

# **Diagnosing coronal evolution using Stokes signals**

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# Plan of the Talk



## 1. One point:

**One understanding learned from previous works of the team**

## 2. Three projects:

**What I think might be interesting to do and might be able to use COMP data to put theory into a test**



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# Coronal Magnetism

# Coronal Magnetism

**Corona: tenuous, hot (1 - 2 MK) plasma**

**1. For good**

**Magnetic field drives plasma.**

**Force-free possibly a good assumption.**

**2. For less**

**Optical thin, need to know 3D structure.**

**Inversion possible?**

# Coronal Magnetism

1. Model inputs: physical quantities

vector  $\mathbf{B}(x,y,z)$ ,  $\rho(x,y,z)$ ,  $T(x,y,z)$

2. Observations:

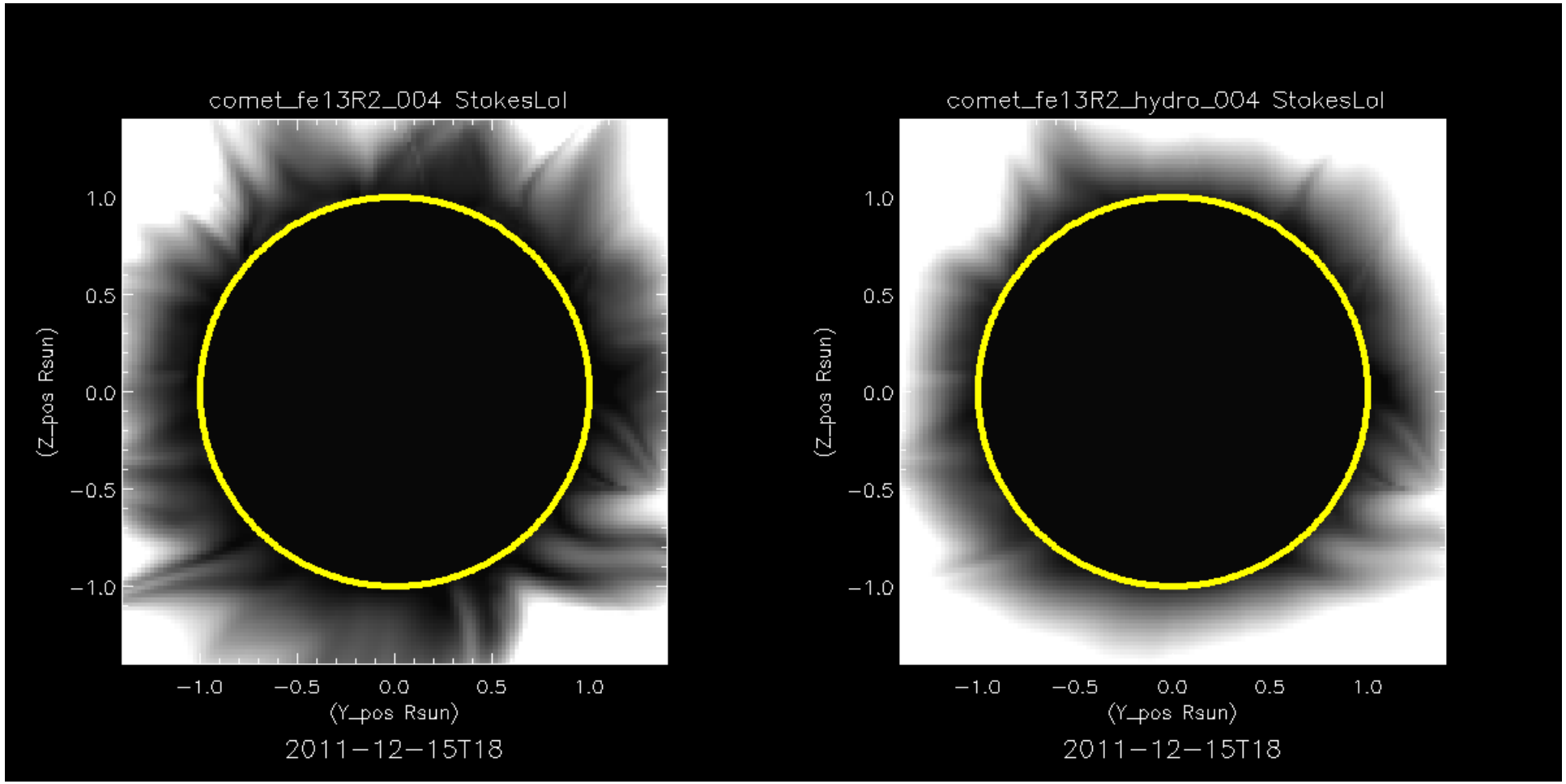
$I$ ,  $Q$ ,  $U$ ,  $V(x,y)$  for a few lines

$I(x,y)$  in EUV, radio etc.

