A coupled model for the formation of an active region corona

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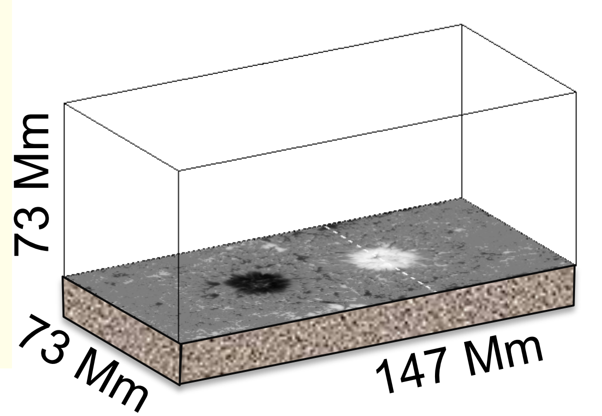
Coronal model driven by emerging flux simulation

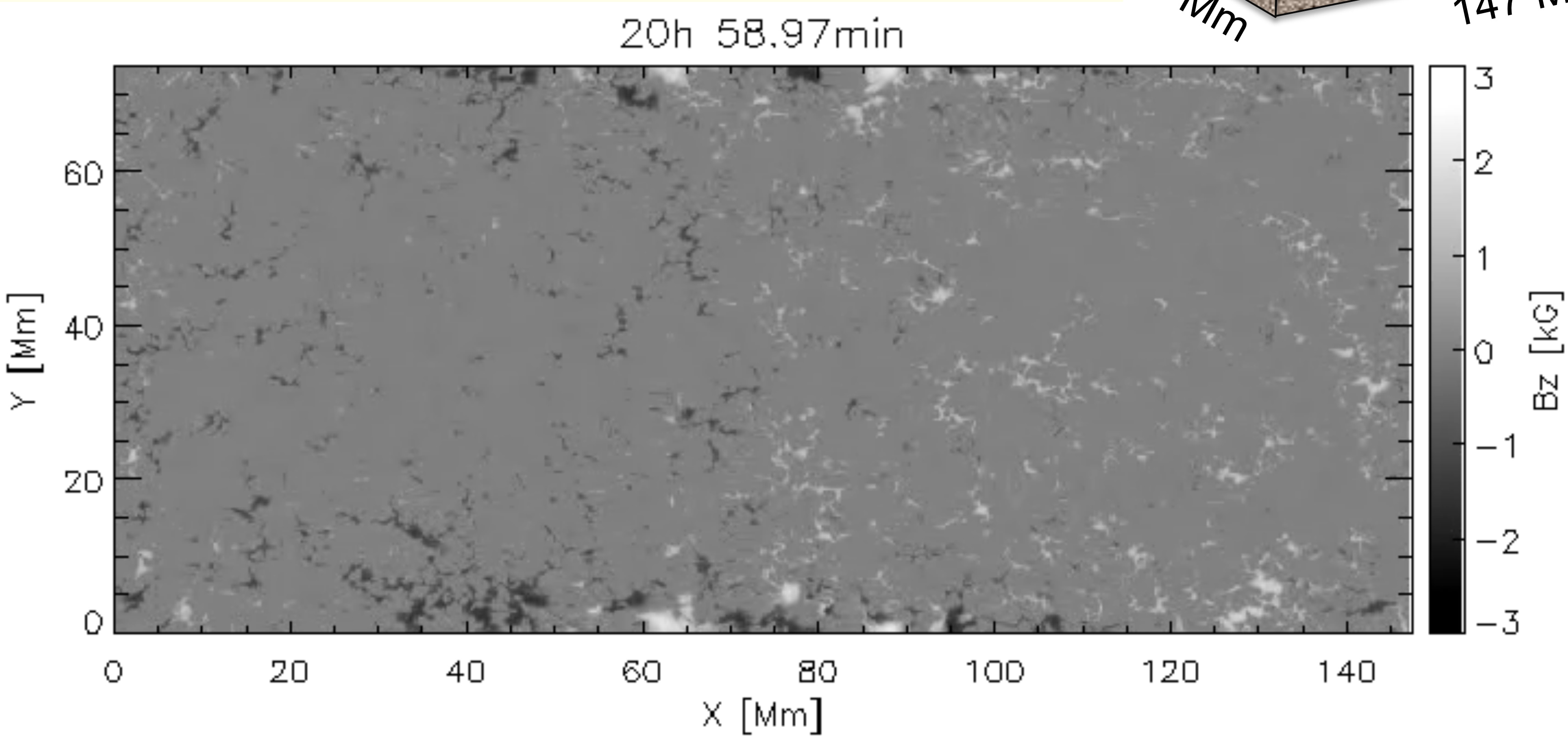
flux-emergence simulation

from / similar to Cheung et al (2010) ApJ 720, 233

– flux rope rises from bottom
  and breaks through surface

  → pair of sunspots





Coronal model driven by emerging flux simulation

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– flux rope rises from bottom and breaks through surface

