

# Observations of small scale reconnections during the emergence of undulated flux tubes

Pariat E.<sup>1</sup>

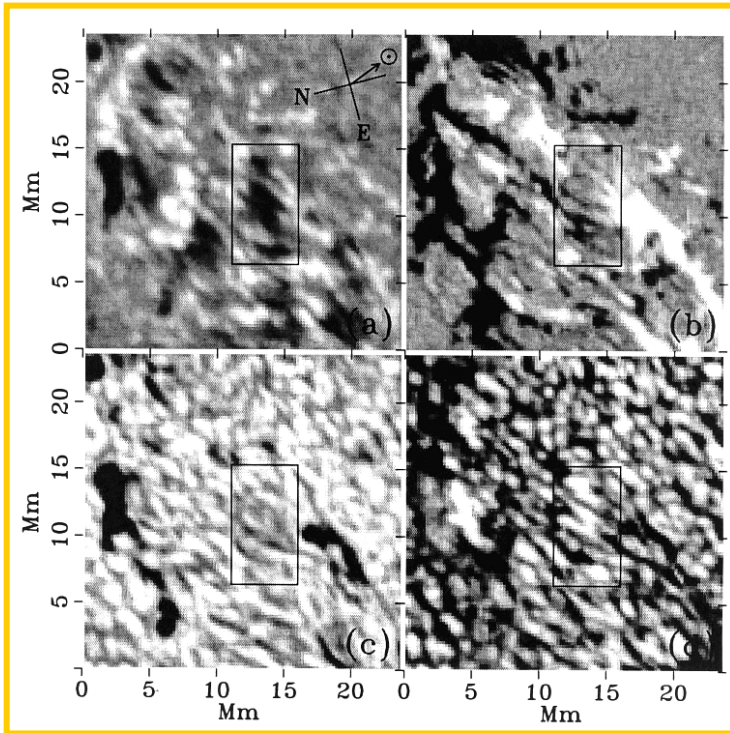
In collaboration with:

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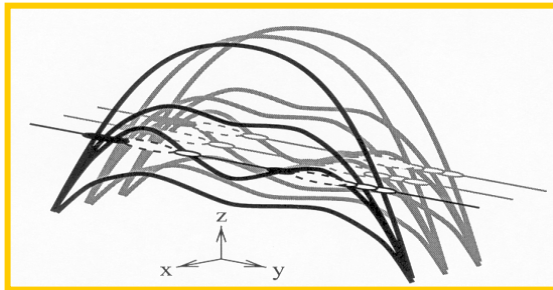
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<sup>2</sup> John Hopkins University/ Applied Physics laboratory

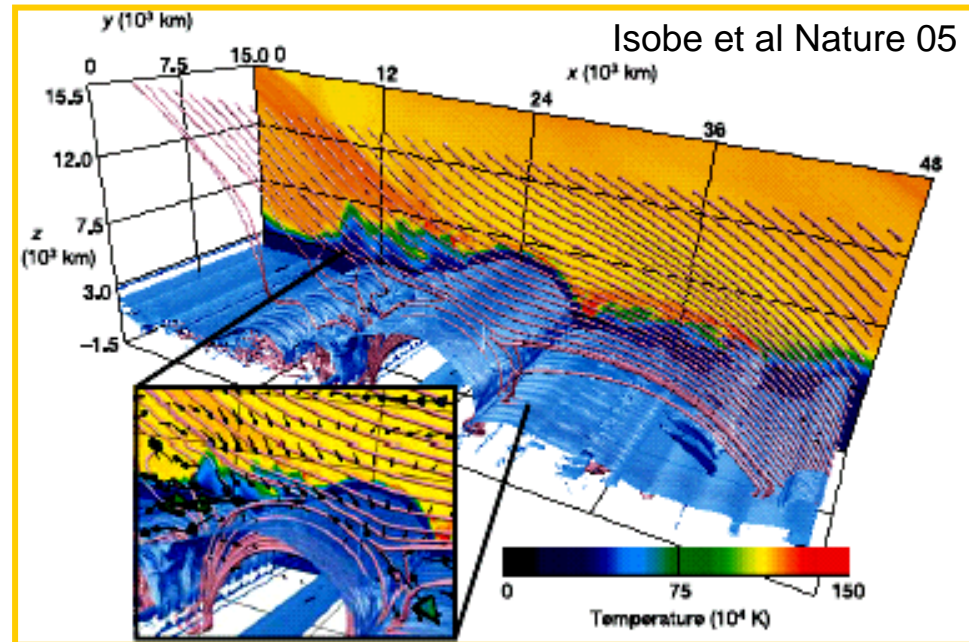
# Existence of the « sea-serpents » topology ?