**Physical quantities coupled in a complicated way to produce observables.**

(Adopted from Cooper's presentation last year)

# Spherical Symmetry L/I

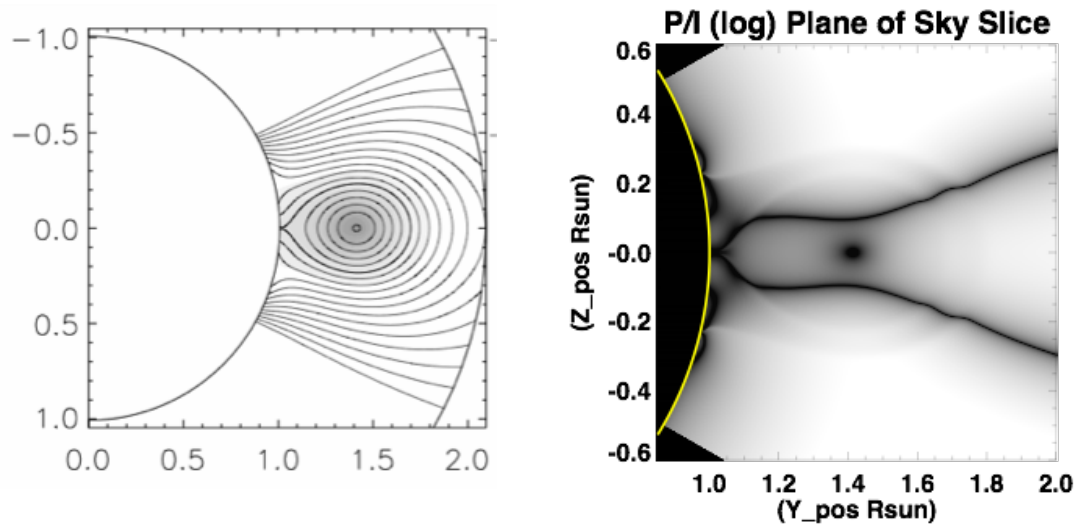


MHD Field + MHD Plasma

MHD Field + Symmetric Plasma

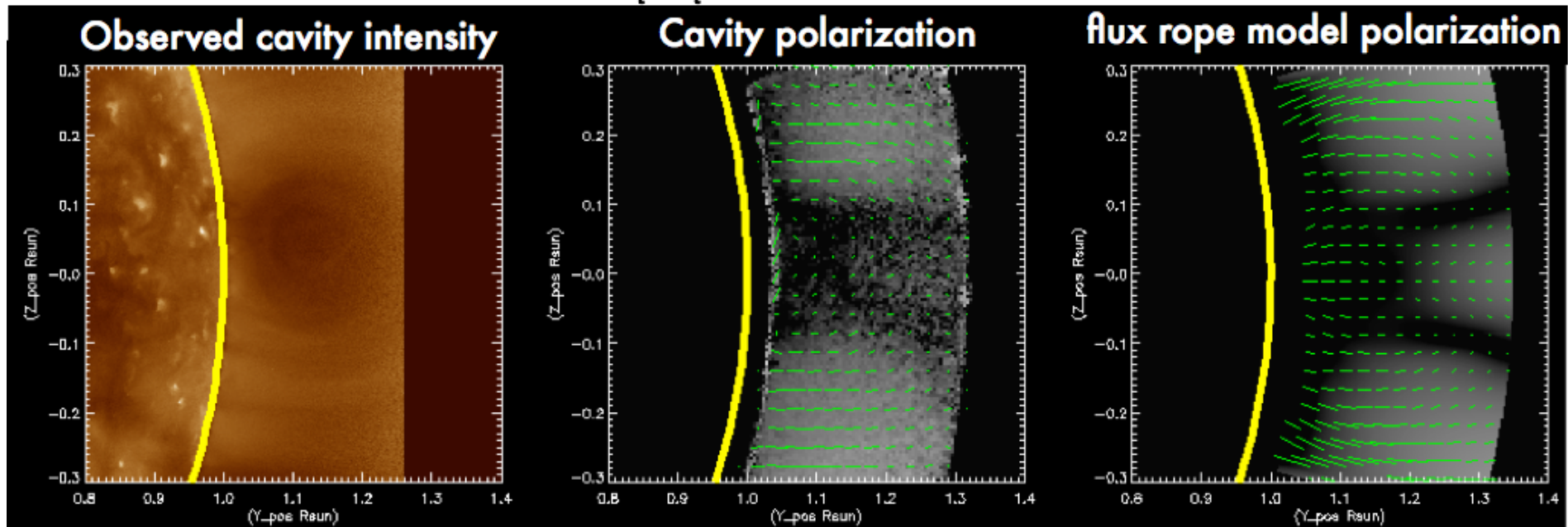
**Fe XIII emission is density weighted → plasma profile matters!**