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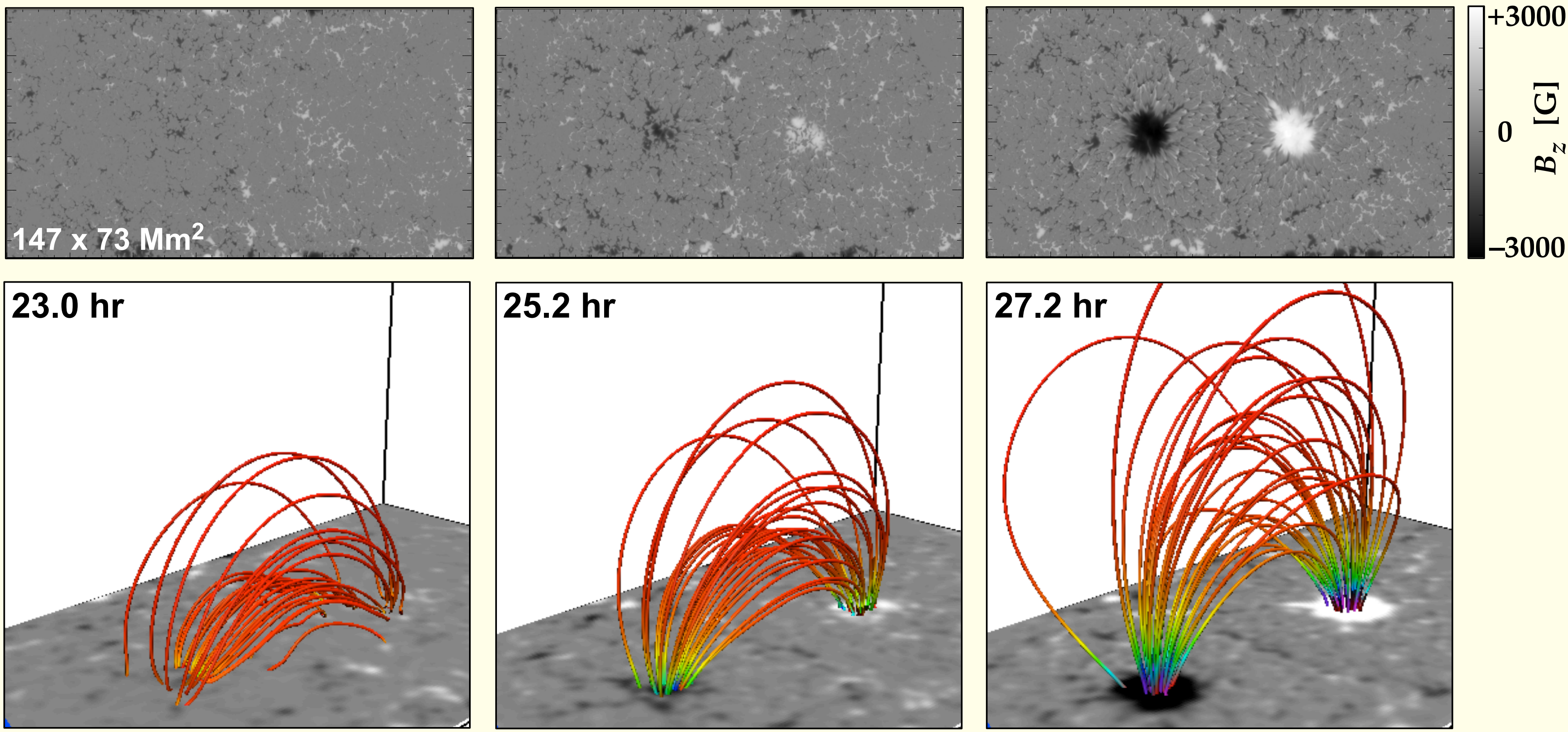
coronal simulation

