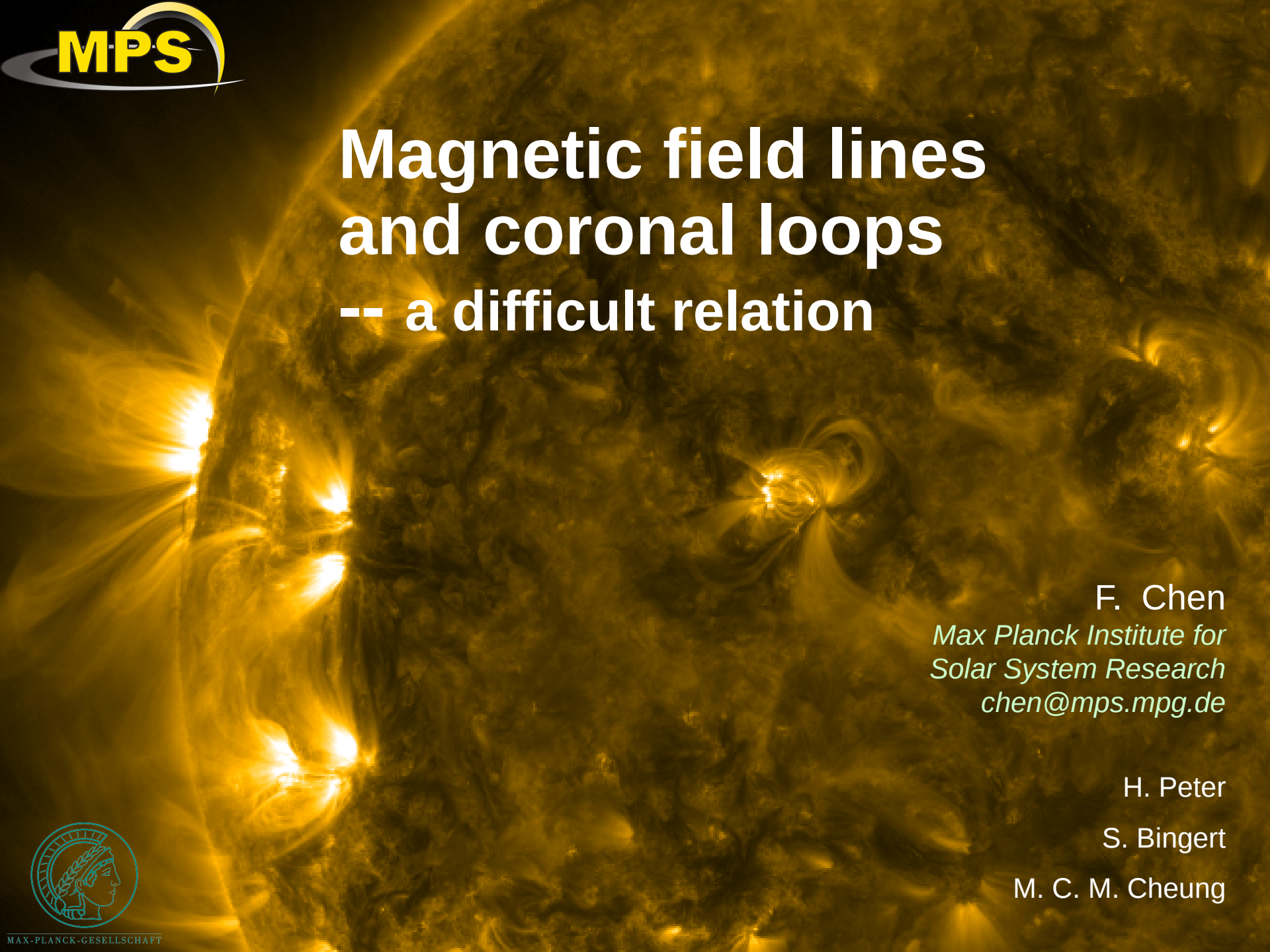

Magnetic field lines and coronal loops
-- a difficult relation

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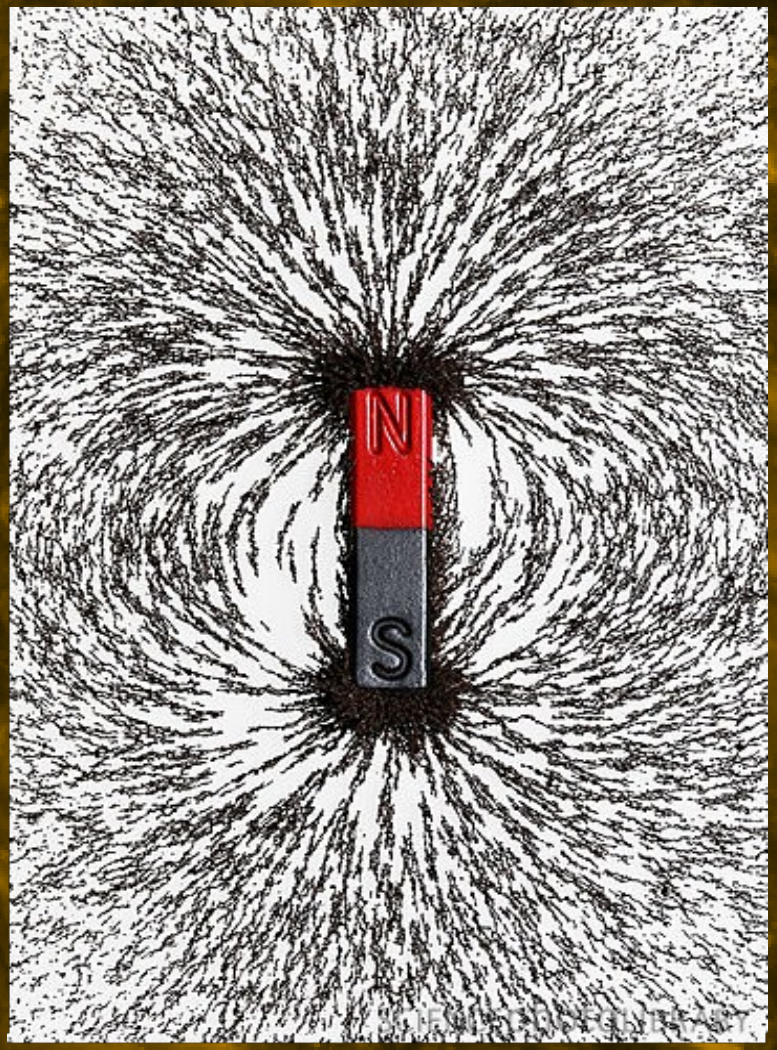
H. Peter