# However, we may be able to see the flux ropes!



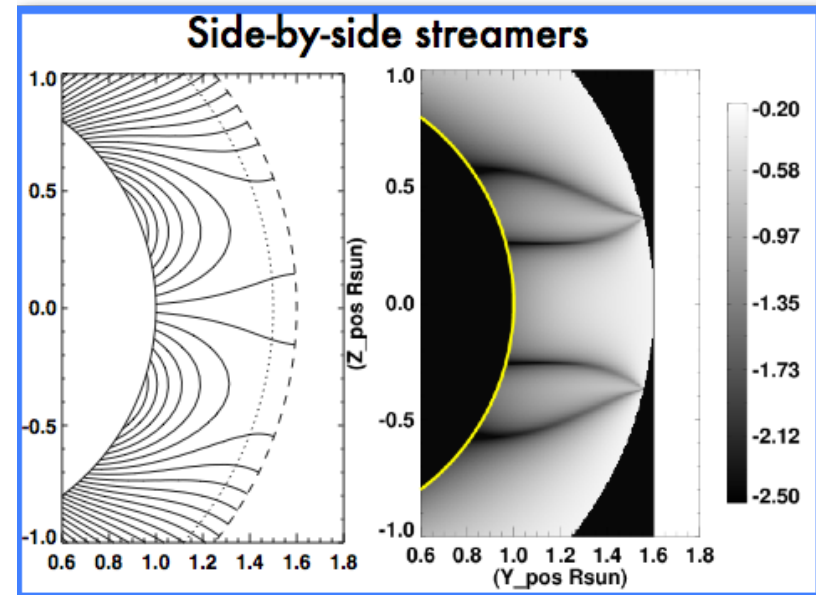
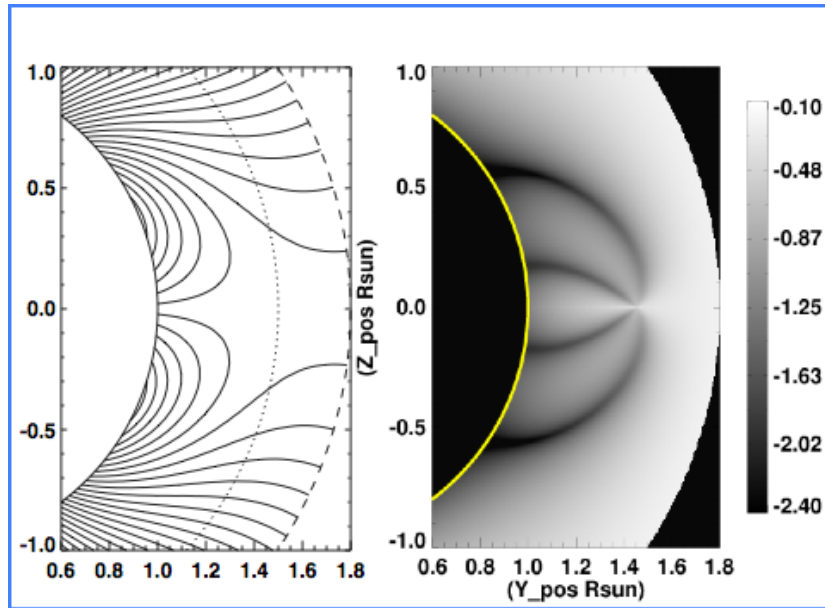
(Adopted from Laurel's presentation last year)

Urszula Bąk-Stęślicka

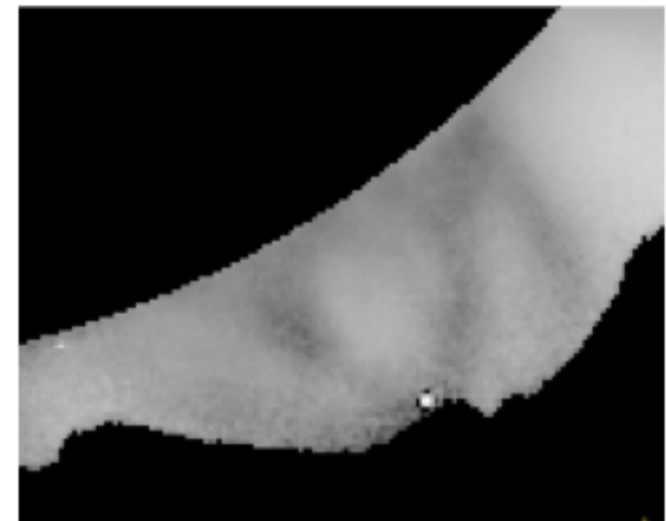


# As well as streamers .....

(Adopted from Laurel's presentation last year)



