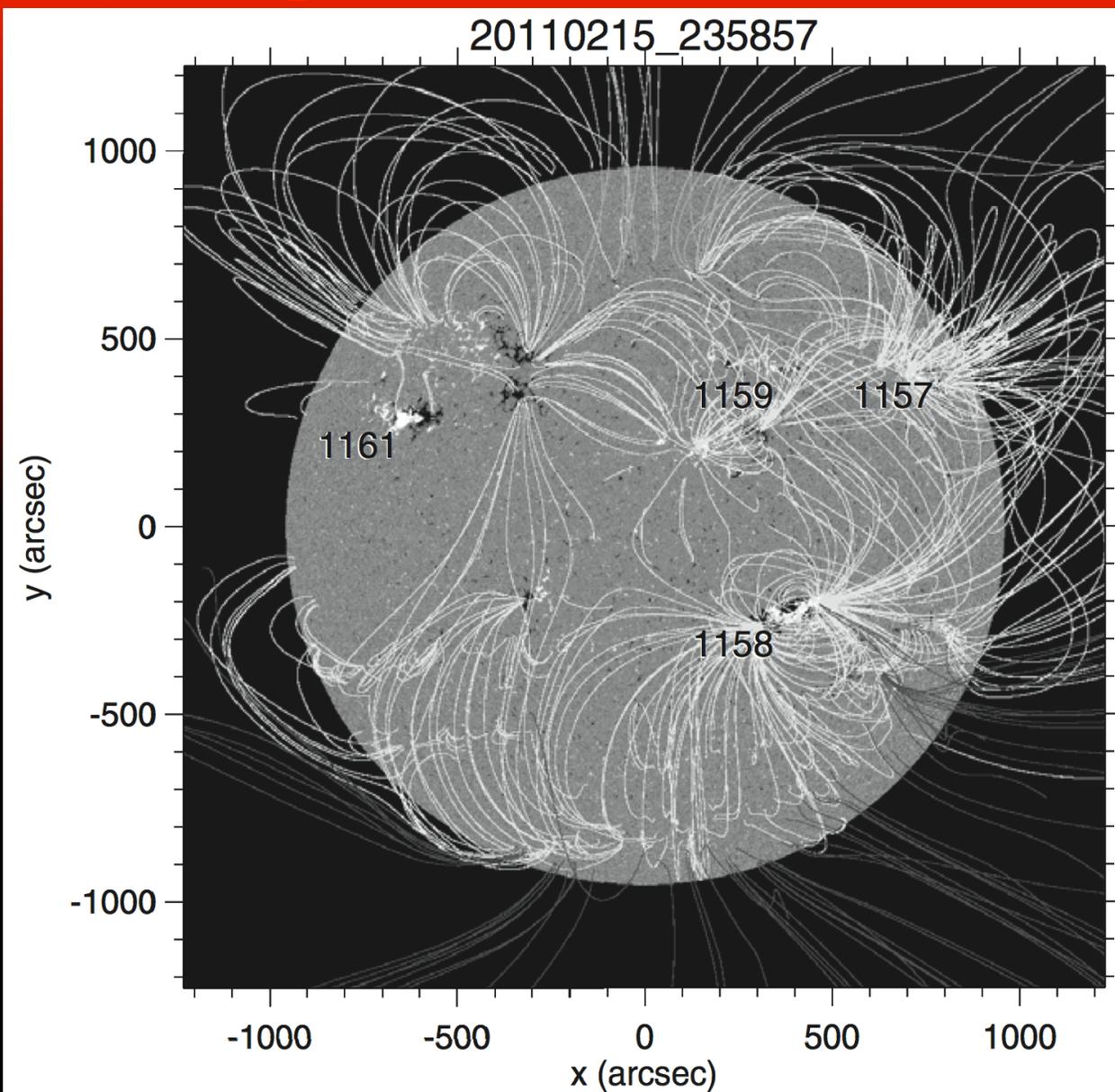
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Topological “Interconnectedness”

(Schrijver et al., 2013)



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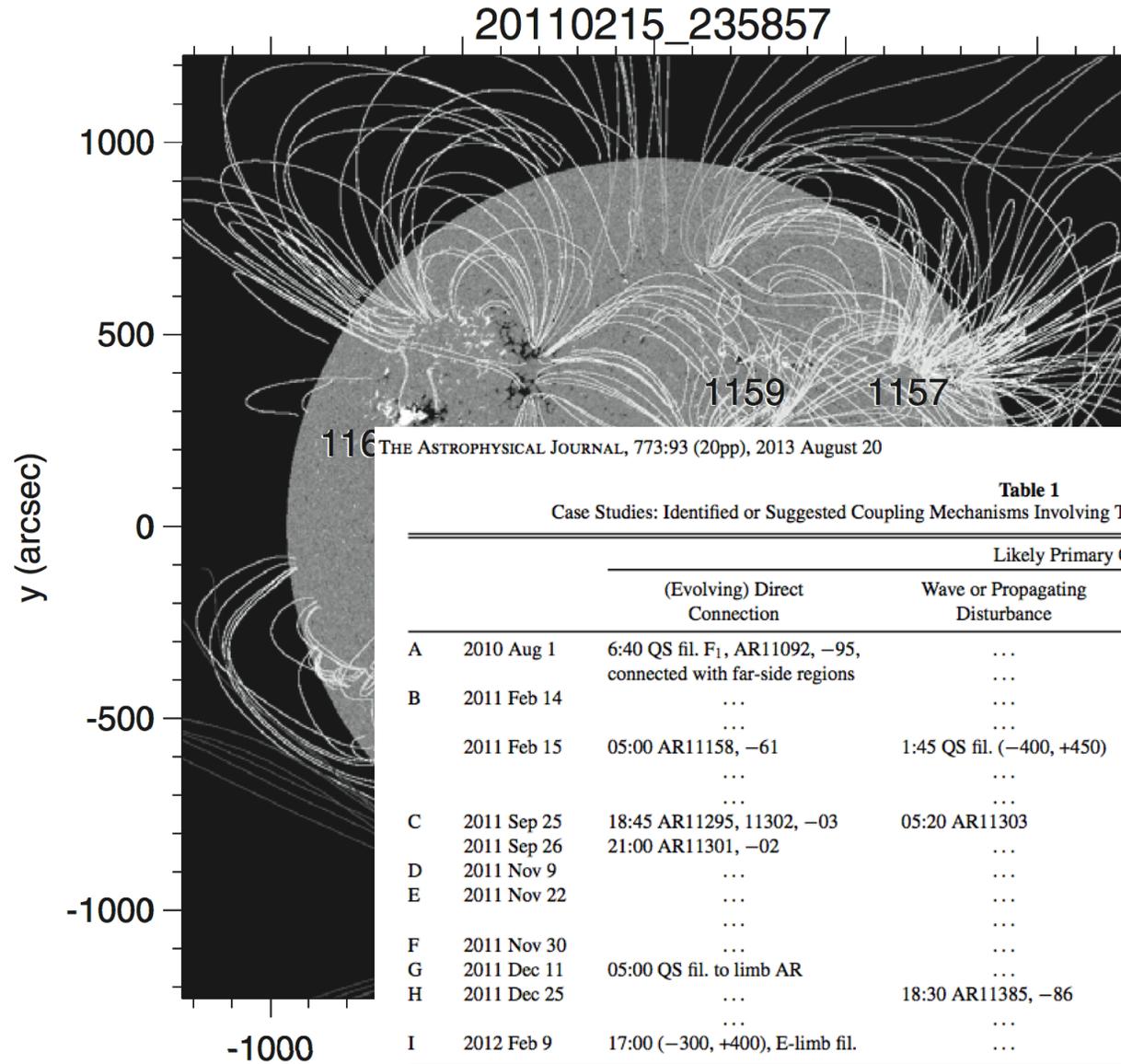
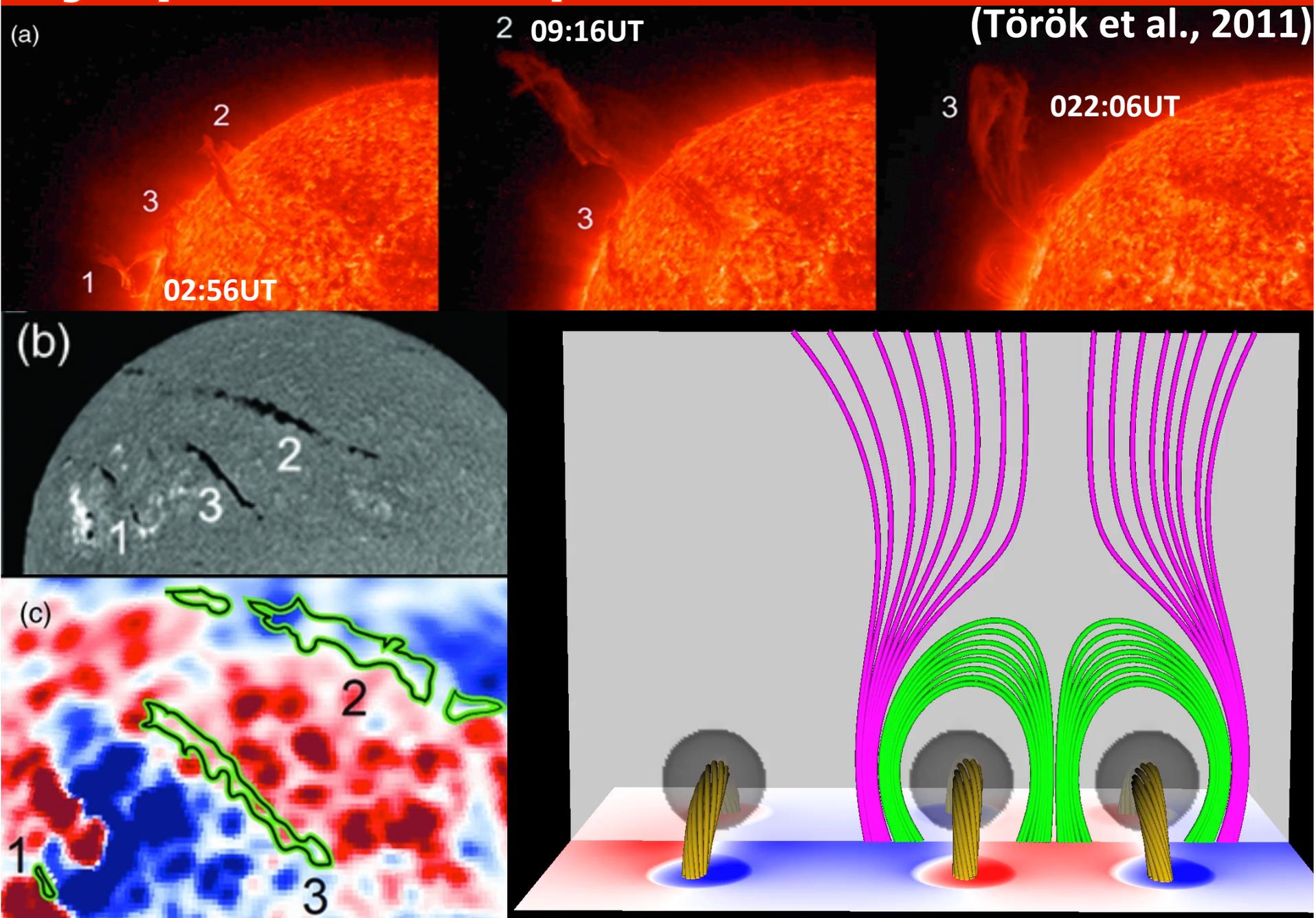


Table 1
Case Studies: Identified or Suggested Coupling Mechanisms Involving Two or More Activations within the Solar Corona

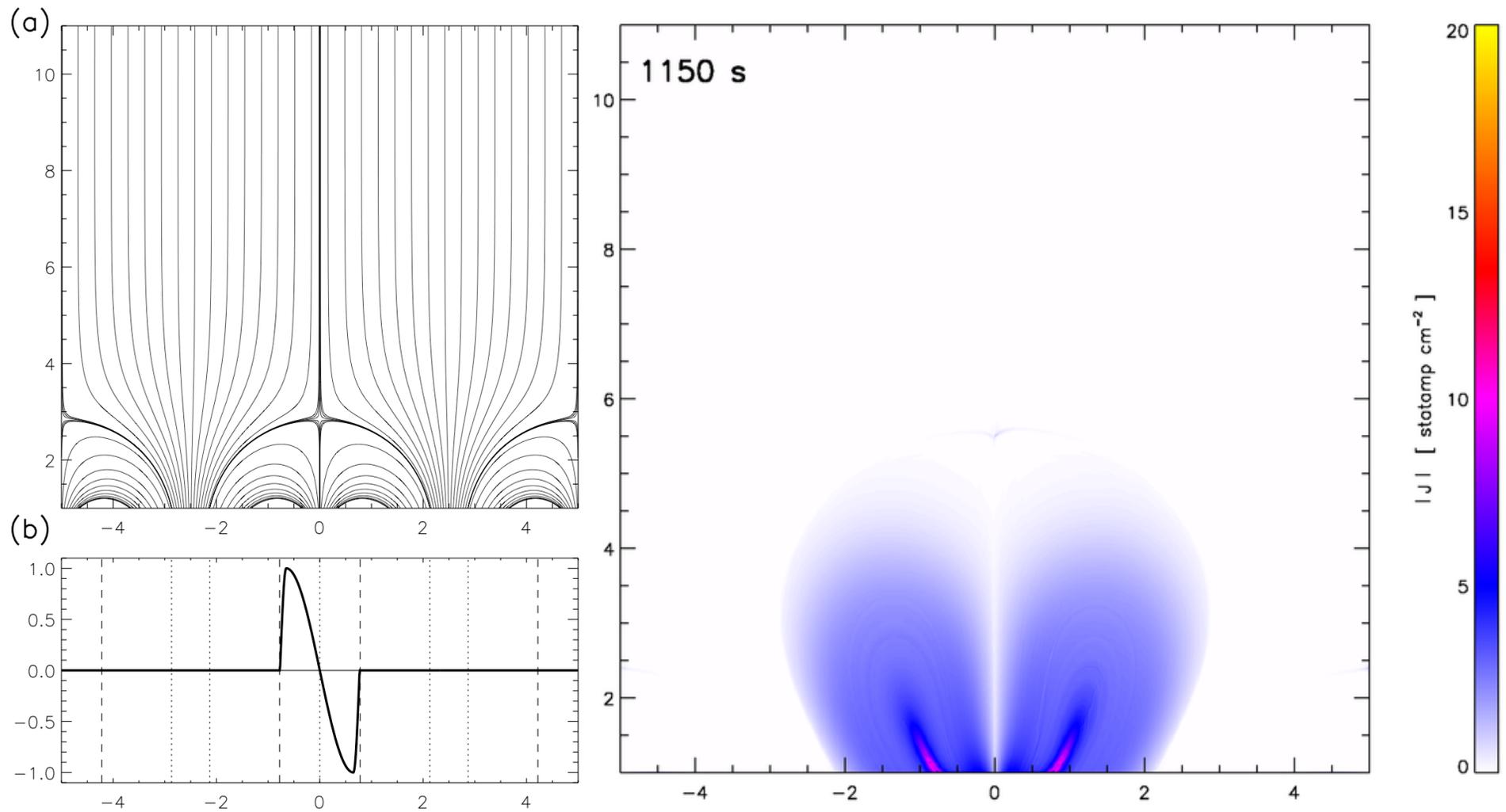
		Likely Primary Coupling Pathway			