S. Bingert

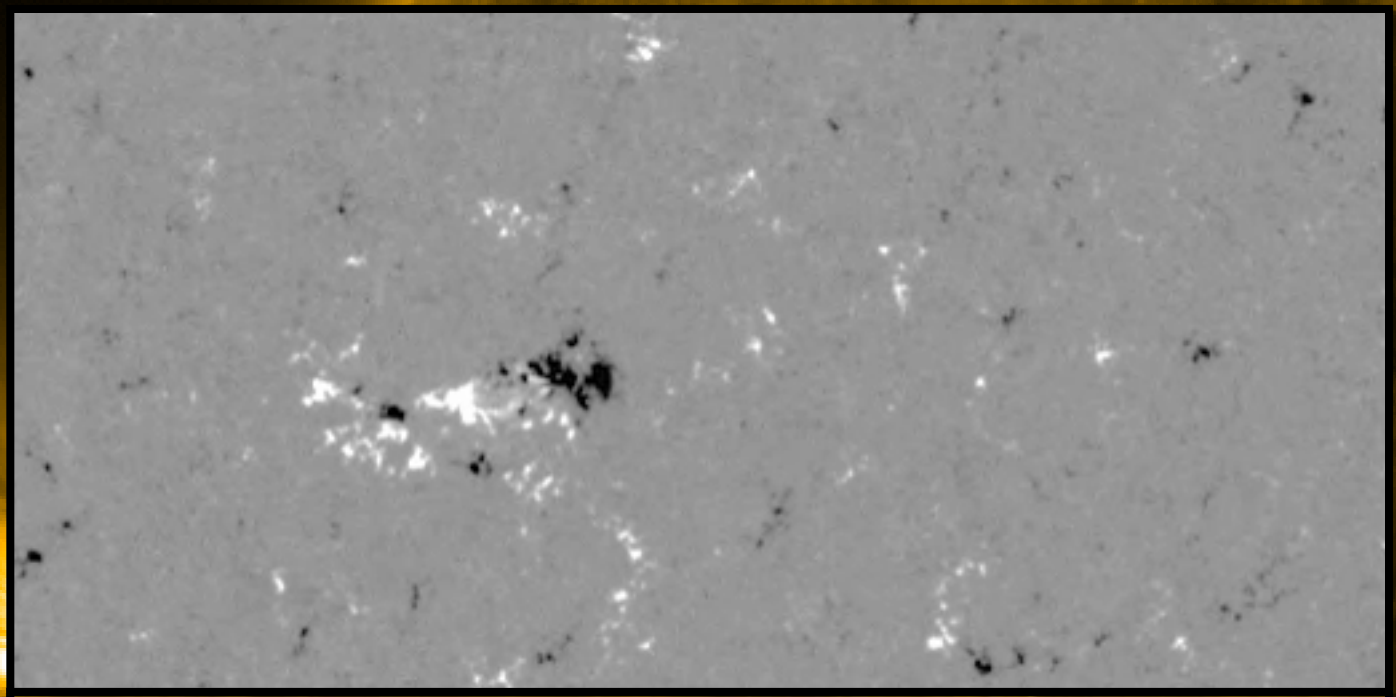
M. C. M. Cheung

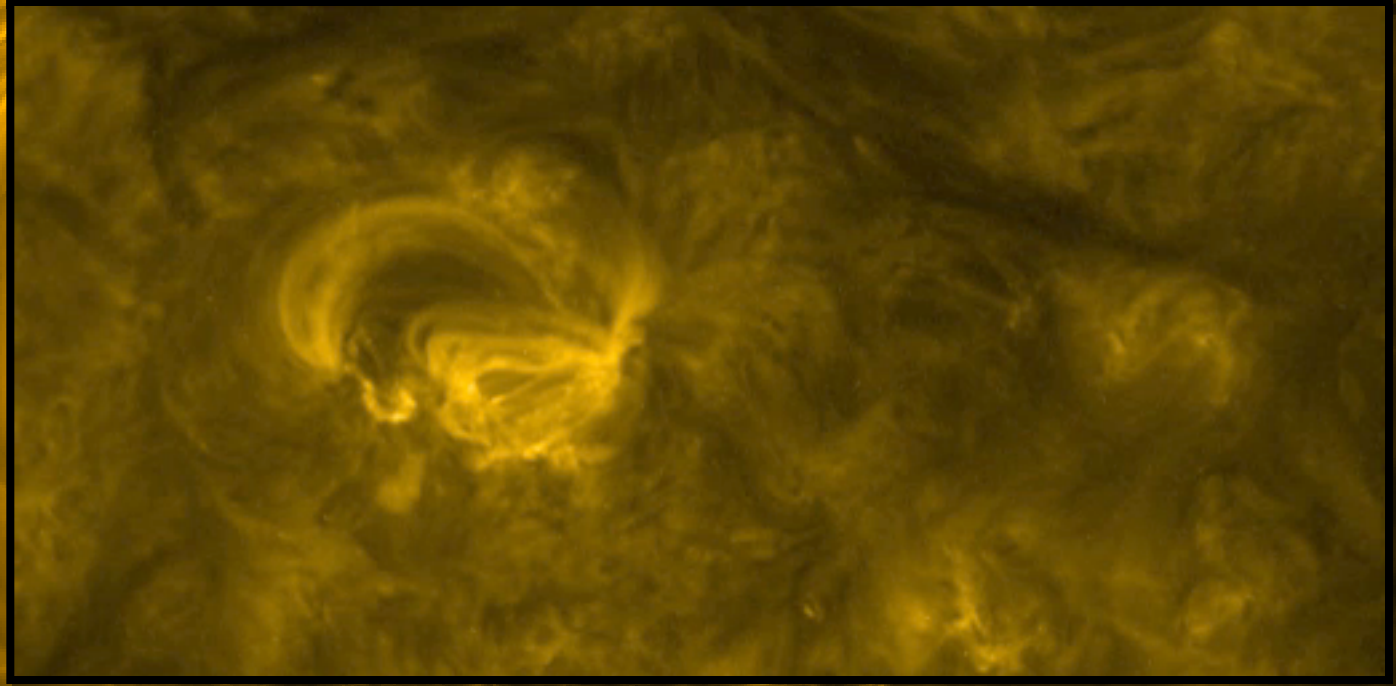
MAX-PLANCK-GESELLSCHAFT

How to see the magnetic field lines?



www.magnetyze.com/page/magnetic-fields.aspx Fig. 4