– use photospheric layer (T, ρ, v, B) as time-dependent lower boundary

→ magnetic field expands

→ coronal loops form



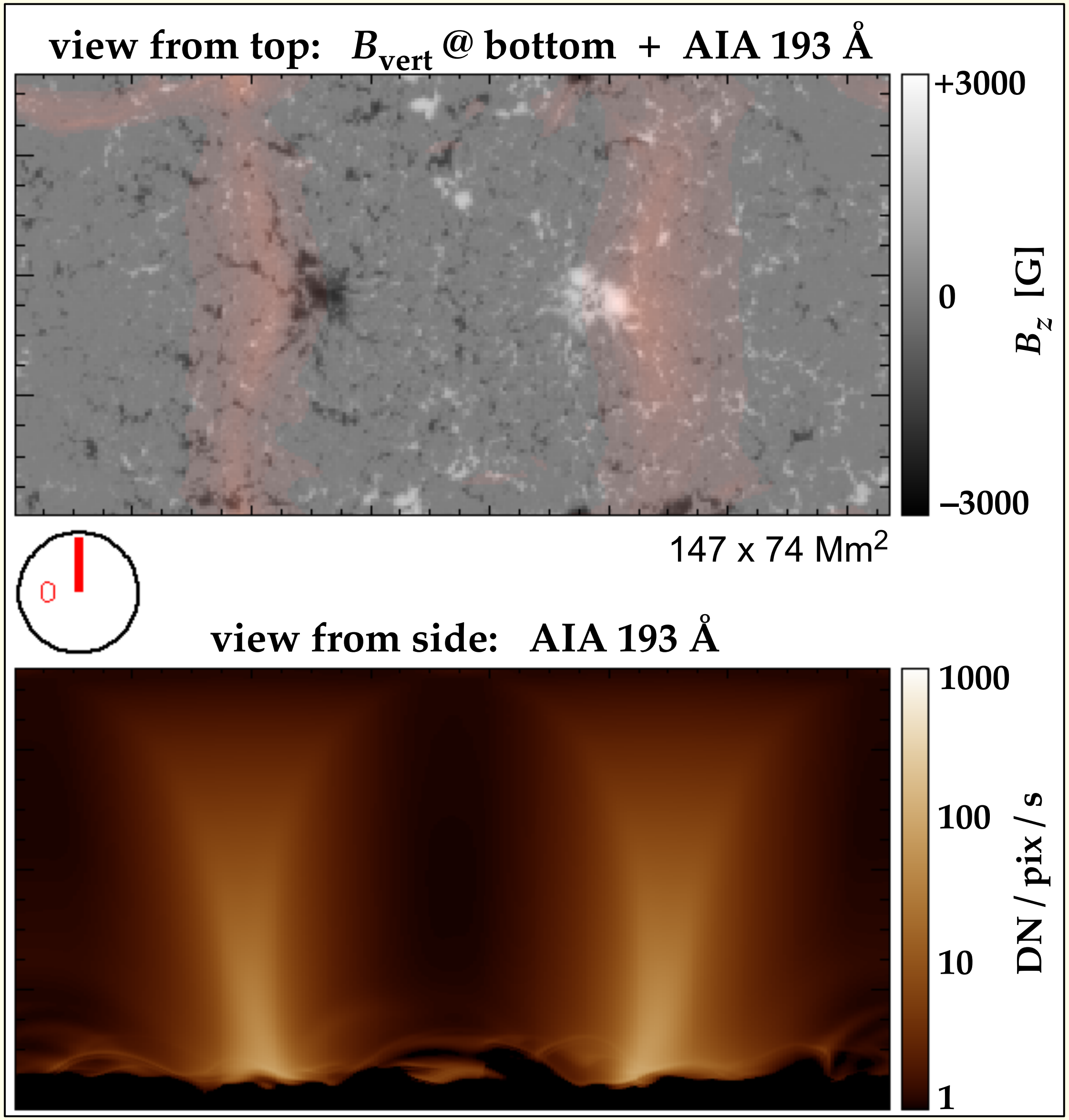
Coronal model driven by emerging flux simulation

- ► loops form at different places at different times
- ► loops appear quickly (< 5 min)
- ► loop footpoints are in sunspot periphery
- ► at times appears with constant cross section
  (Peter & Bingert 2012, A&A, 548A, 1)

Question:

- ► Why, where, when does the loop form?

synthesized coronal emission (1.5 10^6 K)