		(Evolving) Direct Connection	Wave or Propagating Disturbance	Distortion of Overlying Field by Eruption	(Evolving) Indirect Connection
A	2010 Aug 1	6:40 QS fil. F ₁ , AR11092, -95, connected with far-side regions	...	19:30 QS fil. F ₃ after fil. F ₁ erupt.	...
B	2011 Feb 14	...	...	...	18:00, 18:30, and 19:00 AR11158, QS fil. at (-400, +450)
	2011 Feb 15	05:00 AR11158, -61	1:45 QS fil. (-400, +450)	...	05:40 AR11158, -61
		...	...	...	07:00 and 12:20 AR11158, -61, QS fil. (-400, +450)
C	2011 Sep 25	18:45 AR11295, 11302, -03	05:20 AR11303	...	04:30 AR11301, -02
	2011 Sep 26	21:00 AR11301, -02	...	...	...
D	2011 Nov 9	...	...	12:25 AR11341, -42	16:30 AR11339, 11342
E	2011 Nov 22	...	...	...	07:25 AR11353, -5, -7
		...	...	...	10:30 AR11353, -4, polar crown
F	2011 Nov 30	...	...	...	...
G	2011 Dec 11	05:00 QS fil. to limb AR	...	...	...
H	2011 Dec 25	...	18:30 AR11385, -86	00:15 two QS filaments separated by ≈5 hr	...
	
I	2012 Feb 9	17:00 (-300, +400), E-limb fil.	...	...	...

Notes. Listed are approximate starting times (UT) of the main events discussed in the text, followed by an indication of the regions involved. For 2010 August 1 and 2011 February 14–15 references are made to the cases discussed by Schrijver & Title (2011) and Schrijver et al. (2011). Where more than one active-region number is listed, those following the first are abbreviated to two digits. Where specified, coordinates are given in arcseconds relative to disk center. Approximate times (UT) are given for the start of the initiating event.

