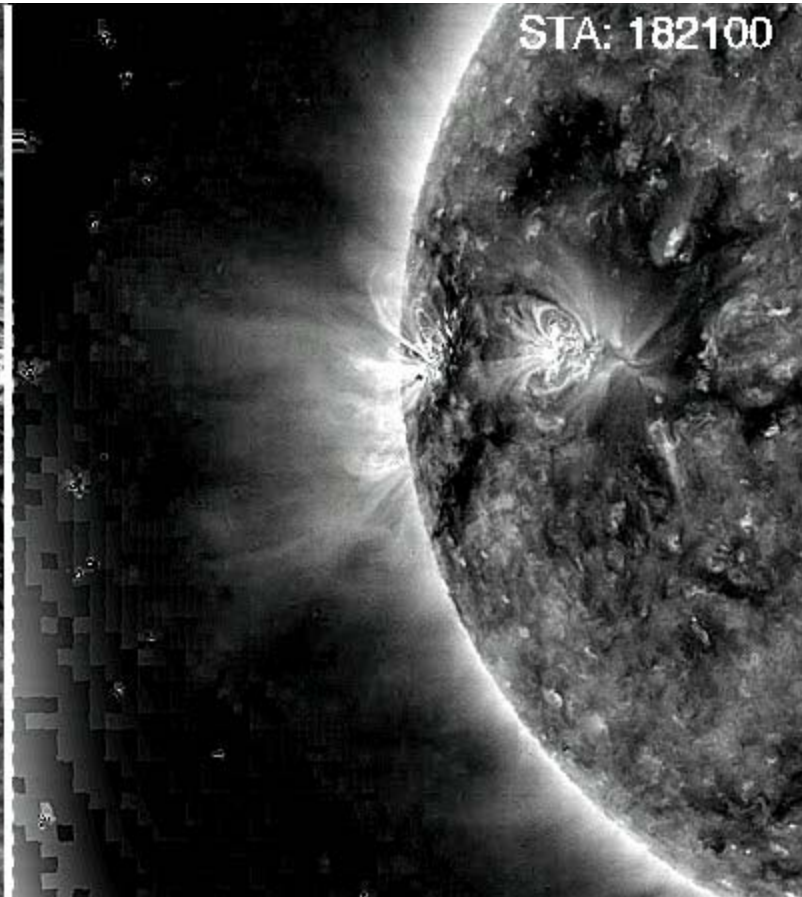
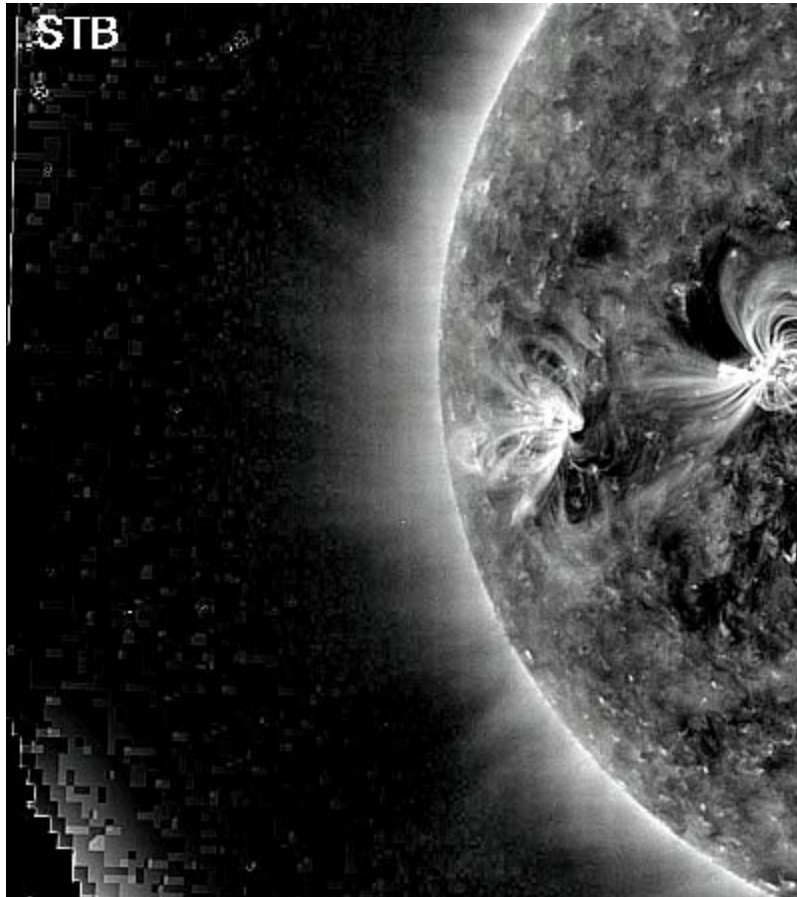