CoMP  
Jan 15, 2013  
SW limb





## The point

**So, we may be able to detect the field topology.**

**Though not the field strength itself.**

**A good ‘warm-up’ is to extend Cooper’s exercise to see how plasma density influence the  $Q/U$  (azimuth) in addition to (rather than)  $L/I$ .**

**If good, we have.....**



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**Things to do**

# Three projects

## Diagnose processes of coronal evolution:

### 1. Coronal field reversal (time scale: months/years)

In response to magnetic flux emergences

In relation to field reversal on the photosphere

### 2. Formation of magnetic flux ropes (time scale: hours)

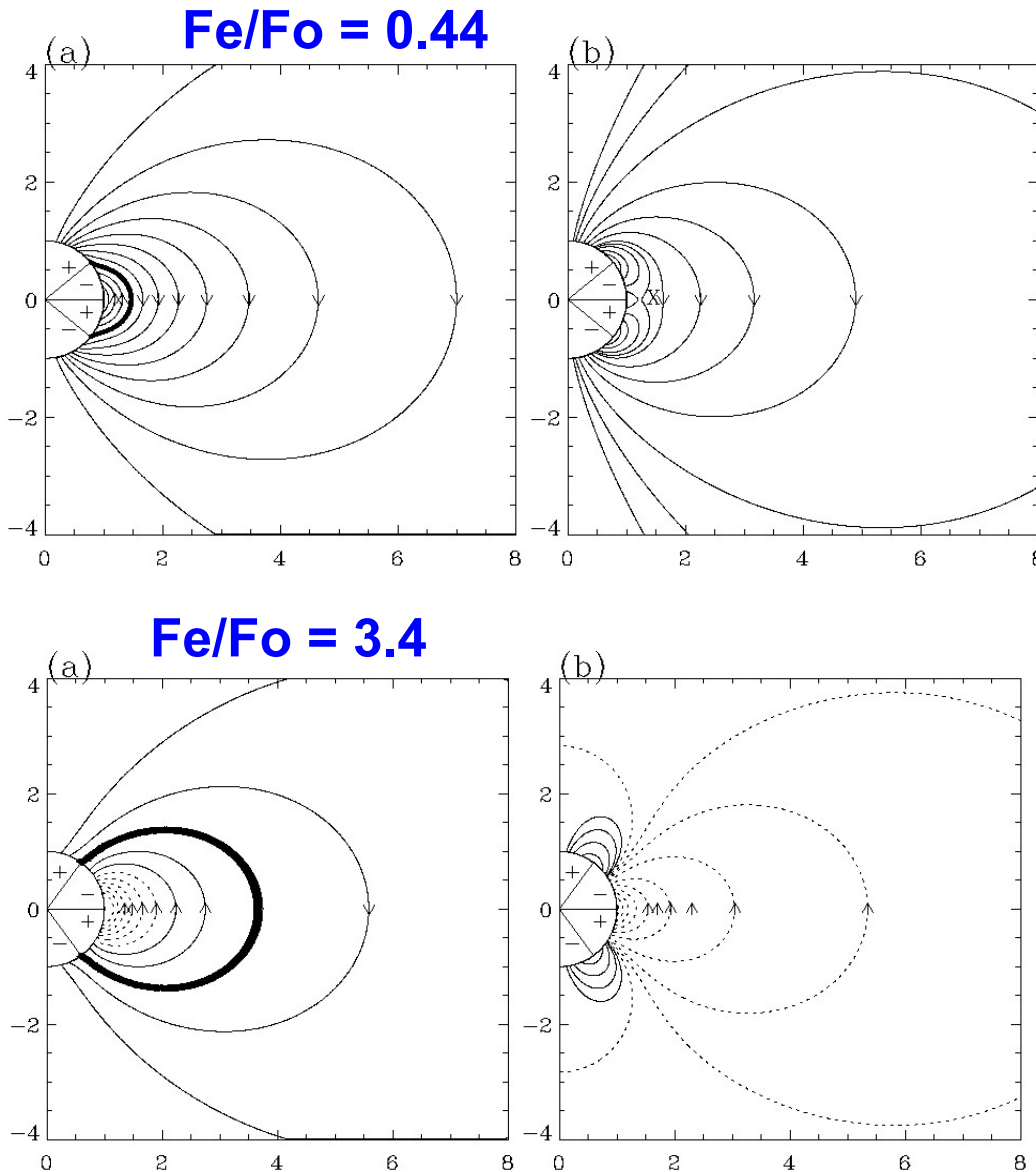
As a result of Taylor relaxation

As evidence of magnetic reconnection

### 3. Accumulation of magnetic helicity (time scale: weeks)

that would result in CME eruptions

# 1. Coronal magnetic field reversal



- Coronal magnetic field reverses in response to flux emergence
- Coronal magnetic field reverses **before** photospheric field does.