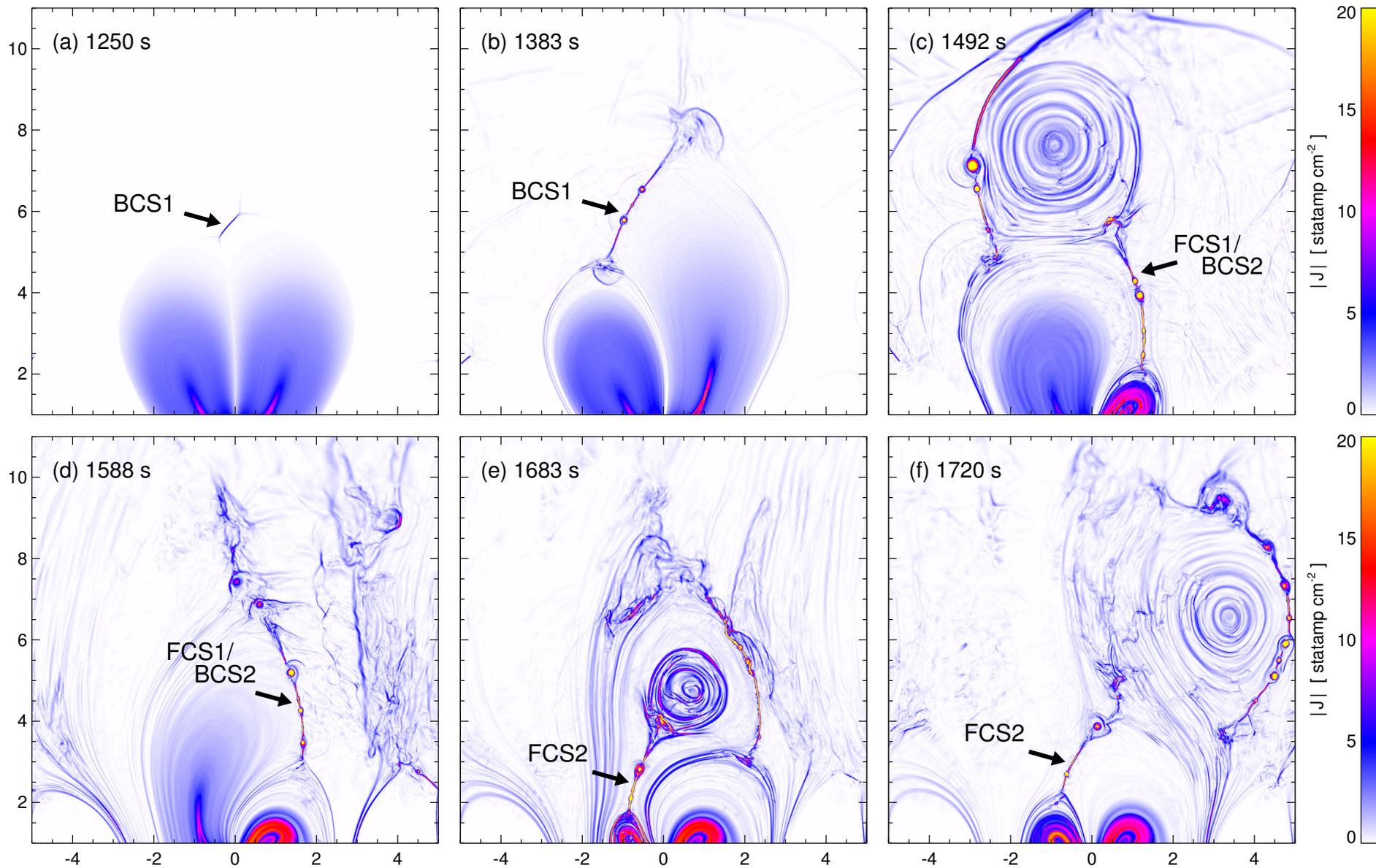
Sympathetic Eruption Overview



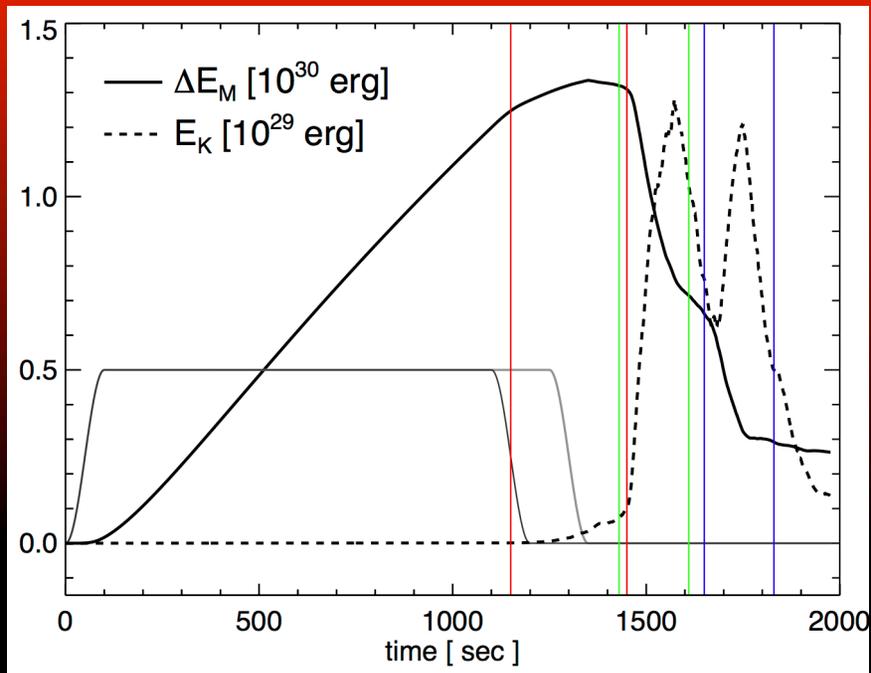
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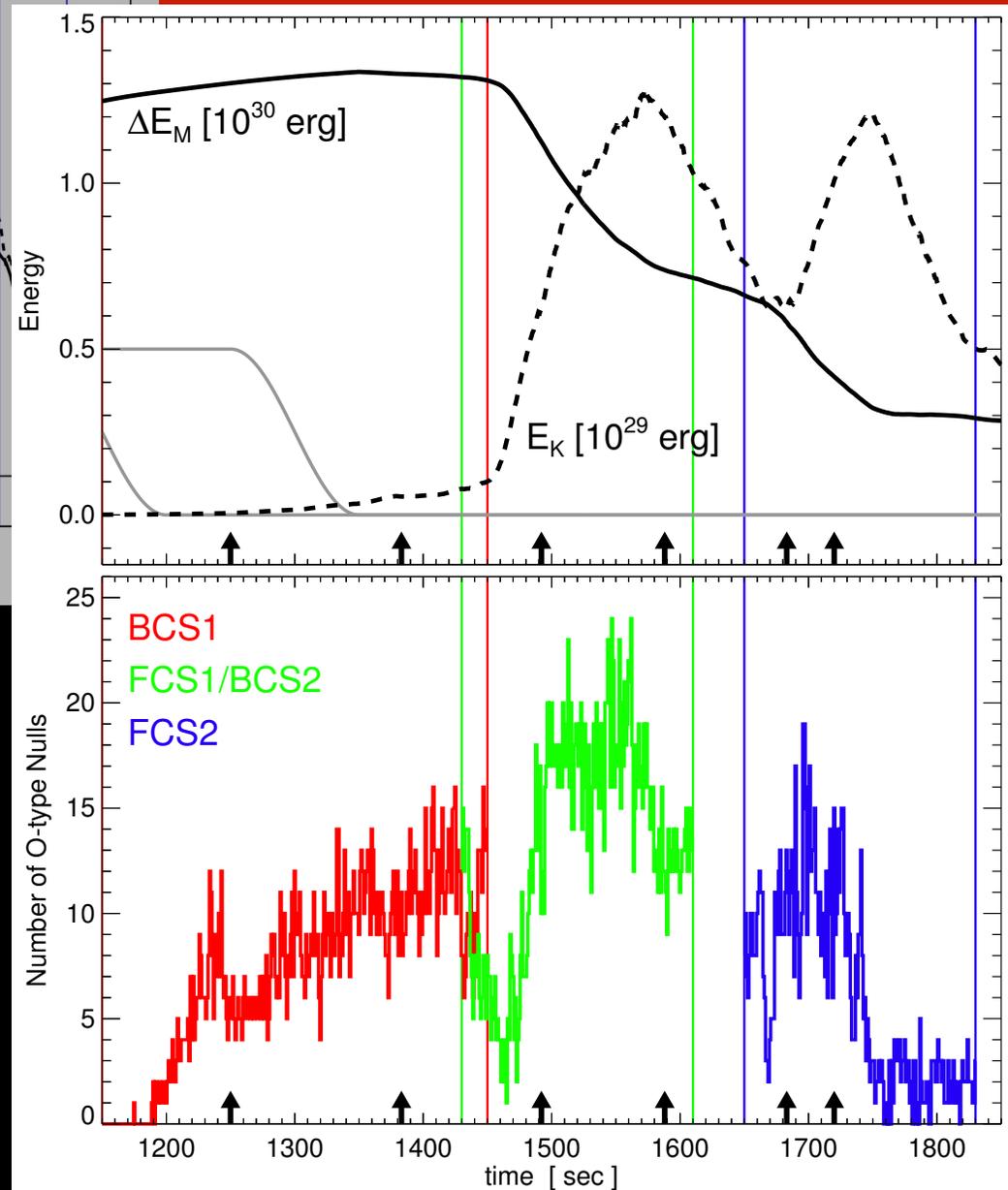