## **CME Initiation in 3D**

**Patsourakos, Vourlidas, Kliem**

# Observing the Genesis of Impulsive CMEs

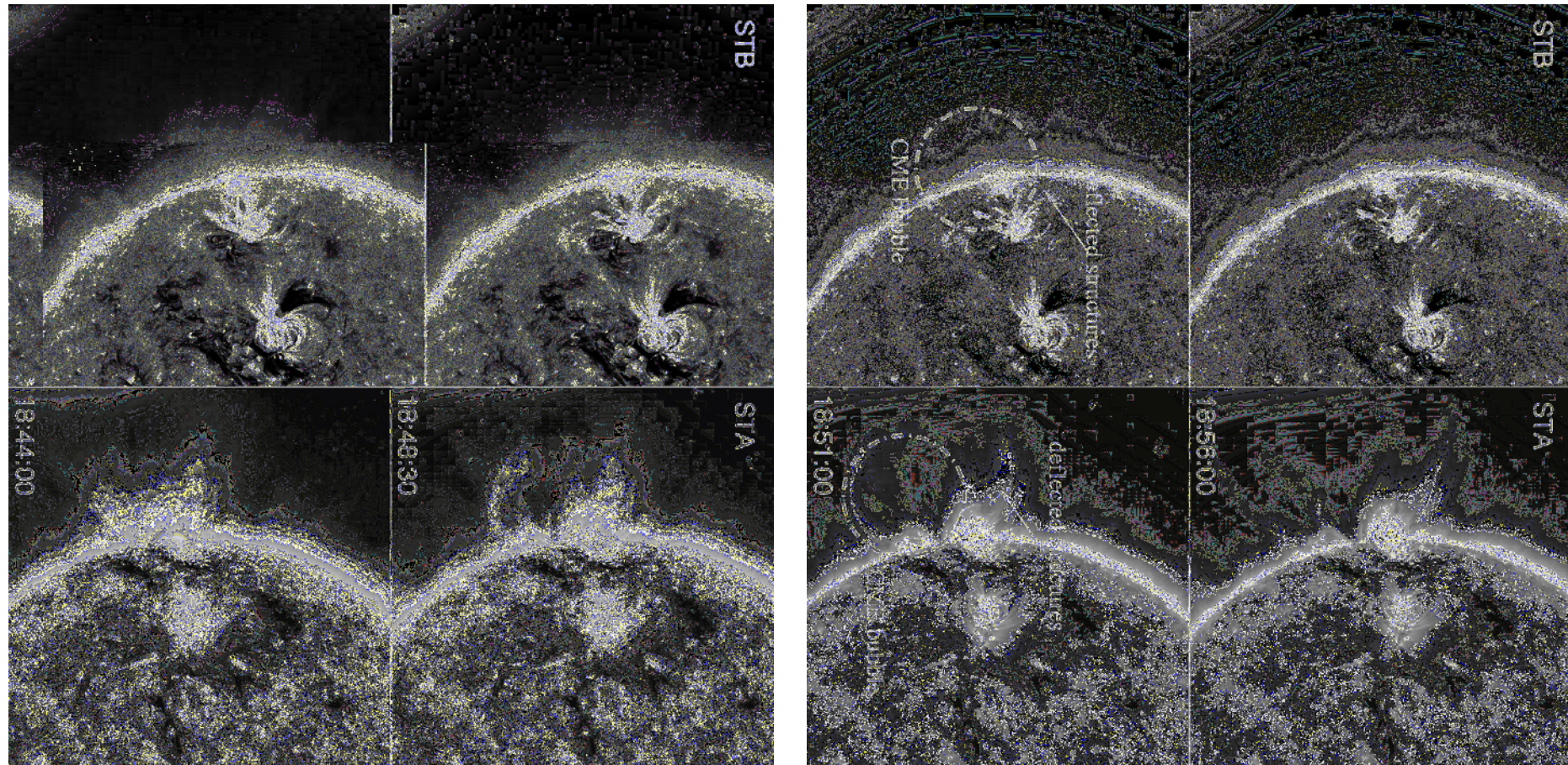


25 March 2008 – 47 deg separation

huge bubble forms in 10 min  
typical of impulsive CMEs;  
12-31-07, 1-2-08, 2-13-09, ...

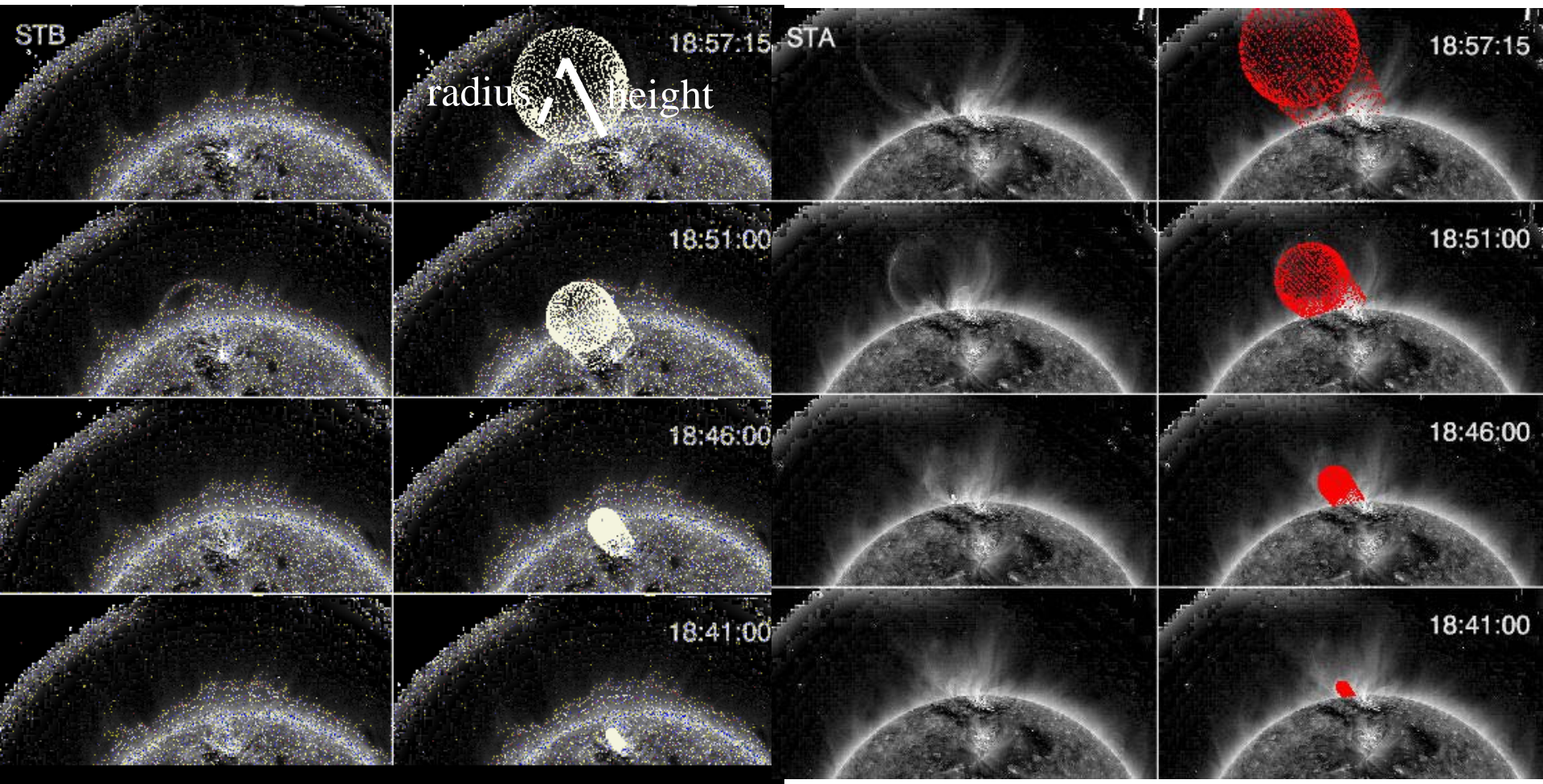
# Two Views Determine the 'Real' Bubble

Patsourakos et al (2010)