Strous &  
Zwaan  
ApJ 99

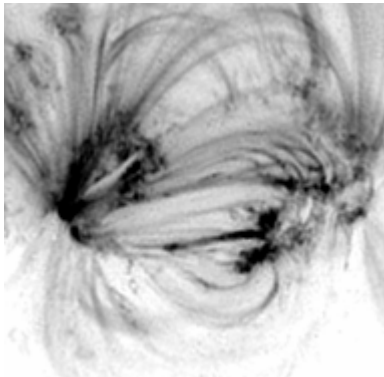


- Suggested by some observations
- Commonly seen in numerical simulations



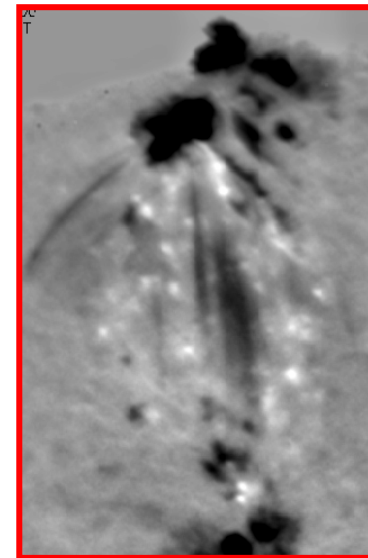
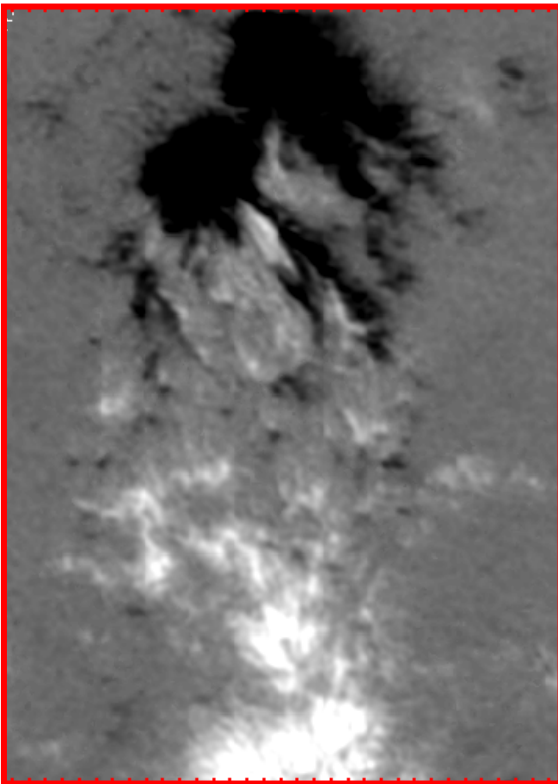
Are there more direct observations of undulated flux tubes ?

# Multi- $\lambda$ observations



TRACE 171 A January 25 2000 at 18:02 UT

- Coordinated obs. of an emerging active region: AR 8844 in 2000/01/25
- TRACE, SoHO, Yohkoh
- Flare Genesis Experiment:
  - 80 cm Balloon borne Telescope
  - Dopplergrams
  - H $\alpha$  -0.8 A filtergrams (low chromosphere)
    - Rising loops
    - Brightening: Ellerman bombs
  - **High resolution vector magnetograms** (pix. siz. 0.2'')
    - Vertical field extremely intermittent