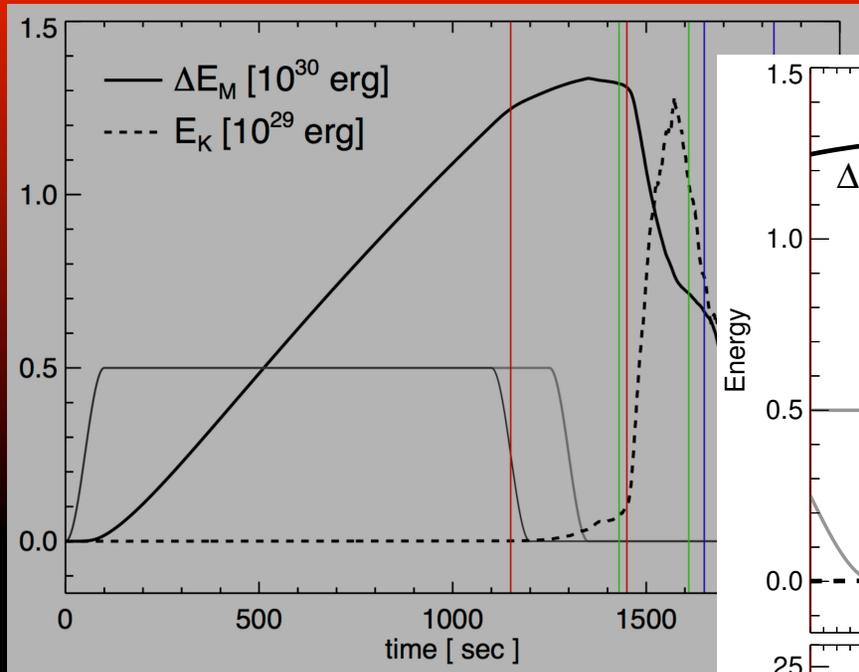
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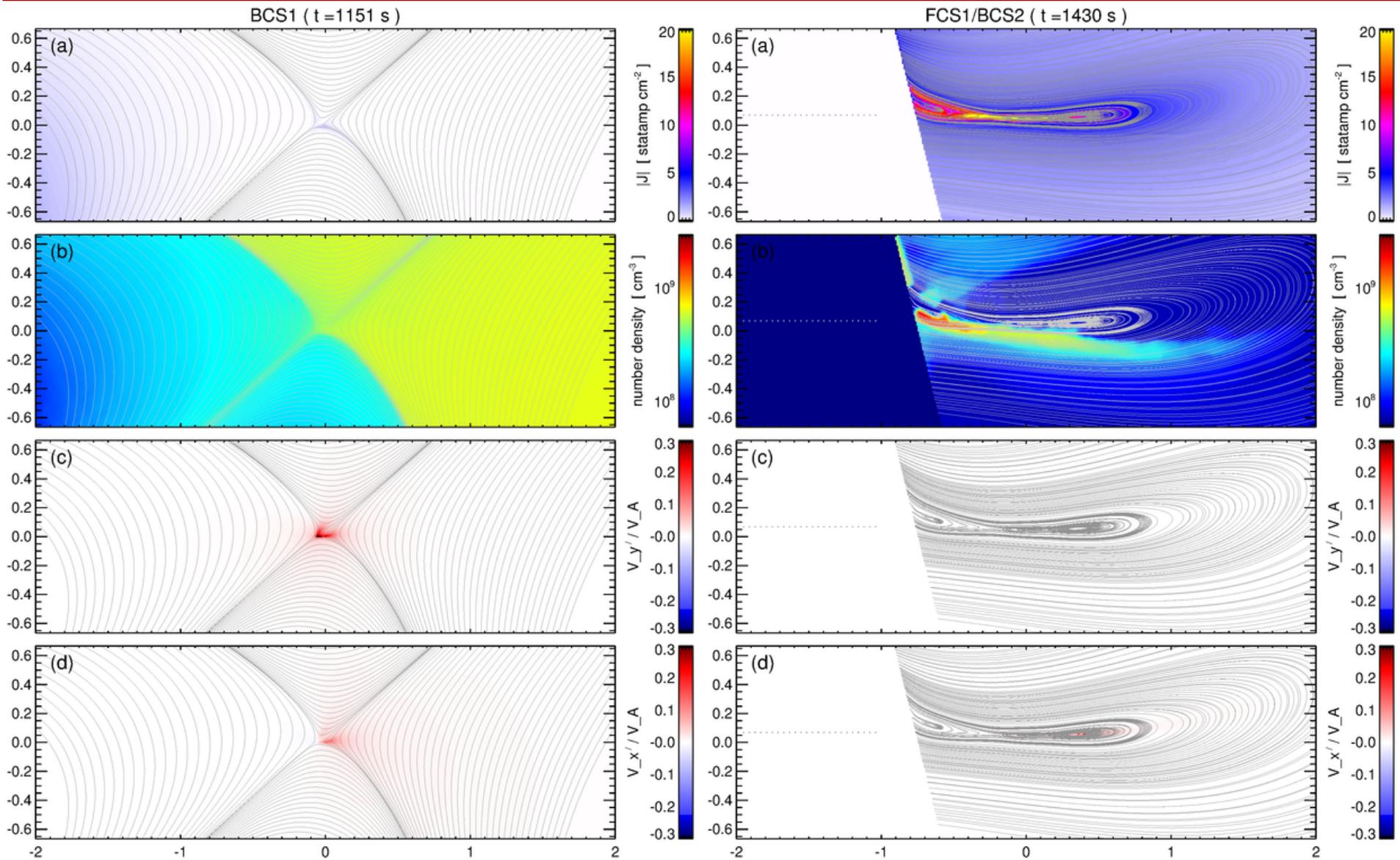
Role of CS Rxn in Eruption Scenario