34 min out of 7 hrs

Coronal loop and energy input

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- ► loops appear quickly (< 5 min)
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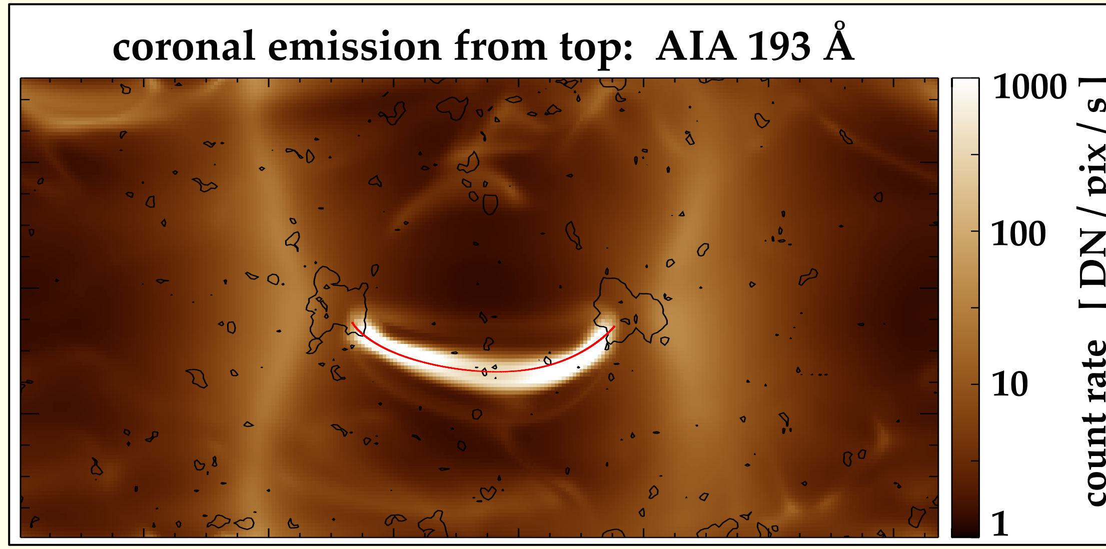
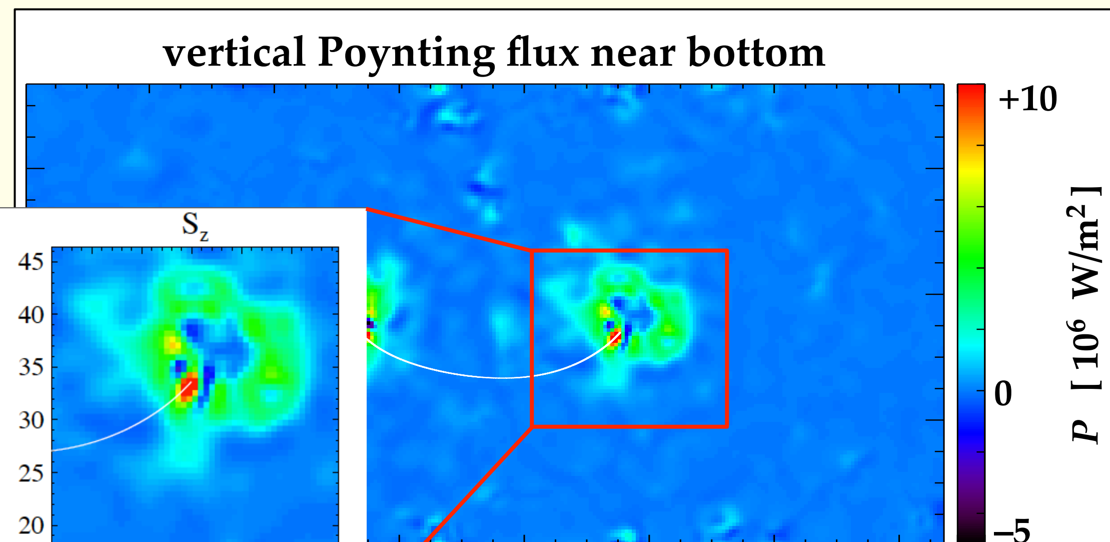
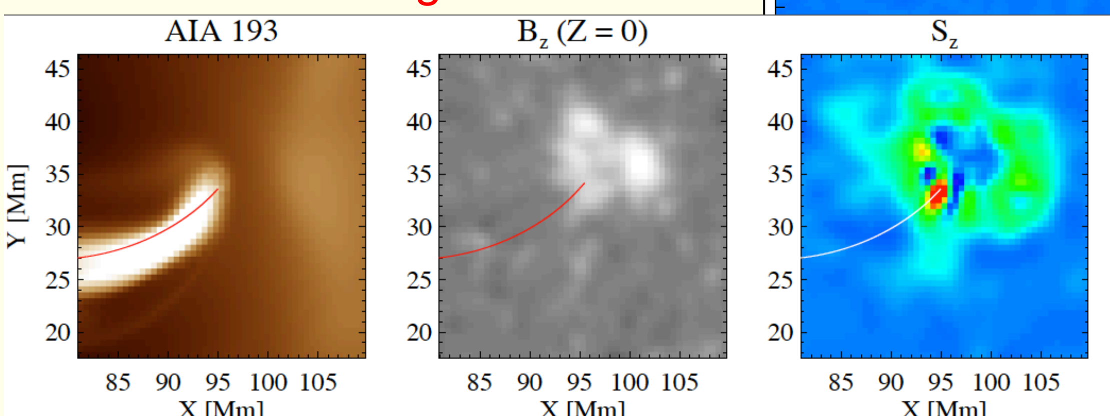
  (Peter & Bingert 2012, A&A, 548A, 1)