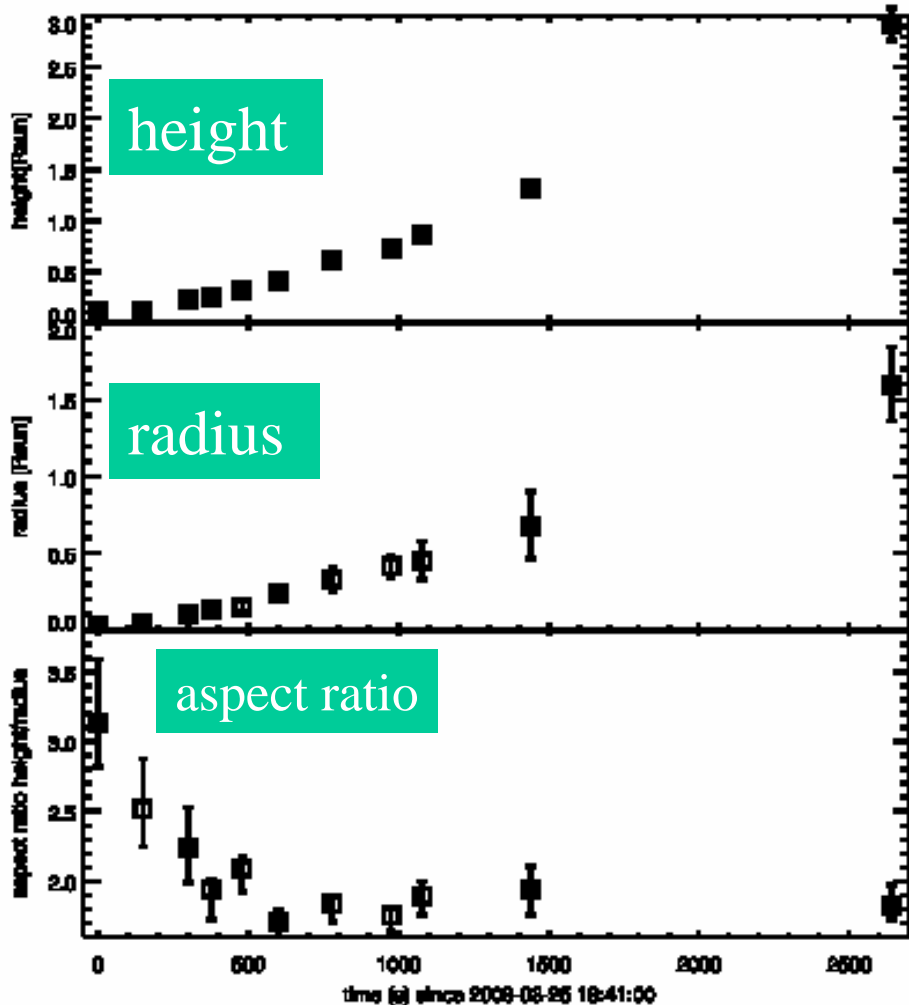
Transformation of a set of loops into a bubble  
'real' bubble induces deflections which could confuse analysis ...

# 3D Modeling of the Bubble



Use parameterized geometric 3D model of Thernisien et al.  
to simultaneously fit the bubble in A+B