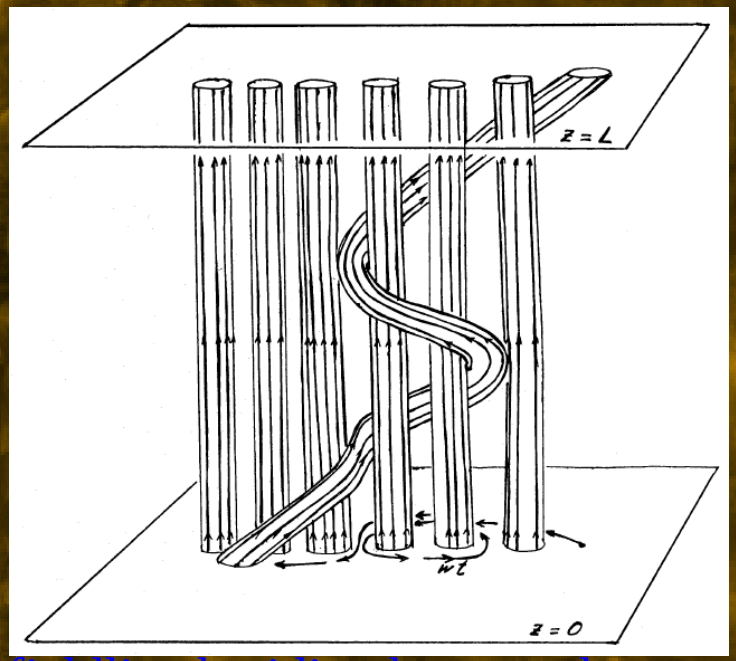
Modeling approach

physical model → 3D MHD simulation → physical quantities $T, \rho, \boldsymbol{u}, \boldsymbol{B}$ → synthesized observation $\mathcal{O}_S$