# Magnetic field extrapolation

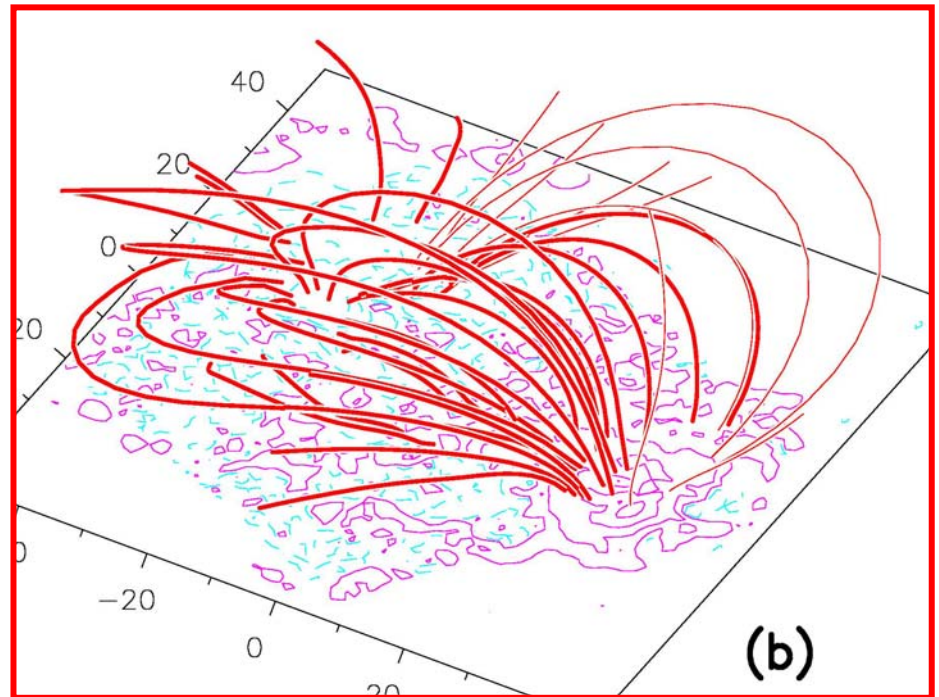
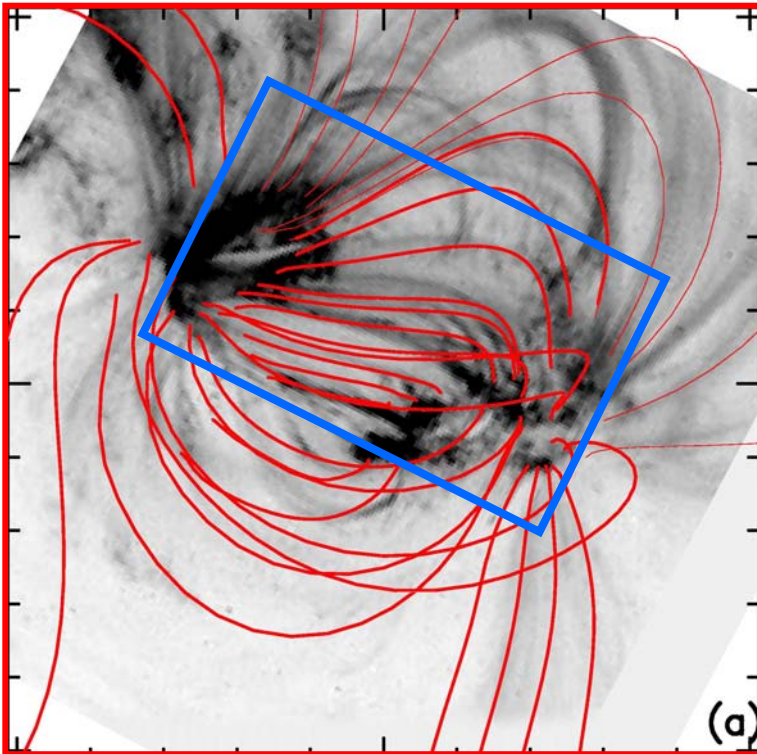
- **Linear Force free field extrapolation:**