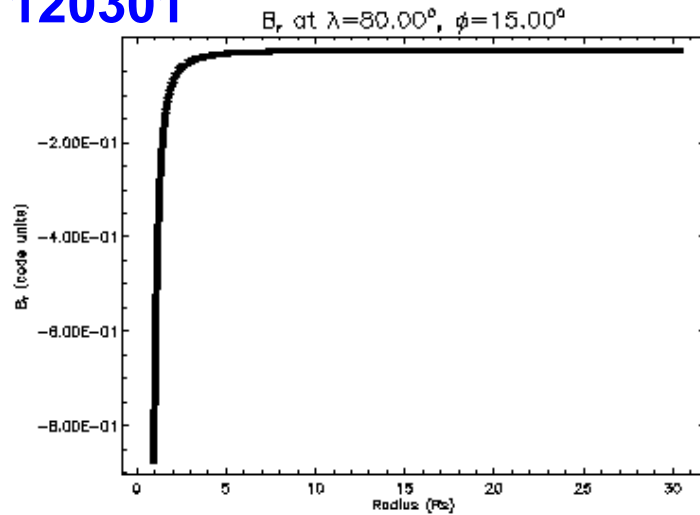
(Zhang and Low, 2001, ApJ, 561,406)

# Coronal magnetic field reversal

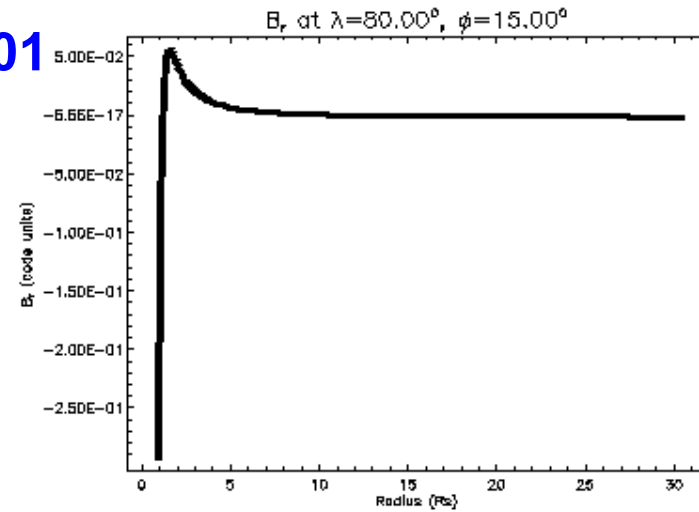
(Images from web page of Predictive Science Institute)