# Bubble Evolution

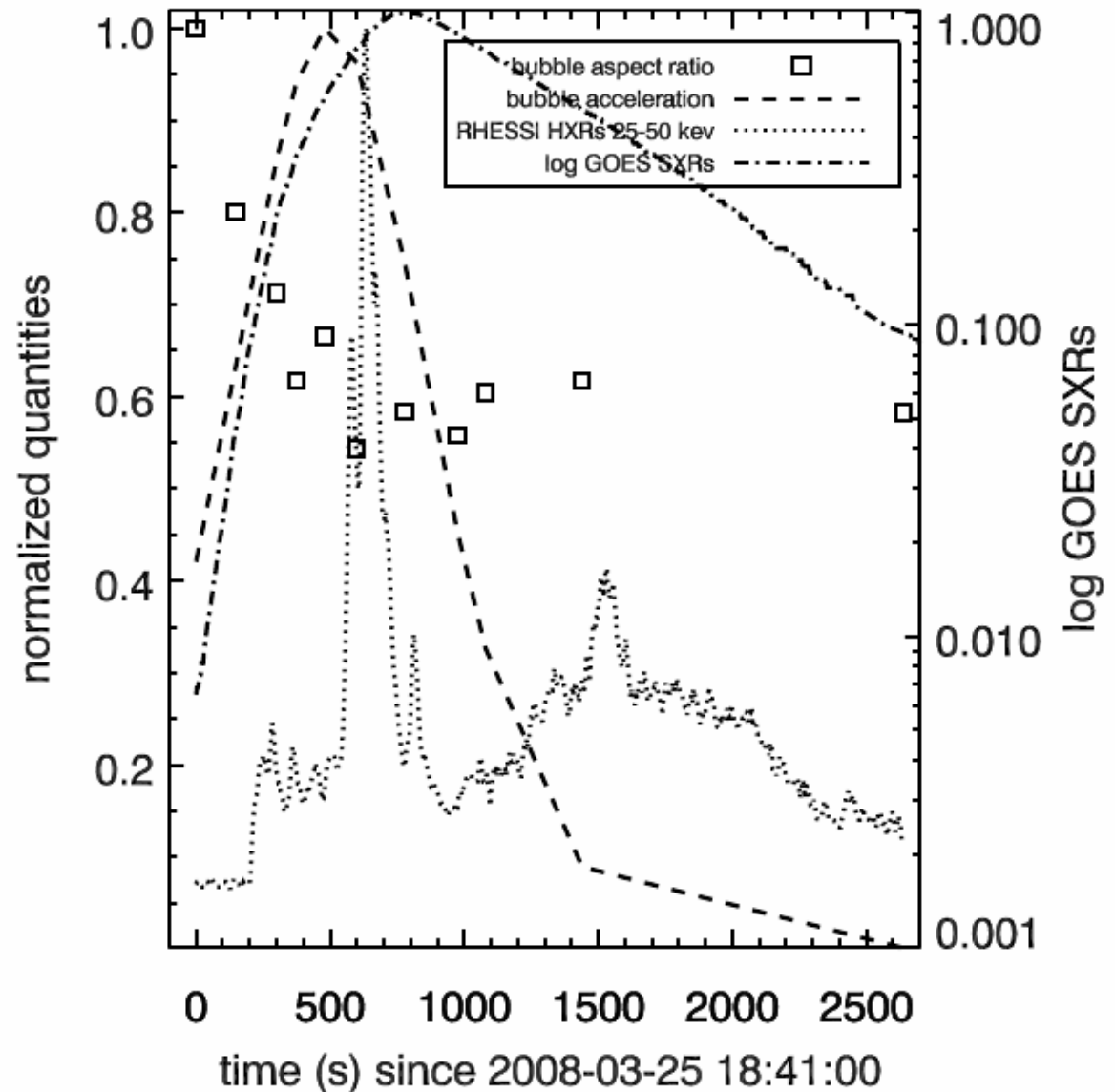


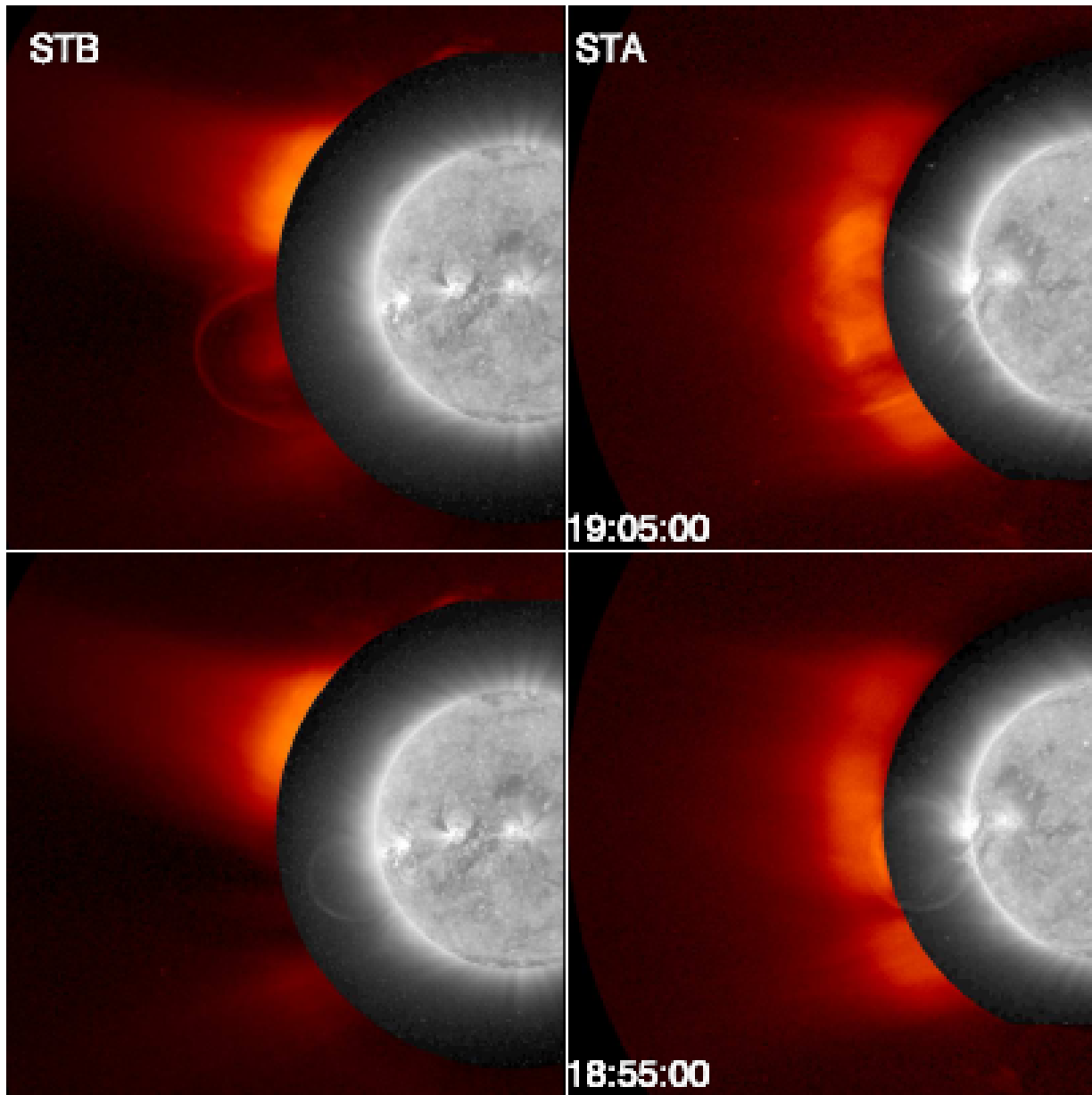
## CONCLUSIONS:

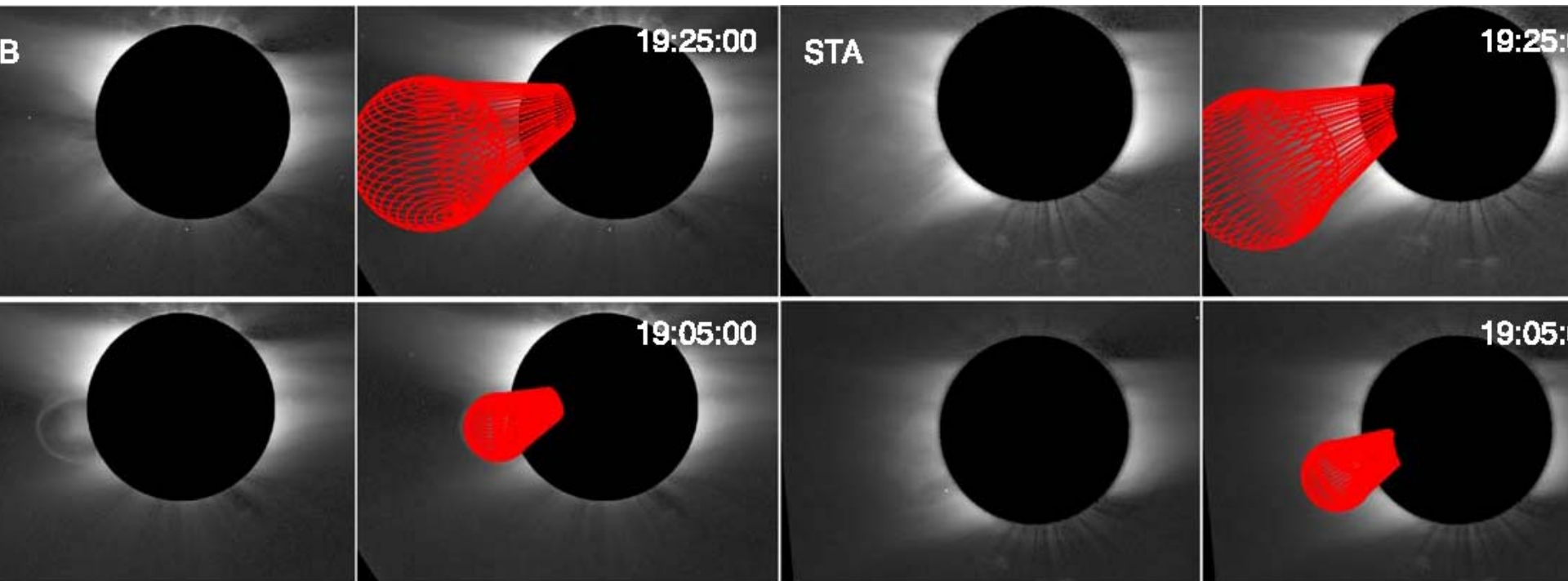
- Expansion speed  $\sim 1000$  km/s
  - Aspect ratio decreases with time
  - Conversion of arcade  $\rightarrow$  flux rope
- $\rightarrow$  Part of the flux rope forms on-the-fly

# Flare-CME Synchronization

**Non-linear expansion of flux rope coincides with impulsive phase of flare**



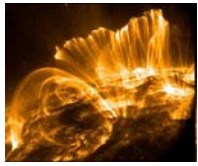






# Implications from a STEREO/EUV Wave

EUVI 171A, 12/7/07 Event from Patsourakos et al 09

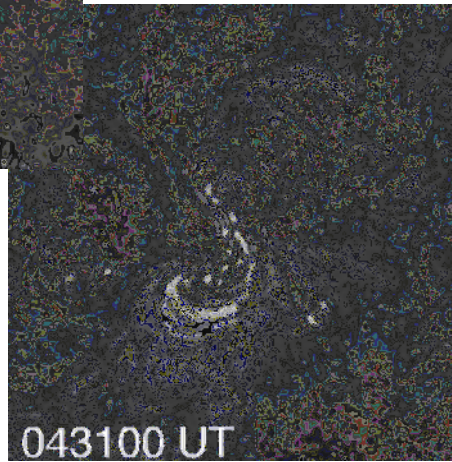


- Loops start to rise
  - 10 min BEFORE wave



- Wave appears
  - No flare!
  - Connection between wave & rising loops?

**Phase transition in 90 sec!!**

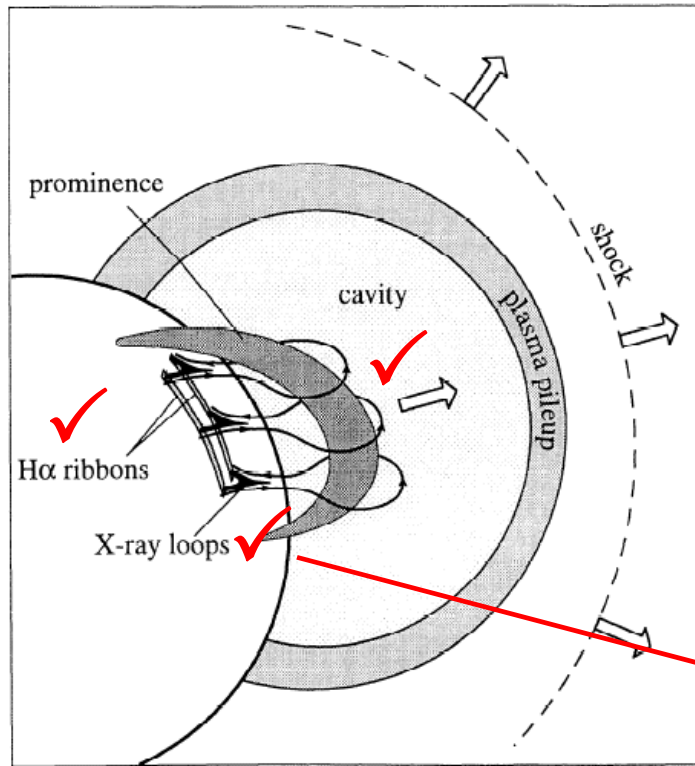


- Flare ribbons appear
  - Rising loops disappear
  - Wave accelerates or forms?