optically thin radiation

thermal conduction along B

corona heating



fieldline braiding by granular motions

Parker 1983 ApJ 264, 635

"real" observation $\mathcal{O}$

Coronal model driven by emerging flux simulation

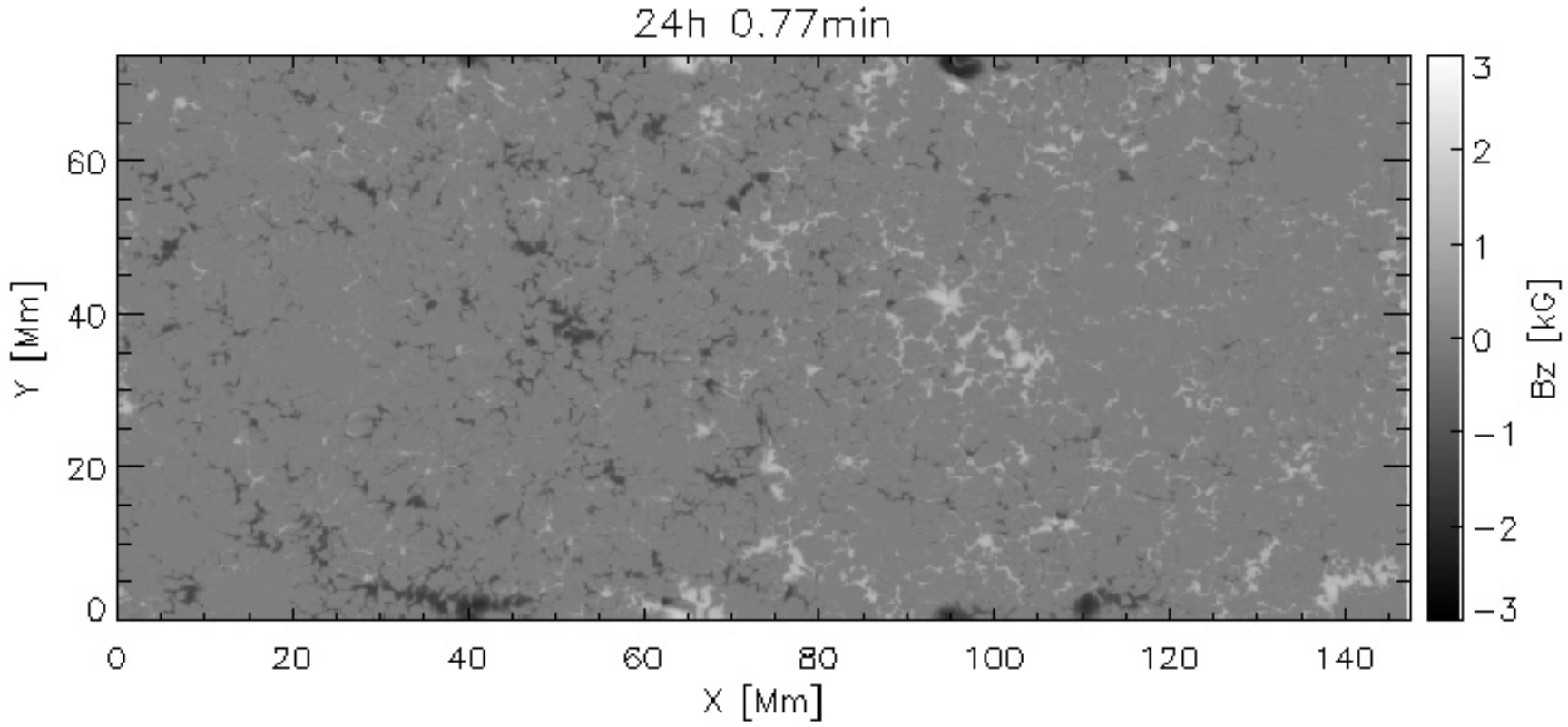
flux-emergence simulation

Cheung et al (2010) ApJ 720, 233

Rempel and Cheung (2014) ApJ 785, 90

– flux tube rises from bottom
and breaks through surface

→ pair of sunspots



Coronal model driven by emerging flux simulation

flux-emergence simulation

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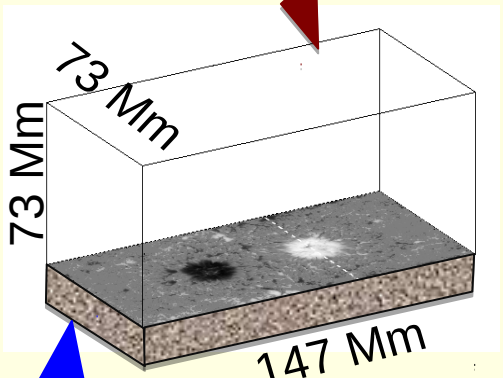
Rempel and Cheung (2014) ApJ 785, 90

– flux tube rises from bottom and breaks through surface

→ pair of sunspots

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



coronal simulation

– solve fully compressible MHD with coronal energy balance:

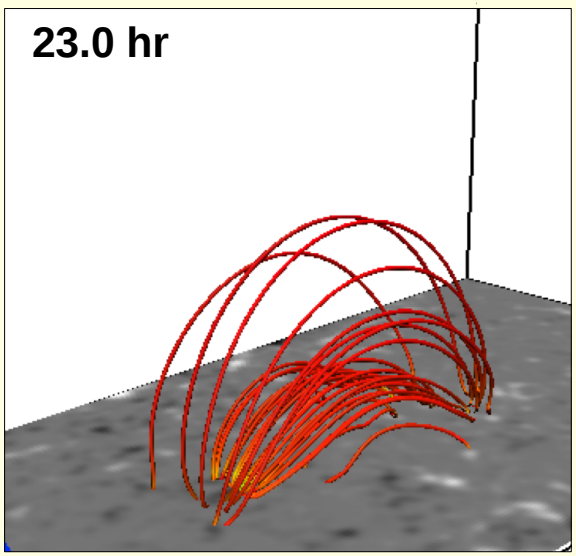
Spitzer heat conduction

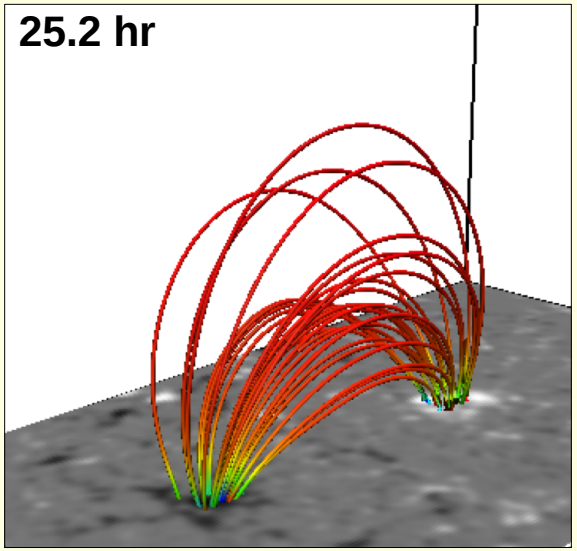
radiative cooling

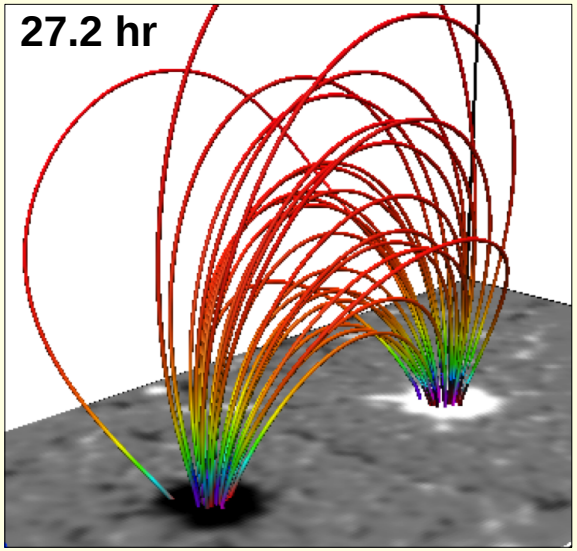
heating from Ohmic dissipation

→ magnetic field expands

→ coronal loops form