► EUV loops form through increased heating:



147 x 73 Mm^2





Expansion and fragmentation of loop

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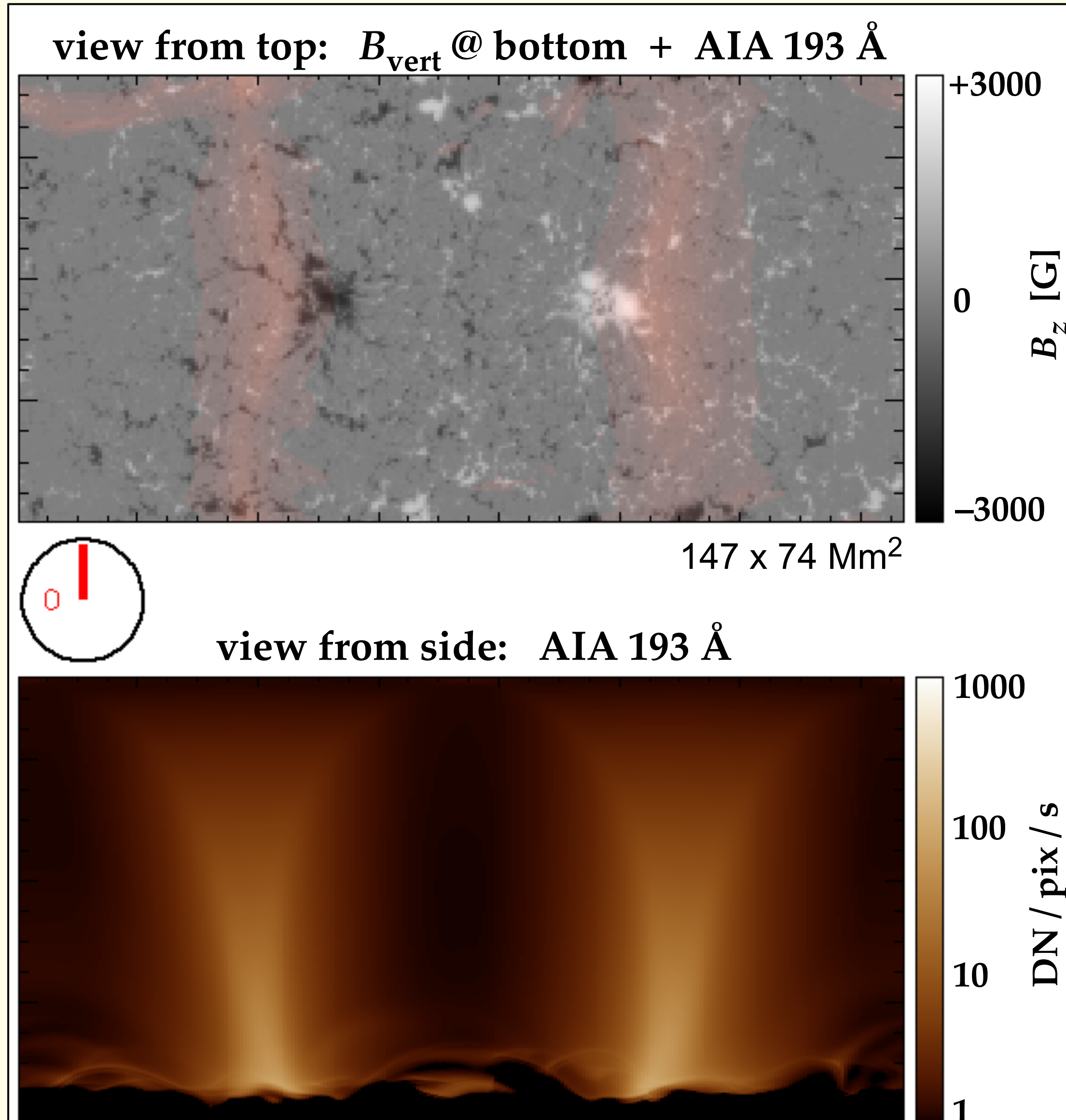
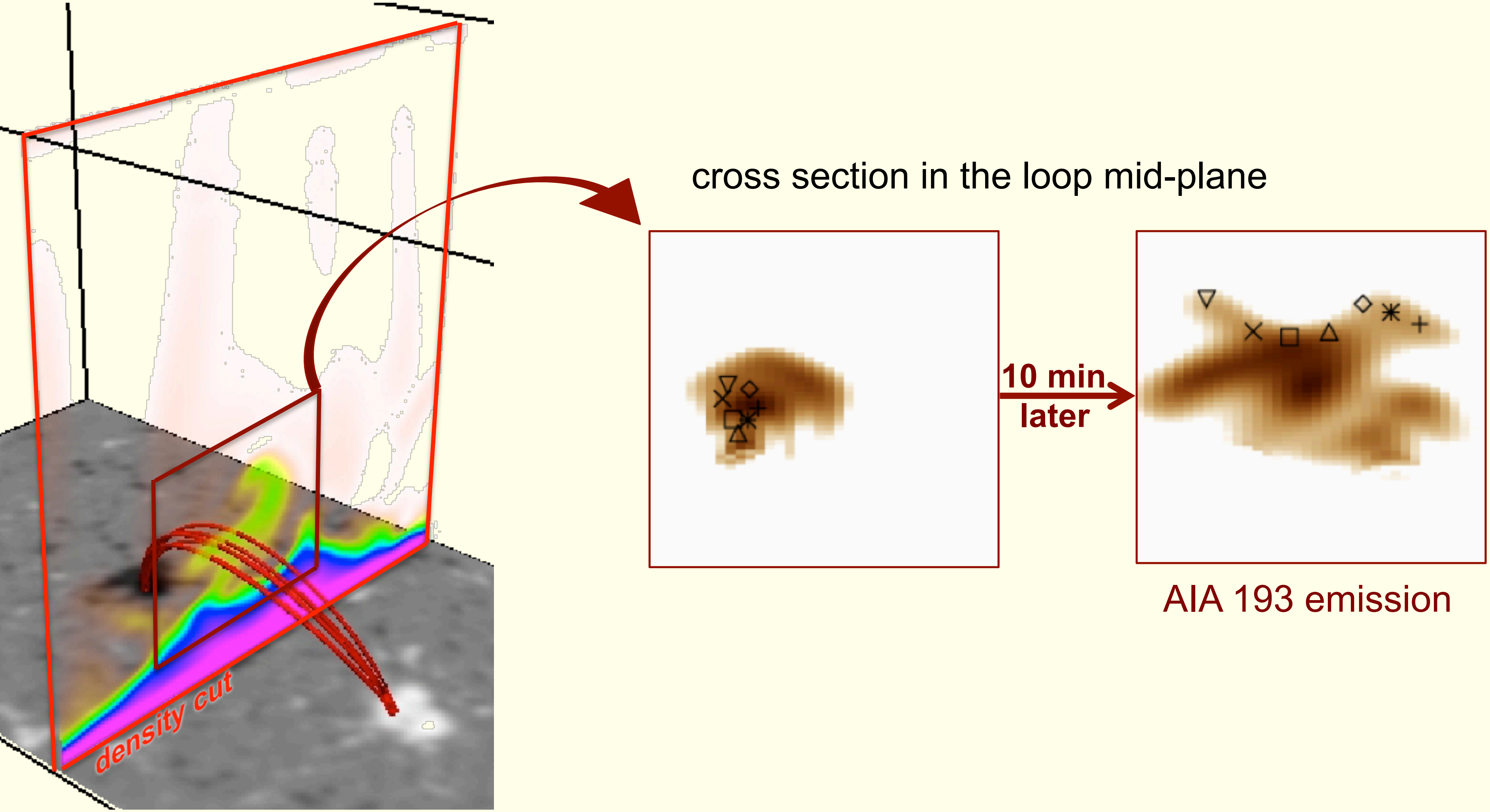
synthesized coronal emission ($1.5\ 10^6$ K)