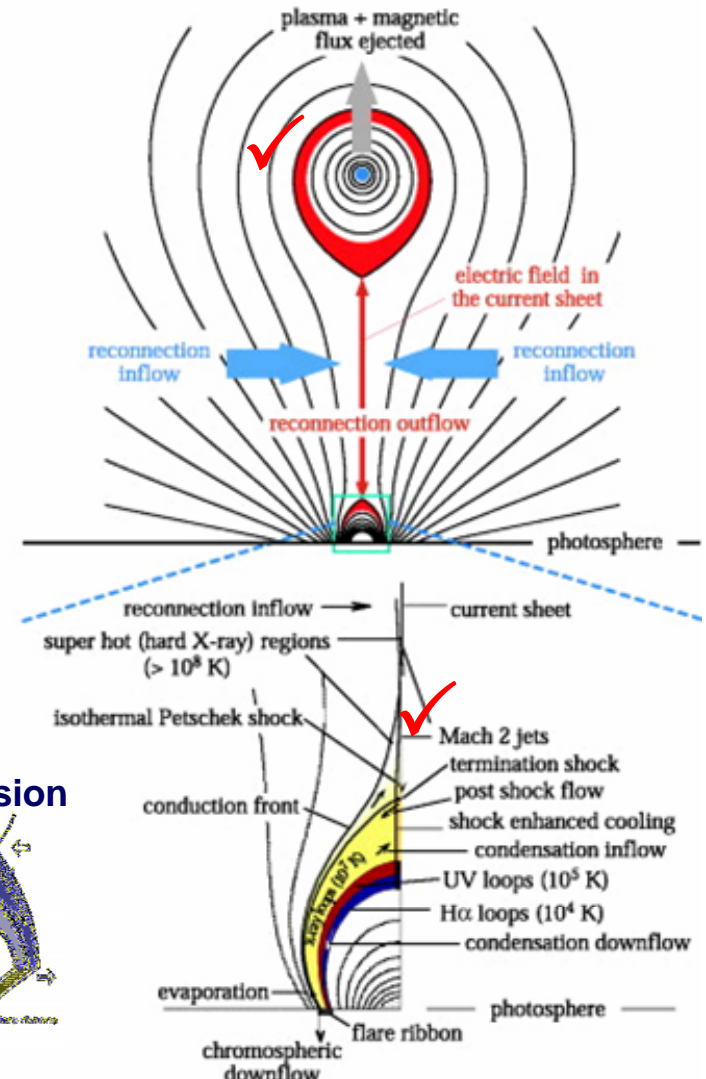
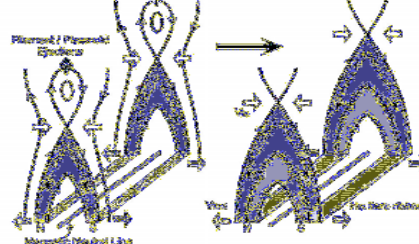
# The "Standard" Flare-CME Concept

Where is the direct physical connection between CME and Flare?