## Also in MAS model

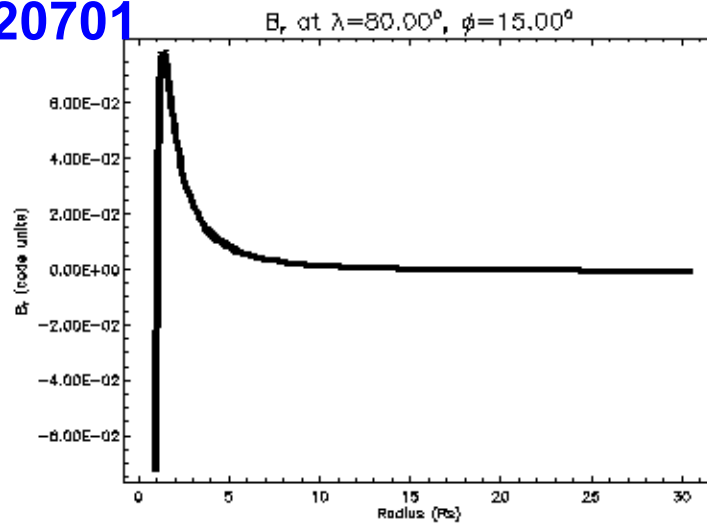
120301



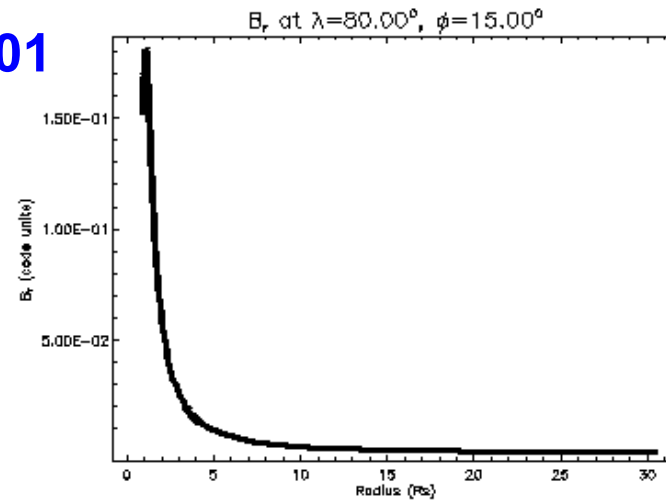
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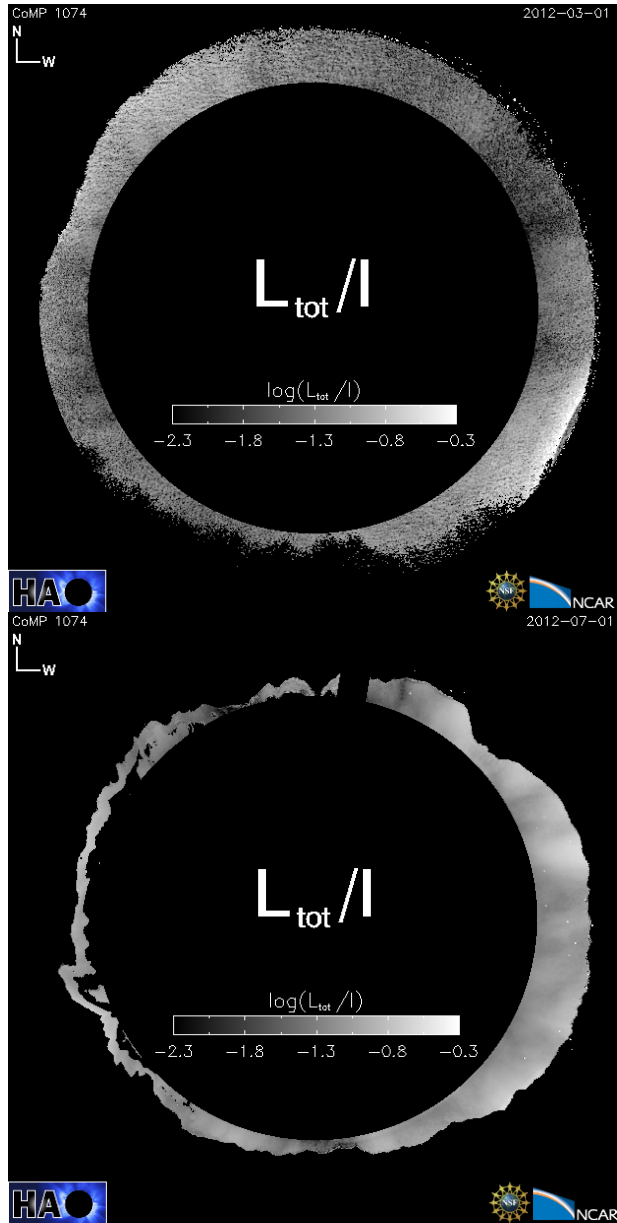
120701