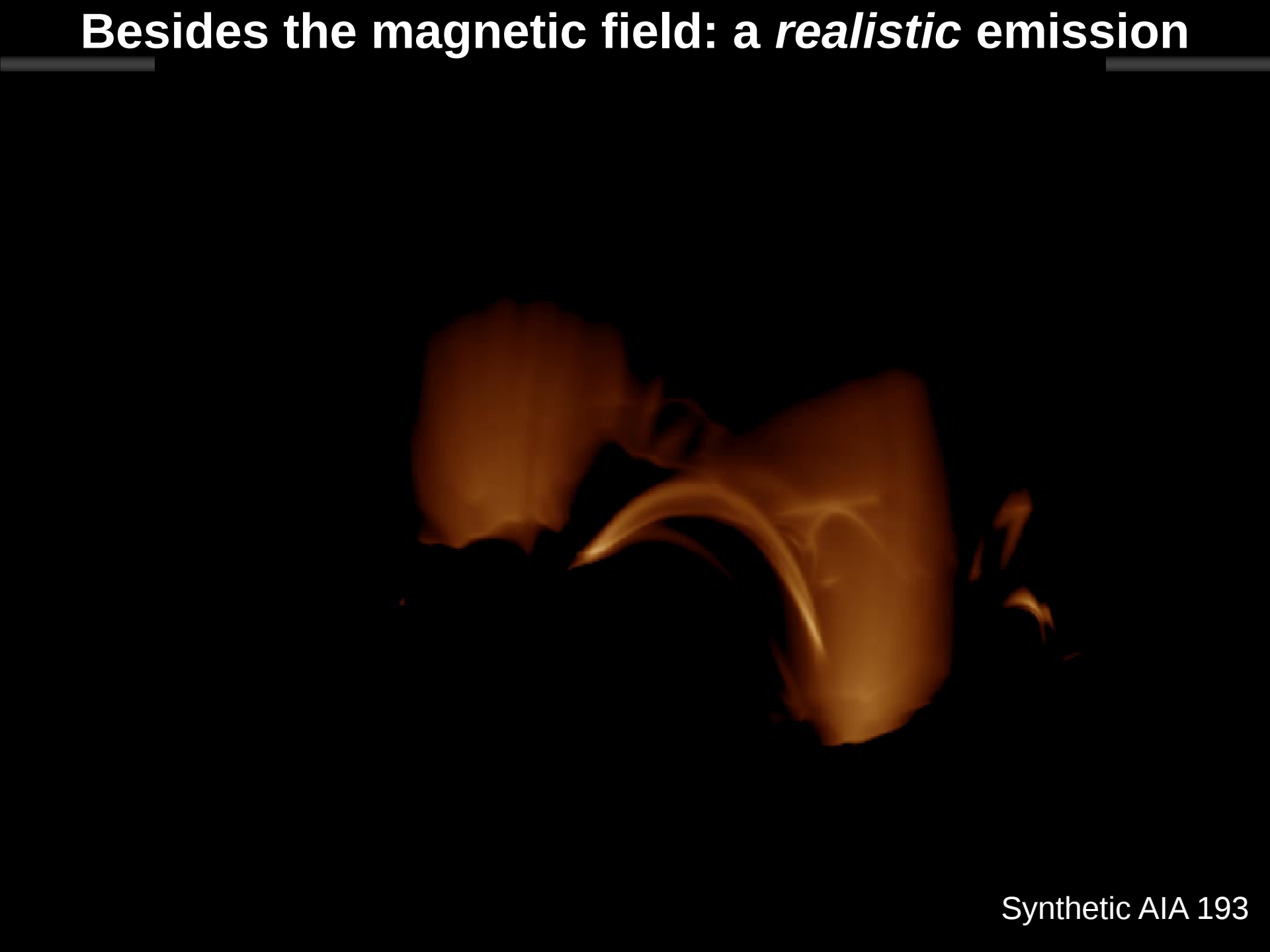






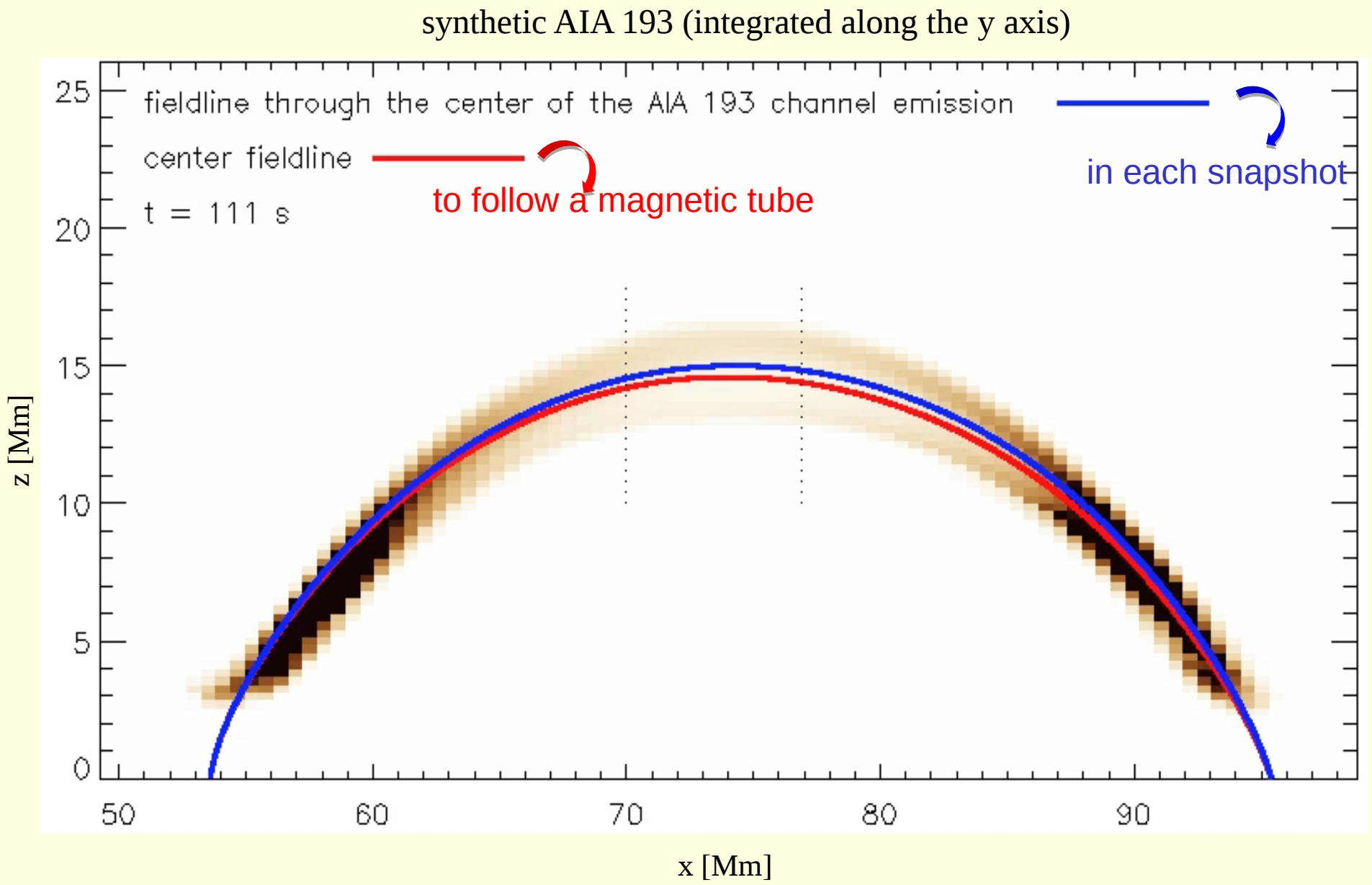
Chen et al (2014) A&A 564, A12

Besides the magnetic field: a *realistic* emission



Synthetic AIA 193

The EUV loop & field lines behave differently



How does a EUV loop get bright?