- Observations used to set the free parameter  $\alpha$

$$\nabla^2 \vec{B} + \alpha^2 \vec{B} = 0$$

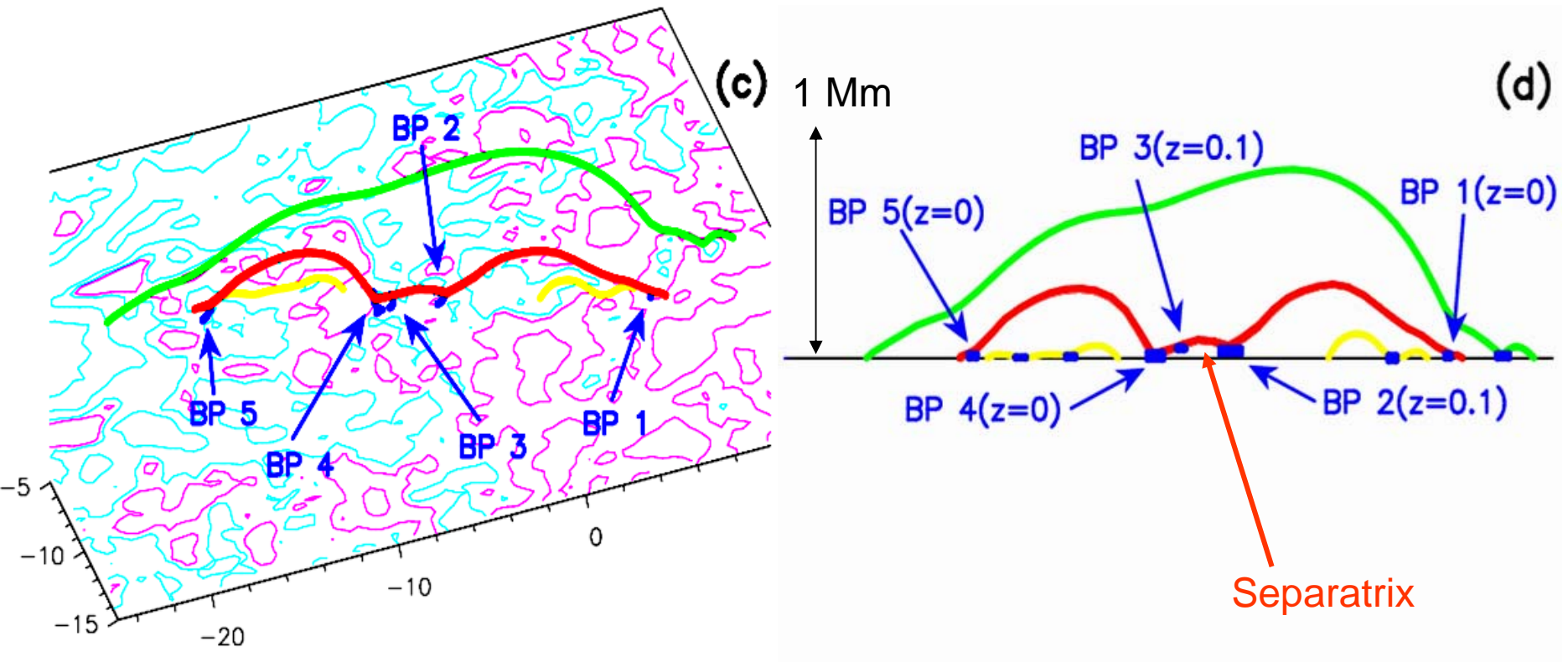
extrapolation code by P. Demoulin

- Comparison of some extrapolated field lines with the UV loops (TRACE) :