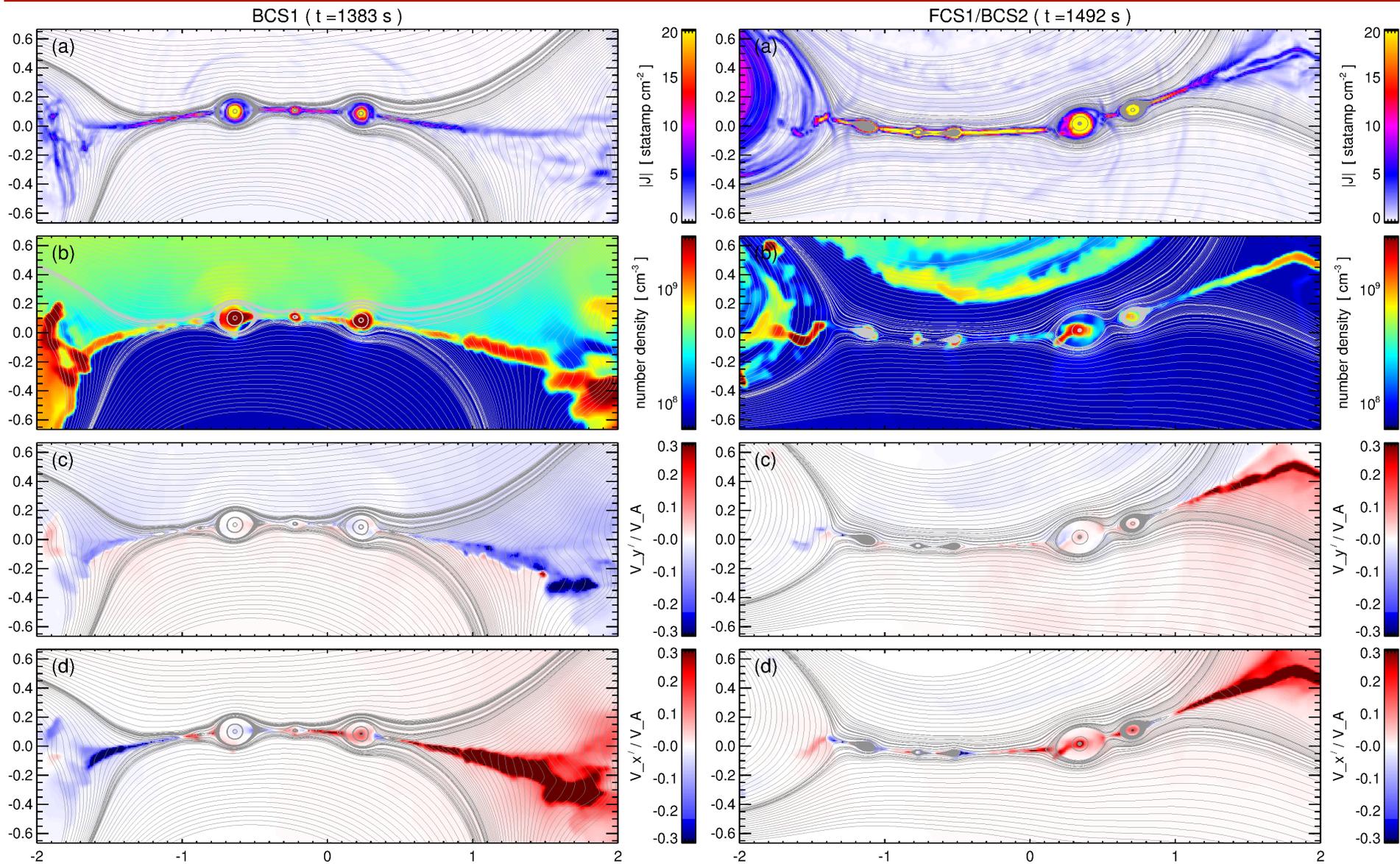
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- *Can Rotation Signatures Differentiate Between Different CME Initiation Models?*
- *What is the Exact Role of Magnetic Reconnection in CME Initiation?*
- *Can We use SDO/AIA Observations to Constrain/ Improve MHD Modeling of Reconnection and therefore CME Initiation?*

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