Forbes 2000

Ribbons = CME expansion



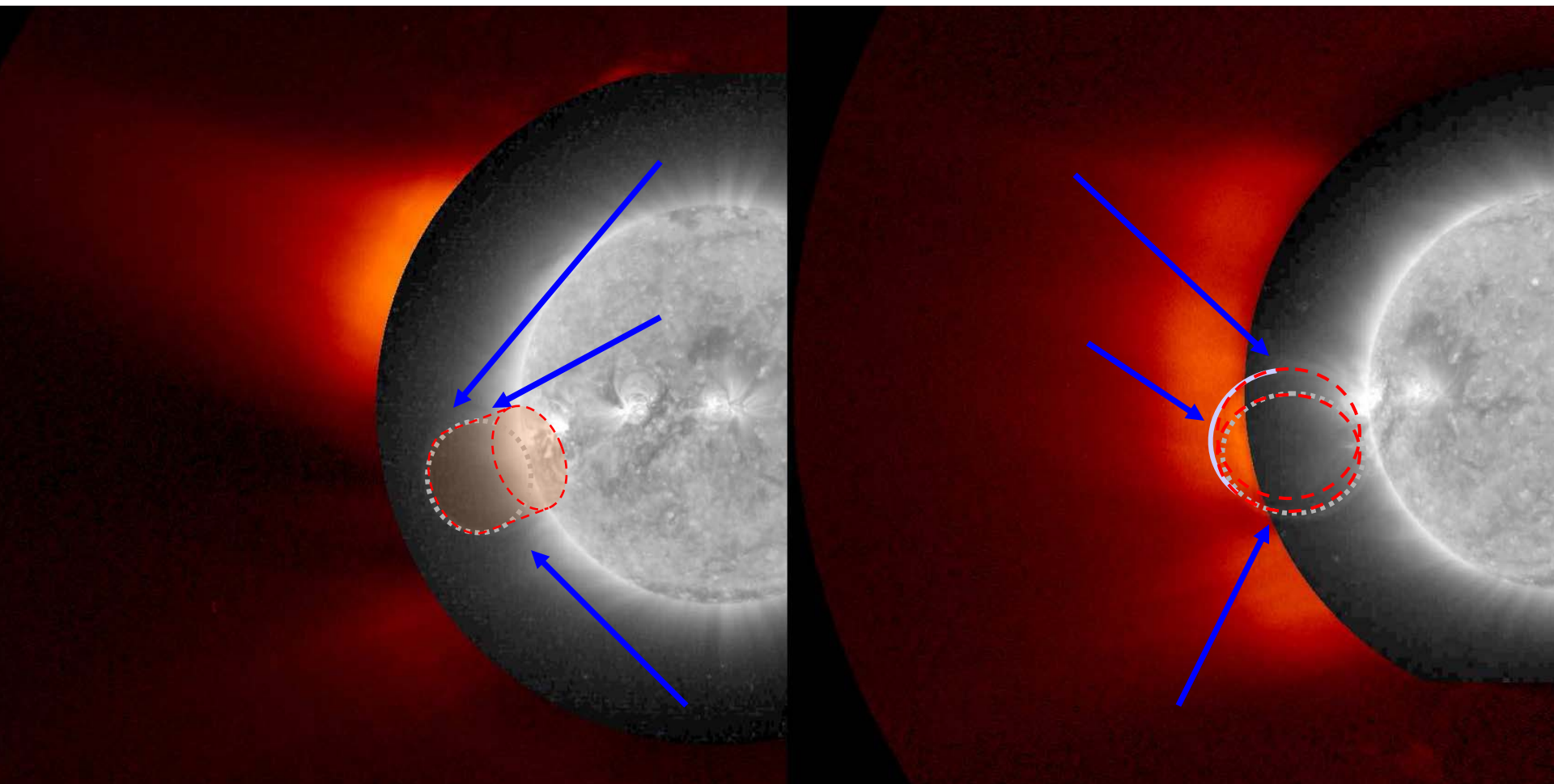
Lin & Forbes 2002

# Conclusions

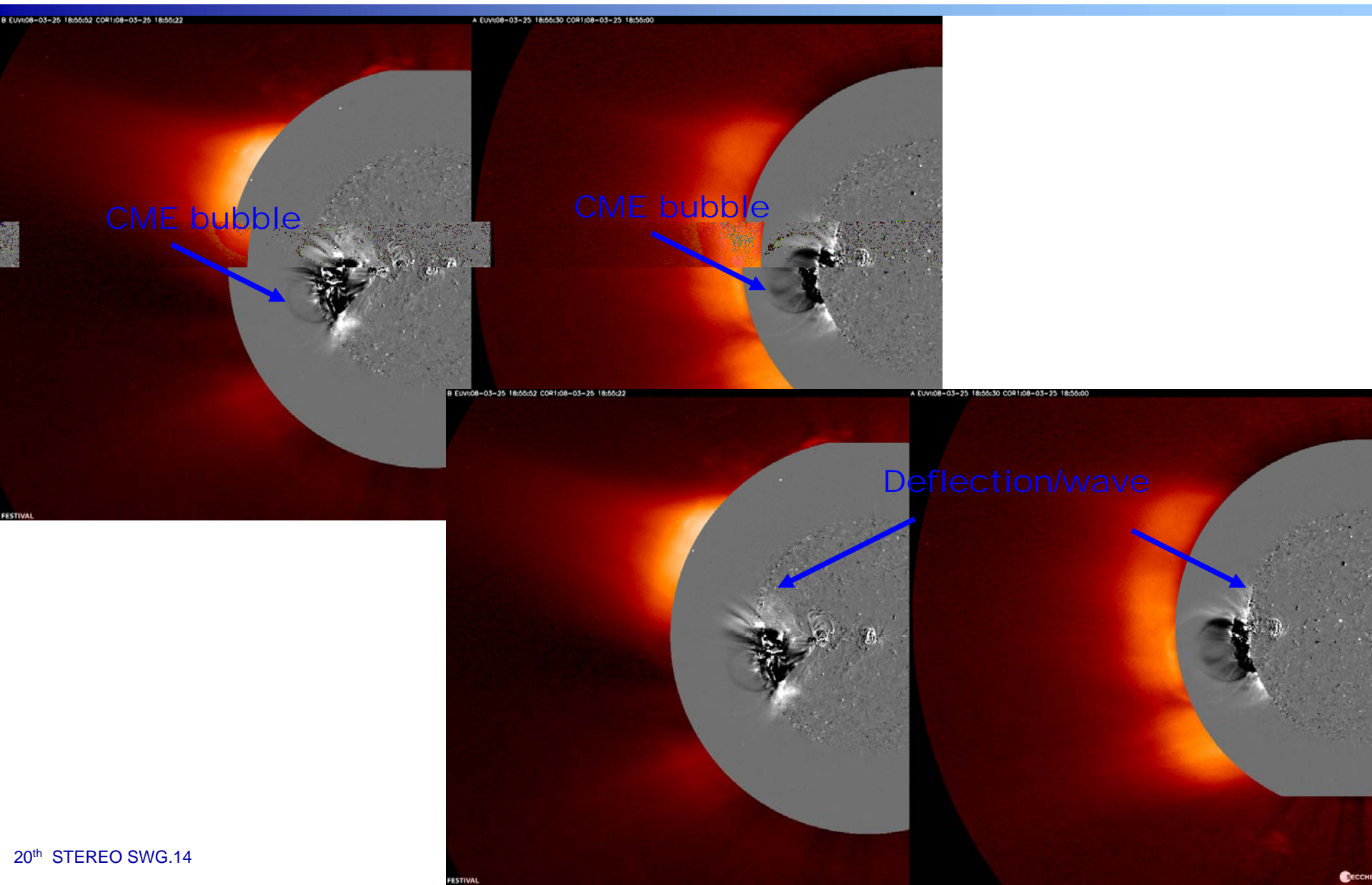
- CME starts as a set of rising loops at AR core (speed ~ **50 km/s**)
- Extremely sharp transition (**< 75 sec**) from loops → erupting bubble
- Bubble = CME fluxrope
- Two phases in formation of fluxrope
  - Non-linear expansion **along** neutral line followed by
  - Self-similar expansion → CME
- Expansion speed of ~1000 km/s drives the EUV wave.
  - When expansion ceases, EUV wave becomes **blast** wave (hence deceleration)?
- The above event sequence seems to be common to impulsive EUVI events!
- “Standard” model of solar eruptions consistent with observations!