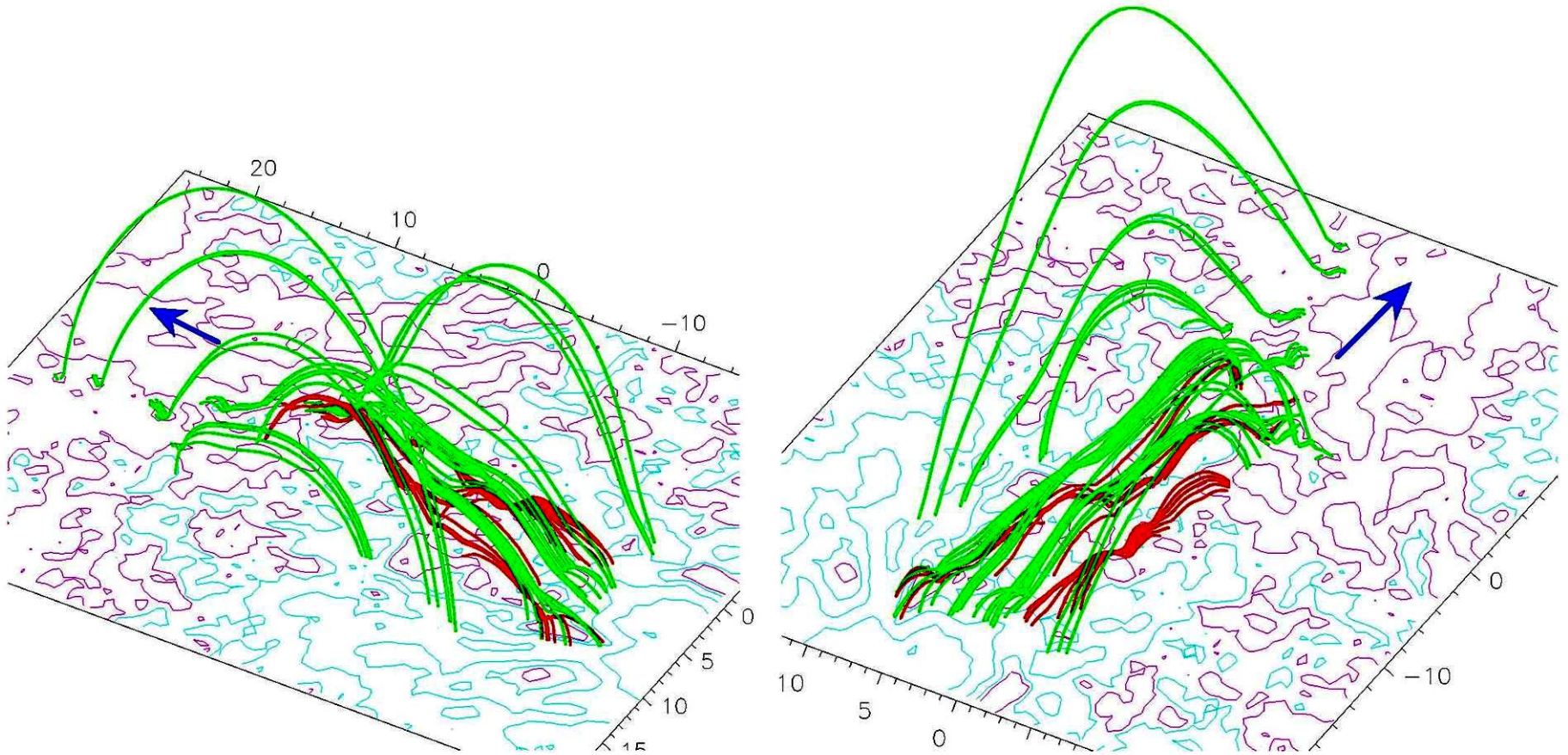
$$\alpha = 2.2 \cdot 10^{-2} \text{ Mm}^{-1}$$

# Low chromosphere magnetic topology: serpentine field lines



**Flux tubes are undulated and connected to the photosphere by several Bald Patches (BPs)**

# Serpentine field line topology



Pariat et al. ApJ 04

**Different types of field lines = different stages of the emergence?**



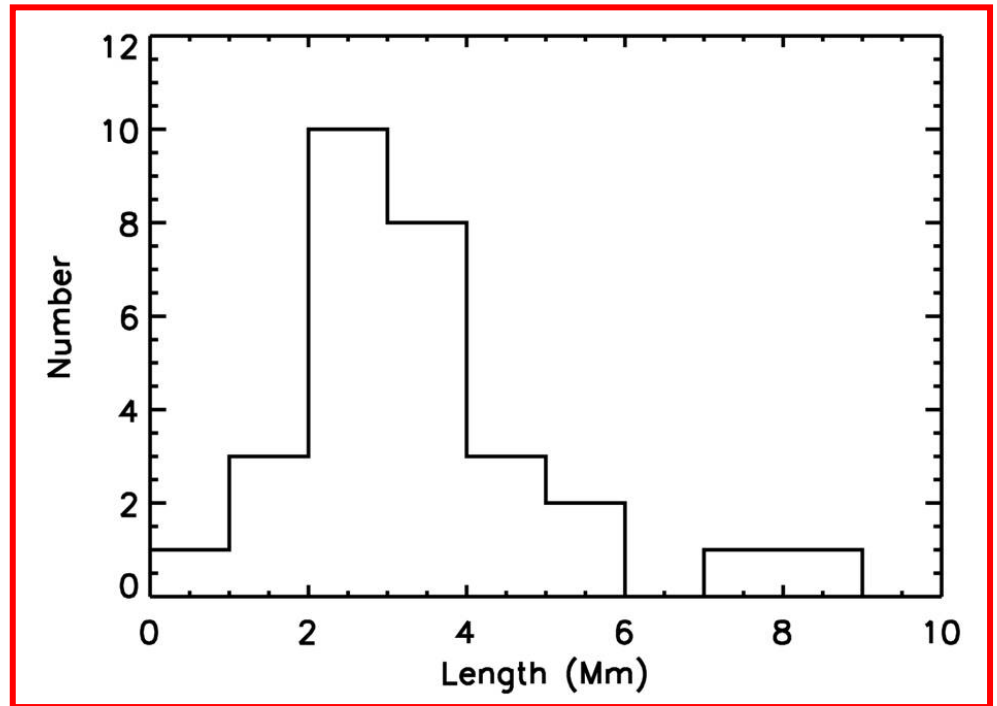
I.