Emerging field lines with cool plasma

Heated to T ~ 1 MK

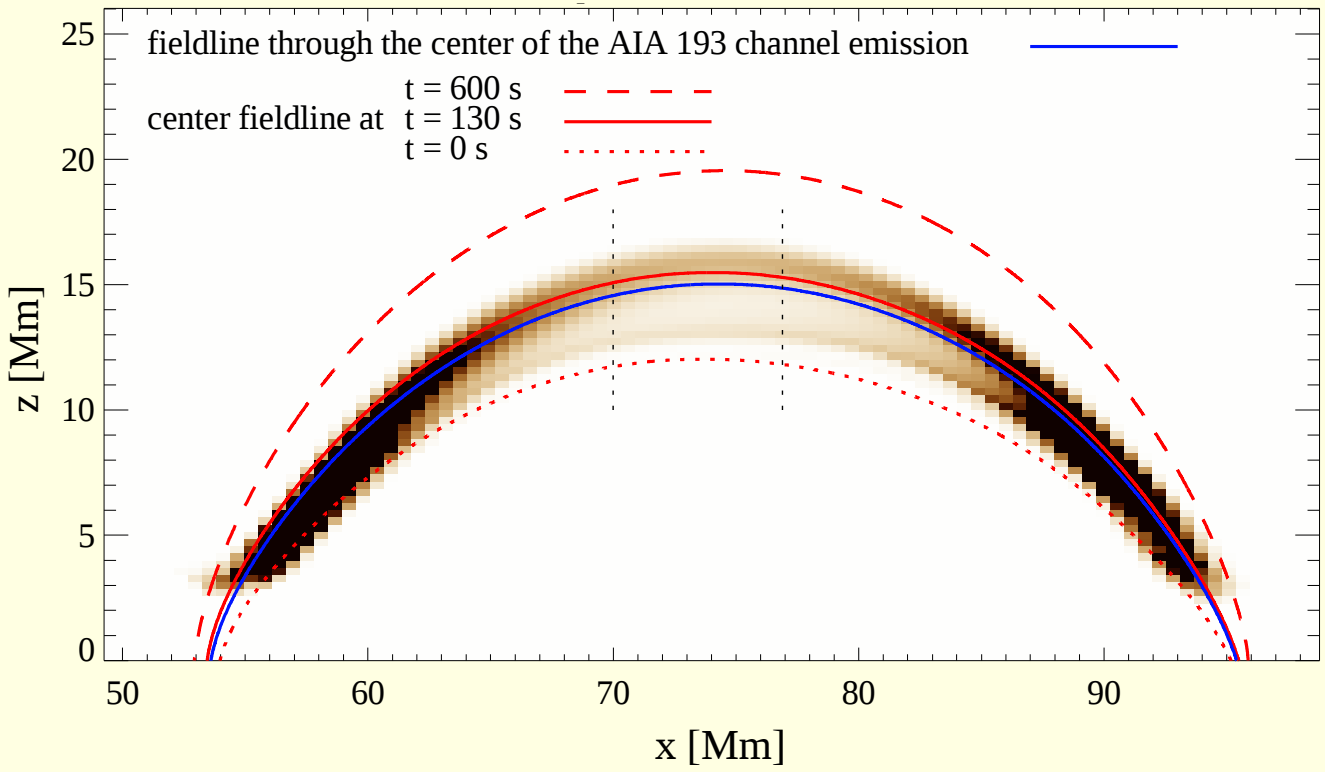
A bright loop in 193

Tmax ~ 1.5 MK

$T > 2$ MK

Loop gets faint again

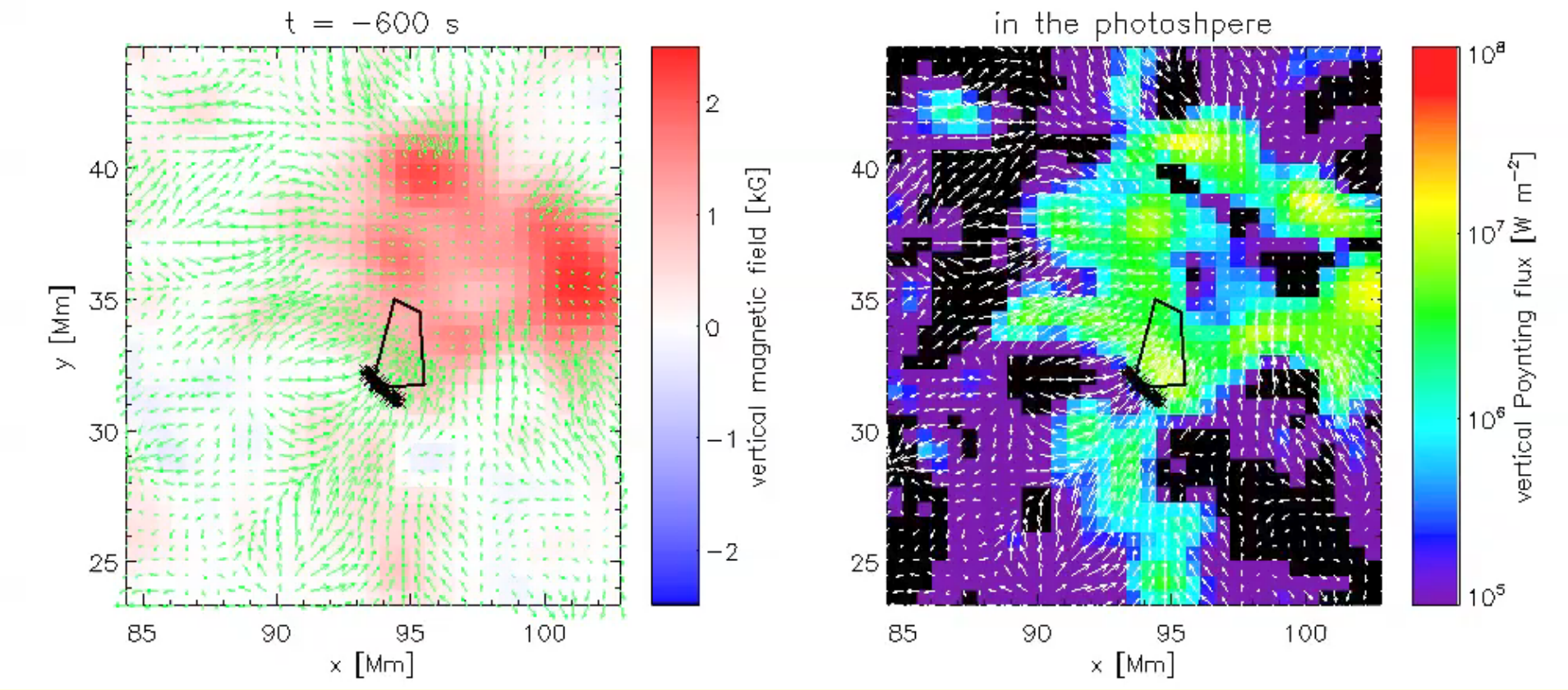
- Field lines move up
- The EUV loop doesn't
- field lines heated at the same place?