120901

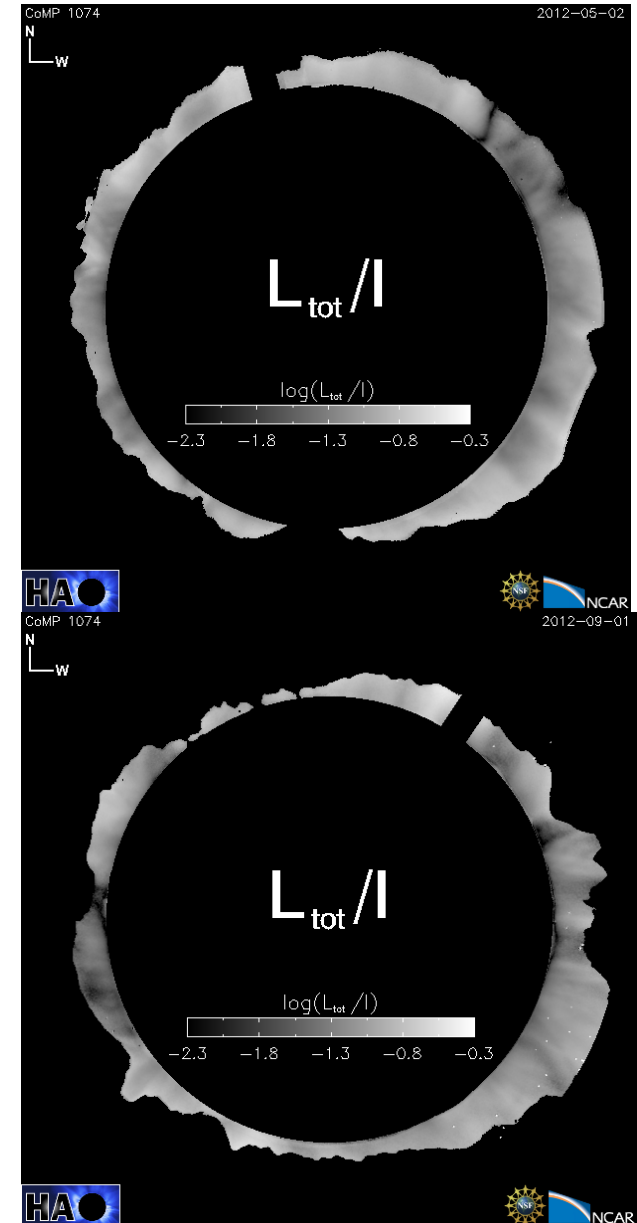


# Coronal magnetic field reversal



Seen in  
COMP?