# Backup Slides

---

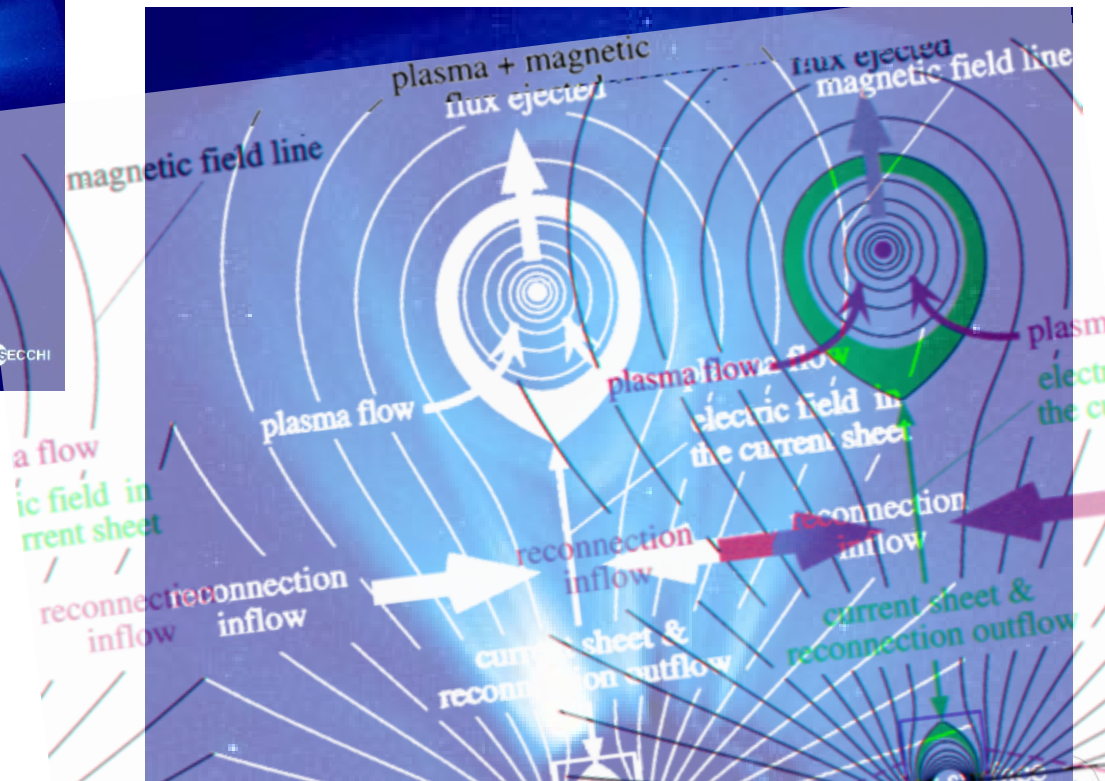
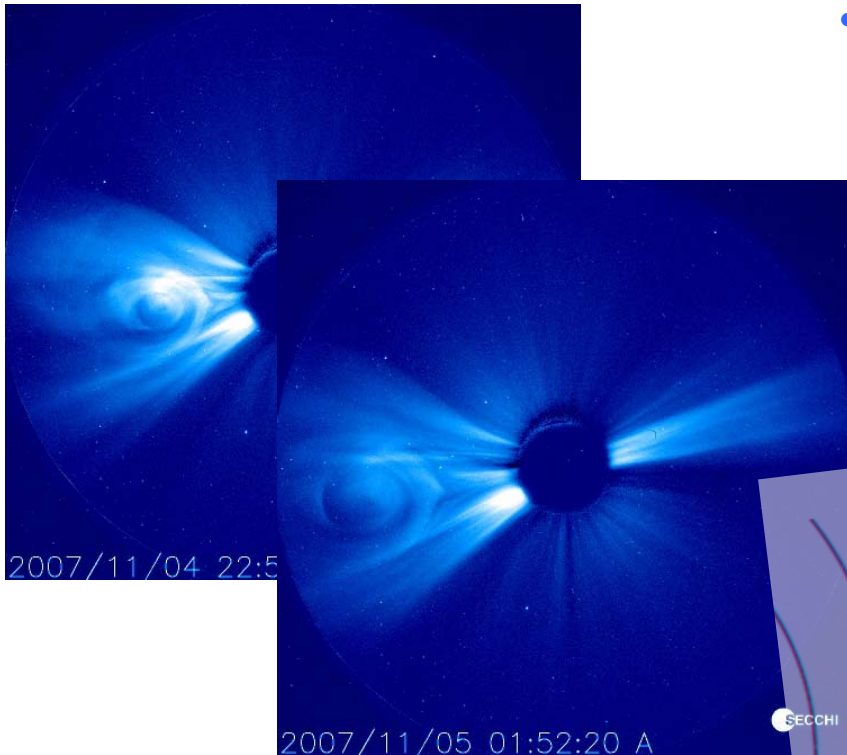


# EUV Wave and Bubble are Different Entities



# CME Internal Structure

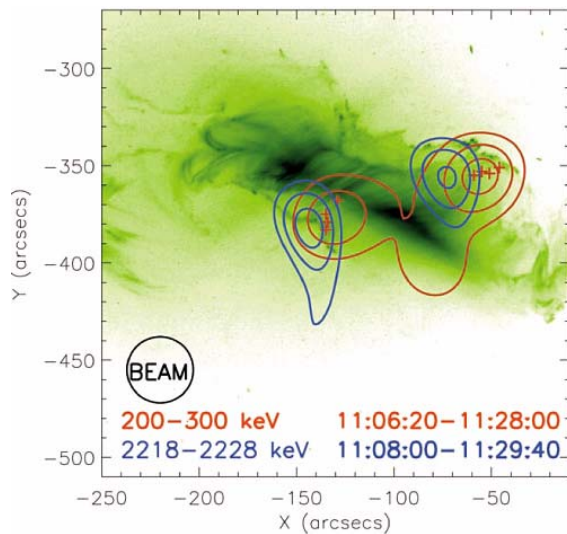
- The tip of the post-CME current sheet is visible.
  - The current sheet should be visible in the low corona.





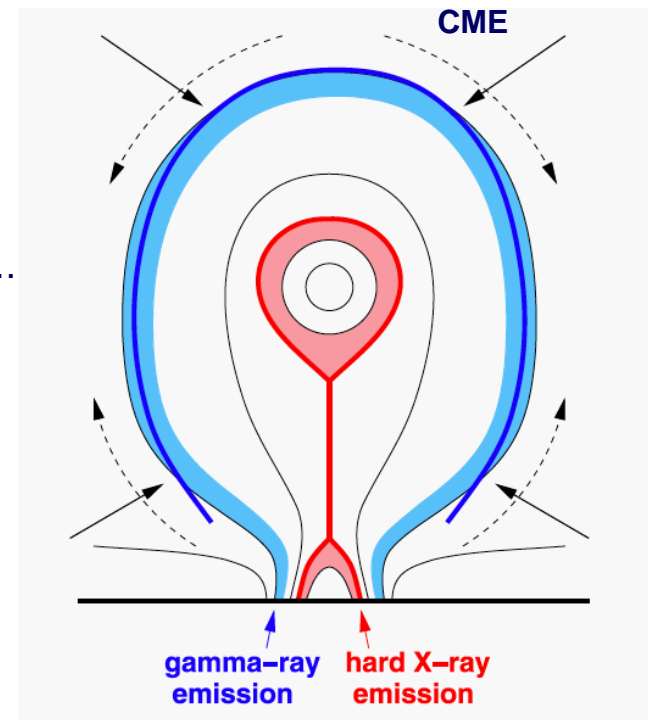
# Flare-CME Connection: Ions don't like Electrons?

- Ions & electrons seem to be accelerated at different sites
  - Different loop sizes? (Emslie et al 2004)



Hurford et al (2006)

But if we look at the big picture....



Pomoell et al (2008)





# Putting it all together

A possible scenario (see Schrijver 2009):

1. Magnetic field rises as fluxrope from convection zone
2. Top of fluxrope bursts through the chromosphere; rests stays anchored in photosphere
3. The new coronal fluxrope interacts w/ background:
  1. Flare only if reconnection is quick
  2. Flare+CME if enough  $E_{\text{mag}}$
  3. Eruption only if energy release is slow