Energy input in the photosphere

"Hot spot": stays at the edge of the sunspot

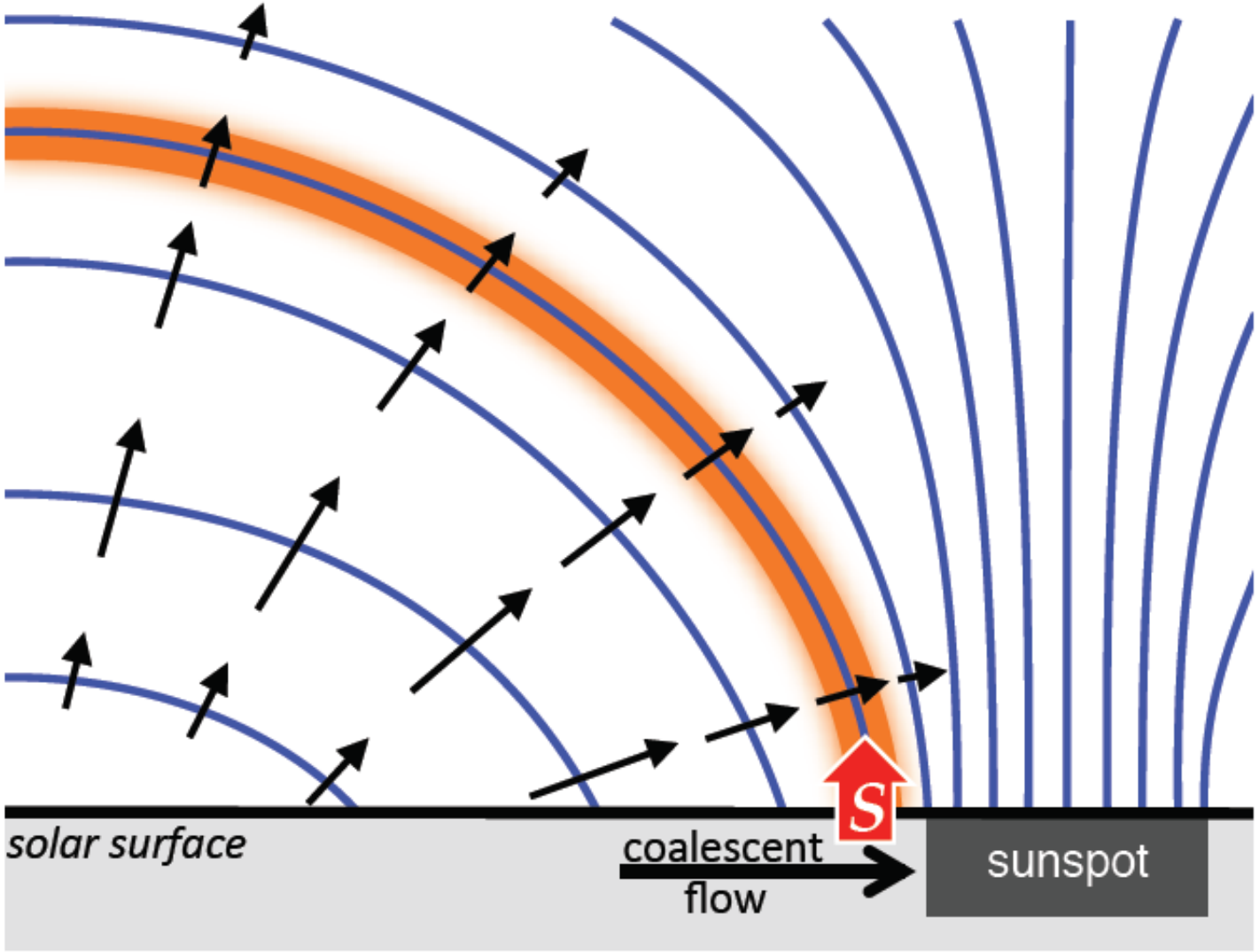
Convective motion can work on magnetic field efficiently



Foot points of field lines move across the hot spot

Conclusion

- In each snapshot, EUV loops are nicely along the magnetic field line
- In a emerging AR, EUV loops could evolve differently from the magnetic field
  - Be careful to use EUV loops as an field-line indicator in this case



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