Images from  
HAO/NCAR  
webpage

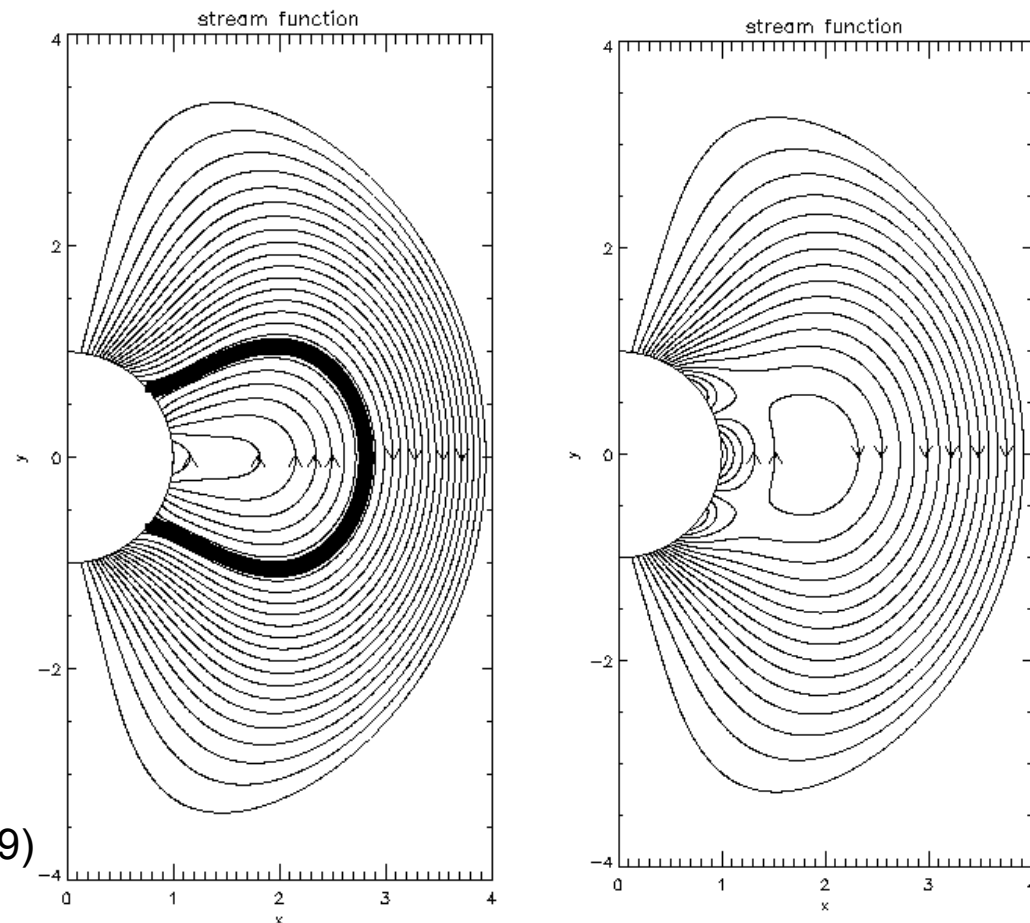


## 2. Formation of Flux Ropes in the Corona

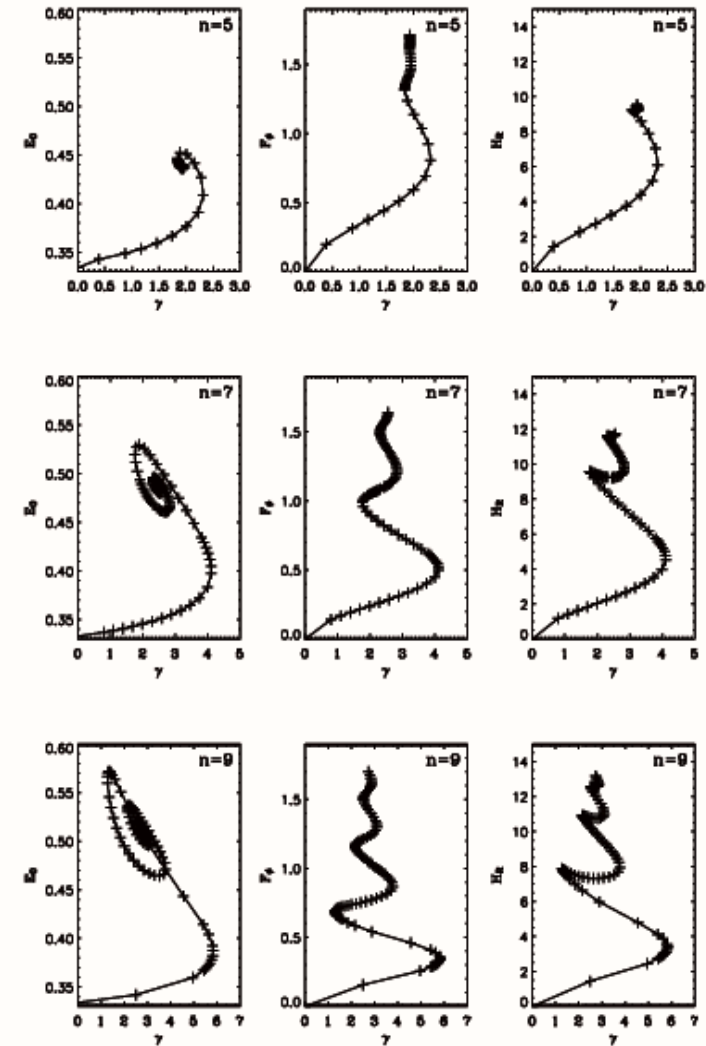
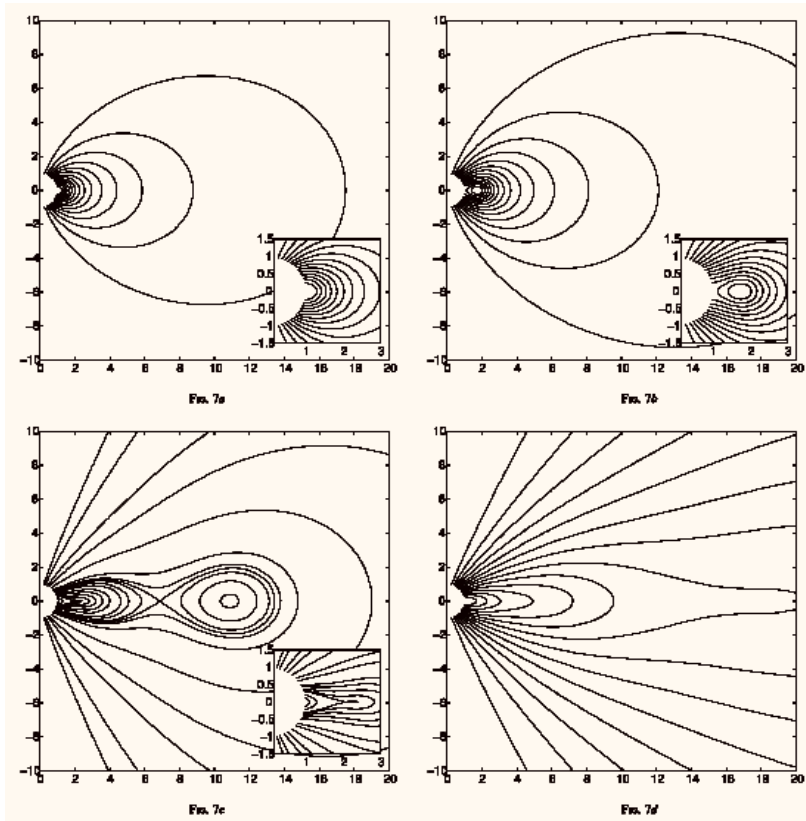
**Taylor relaxation (1972):** Turbulent reconnections take place to relax the field to Woltjer minimum-energy state under helicity conservation.

As a result of Taylor relaxation, magnetic flux ropes will form in the corona, as long as enough total magnetic helicity has been transported into the corona.

(Zhang & Low 2003, ApJ, 584, 479)



# 3. Consequences of helicity accumulation: CME takes place



Nonlinear force-free field calculations indicate that there may be an upper bound on the total magnetic helicity that force-free fields can contain.



## Summary

1. We may be ready to use COMP data to diagnosis field topology.
2. There are a few physical processes of coronal evolution that we could use COMP data to put theories into test.

**Of course, we love to measure the vector  $B$  directly!**

**Thank you for your  
attention!**



**Huairou Solar Observing  
Station, NAOC**