**What is the physical mechanism  
which can undulate the flux tubes?**

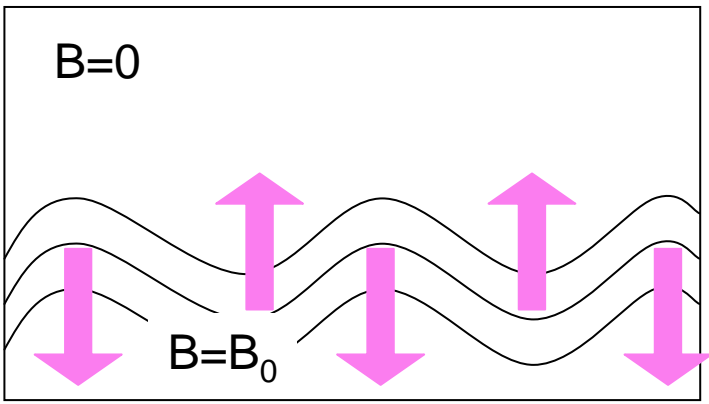
# What undulates the flux tubes?

Distribution of the distance between two consecutive BPs within serpentine field lines: Cutoff below  $\sim 2$  Mm

Consistent with the **Parker instability**:  
(Shibata ApJ 89, Magara ApJ 01, ...)



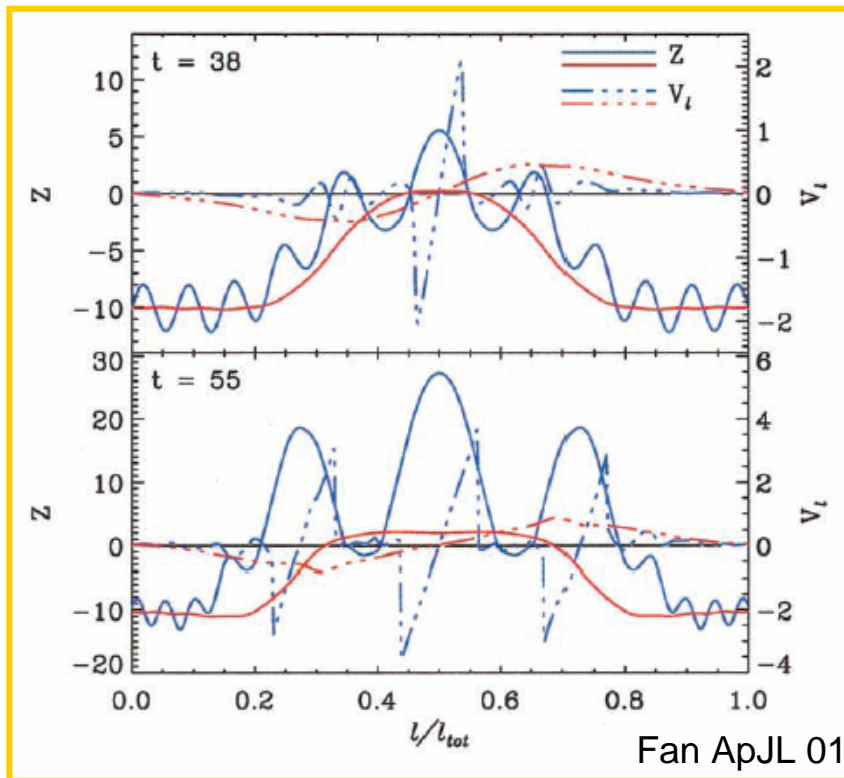
Pariat et al. ApJ 04



**Undulations for  $\lambda > \lambda_{\text{Parker,crit}}$**   
Photosphere at 5700 K :  
 $\lambda_{\text{P,c}} \sim 2$  Mm