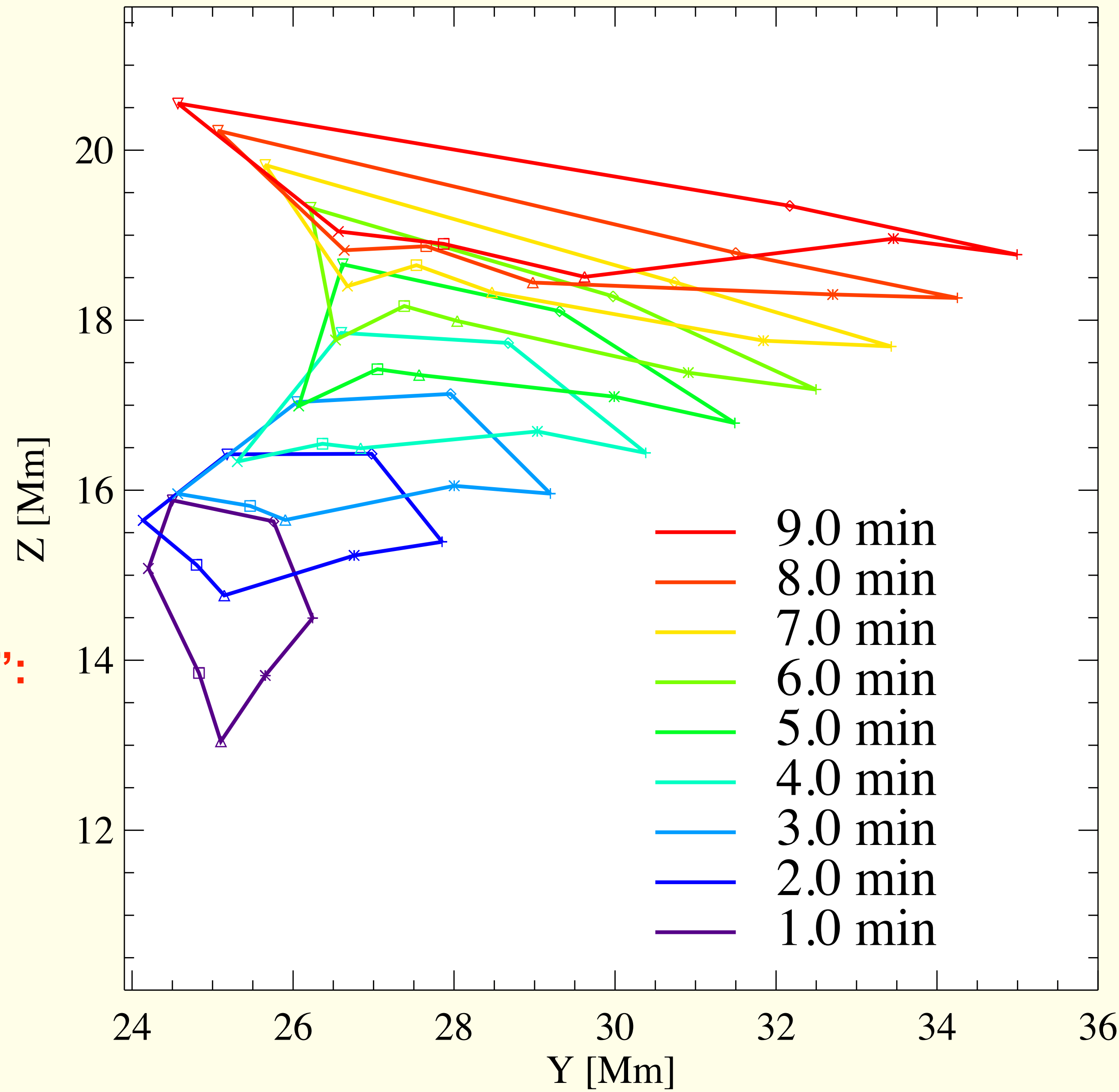
34 min out of 7 hrs

Defining a magnetic tube



Expansion of the magnetic tube

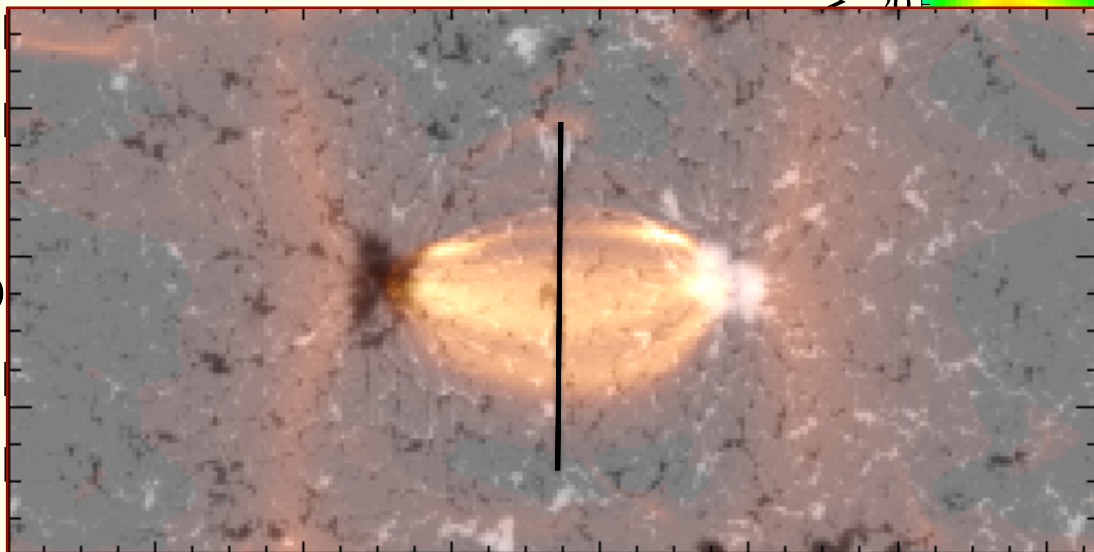
- ► Cross section of the magnetic tube
- ► Cross section slightly increasing
- ► **Non-isotropic "expansion":** deformation of ***B*** during flux emergence