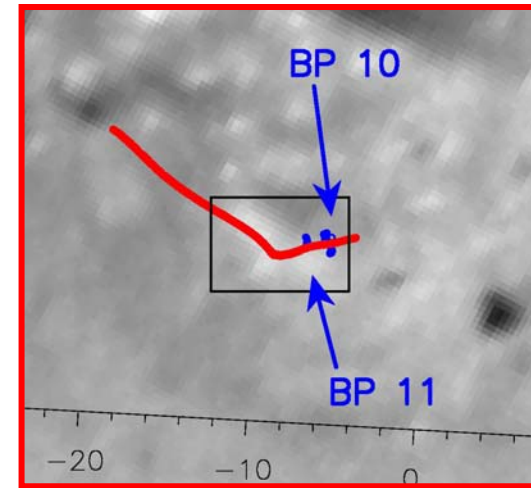
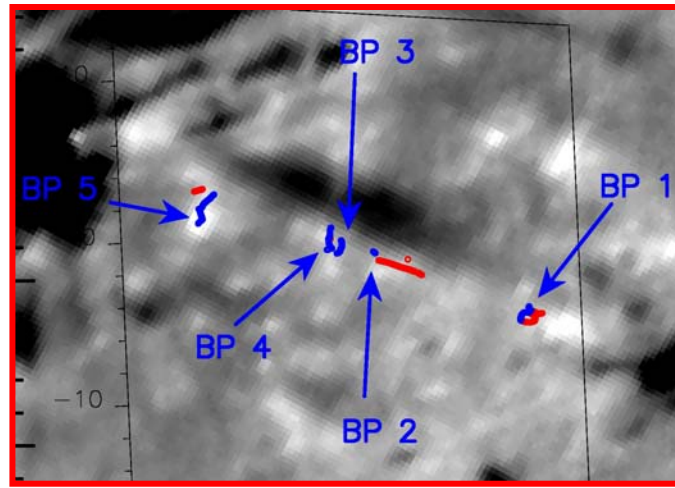
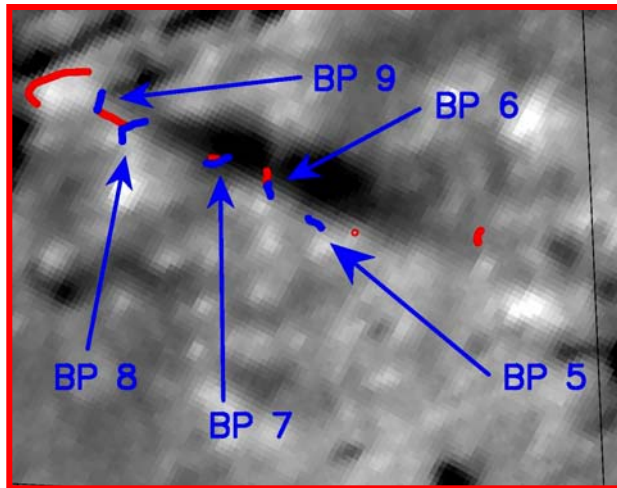


## II. How can the flux tubes get rid of the dense material trapped in and below their dips?



- Plasma flows along field lines:
  - material is trapped in the dips: flux tubes cannot emerge completely.

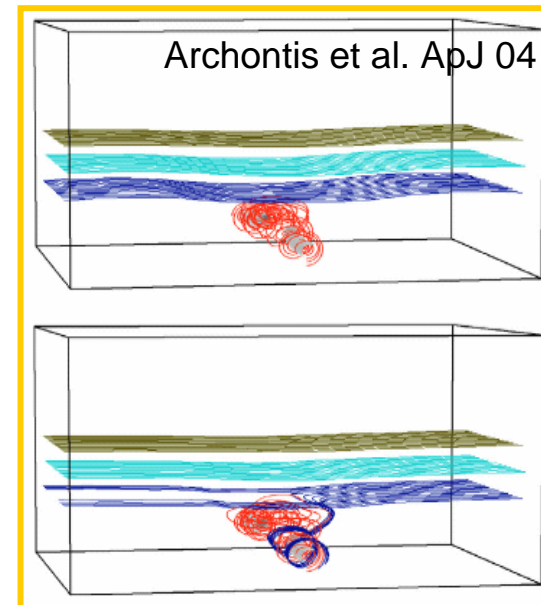
# How do the flux tubes extract themselves from the photosphere ?



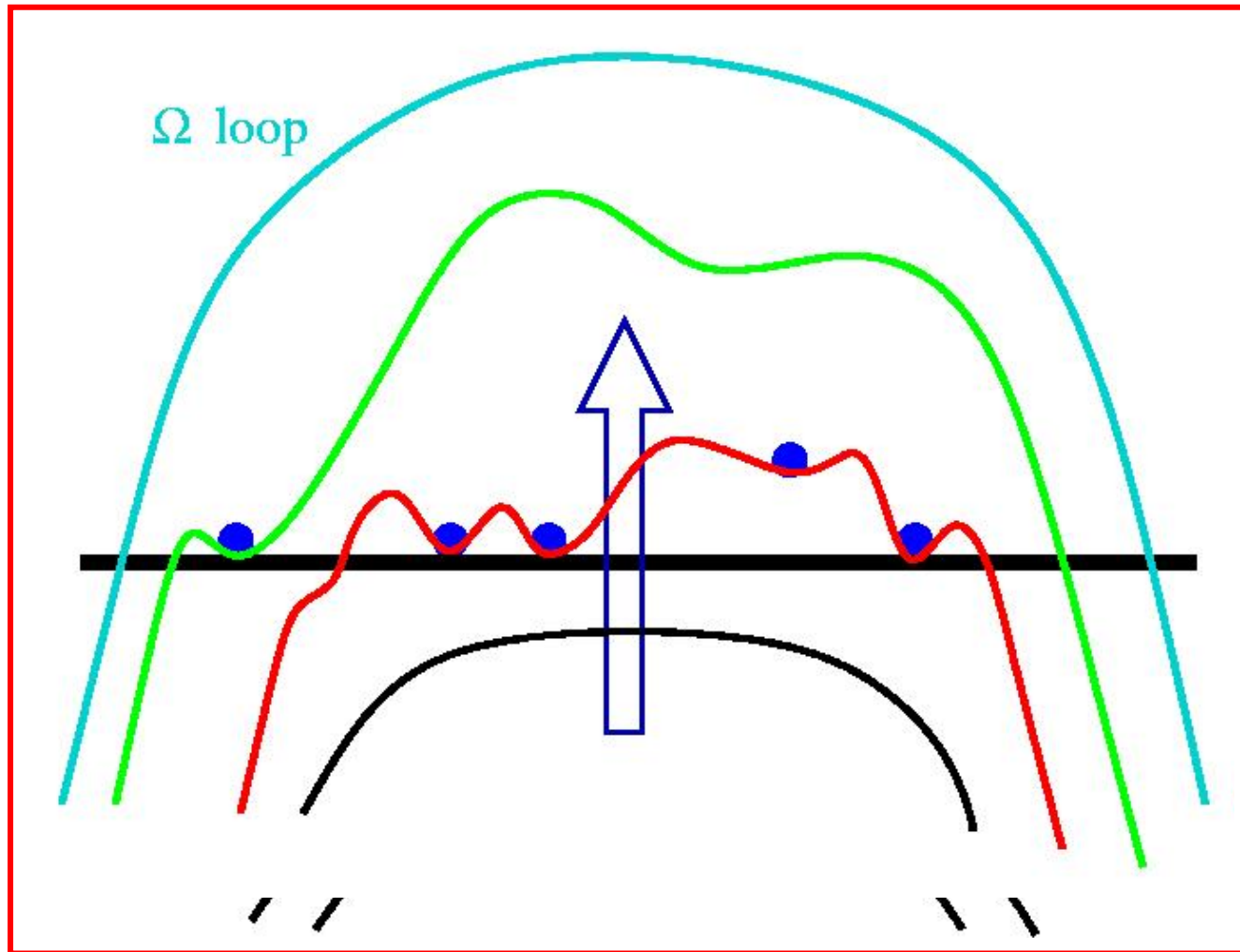
Pariat et al. ApJ 04

- **High correlation between Bald Patches and Ellerman bombs**
- Reconnection occurs all along the undulated emerging flux tubes:
  - allows flux tubes to dispose of the plasma trapped in the dips

**Reconnection is a key mechanism of the emergence**



# Conclusion: a resistive emergence scenario



# The End



# Correlation BPs/EBs

Observations in  $H\alpha - 0.8 \text{ \AA}$

Good correlation between  
local brightenings (47)  
and:

- Bald Patches  
(blue dots) : 23
- Separatrix footpoints  
(red dots) : 15