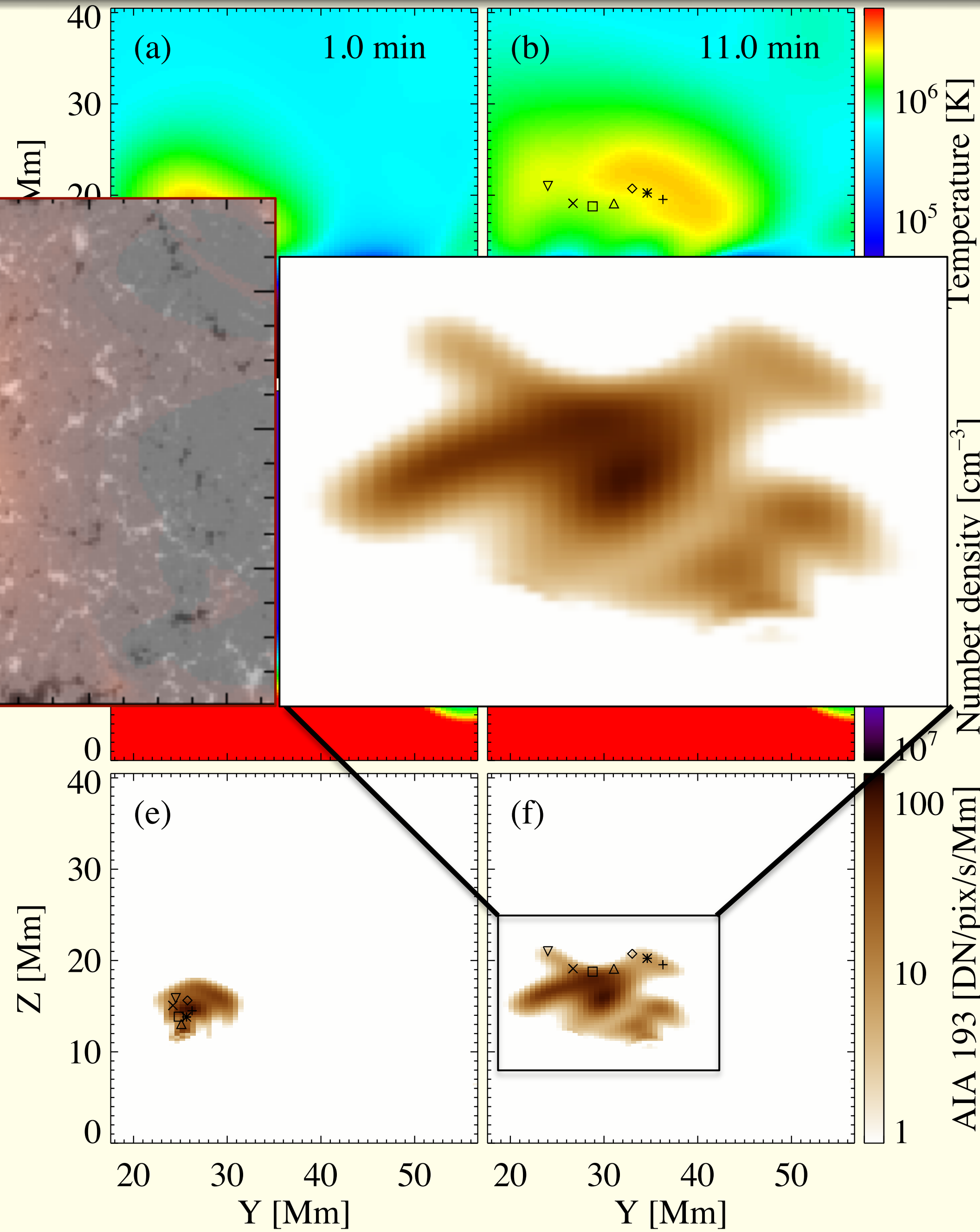


Loop fragmentation

Temperature

- “Hot shell”





Emissivity

- Convolution of T and ρ
- Shows finer structure than both T and ρ
- Fragmentation shows also for l.o.s. integration

Conclusions

- Flux emergence through bottom boundary drives evolution of AR corona
- Heating of corona by dissipation of induced currents
- Strong horizontal expansion of the magnetic tube
- Fragmentation of the loop seen in coronal emission
- loop is truly 3D in nature