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Connecting solar coronal loops to their photospheric footpoints

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in collaboration with

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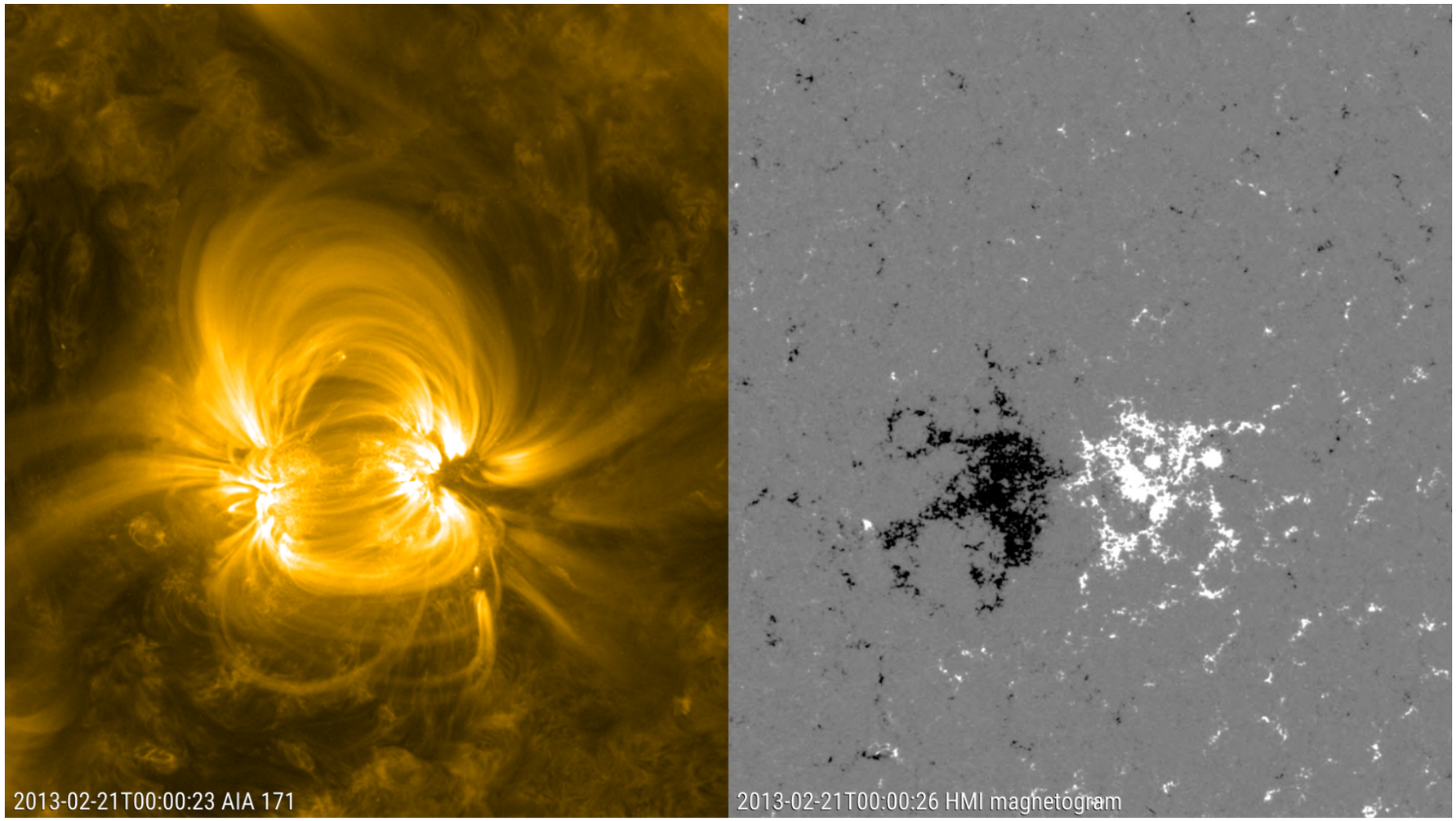
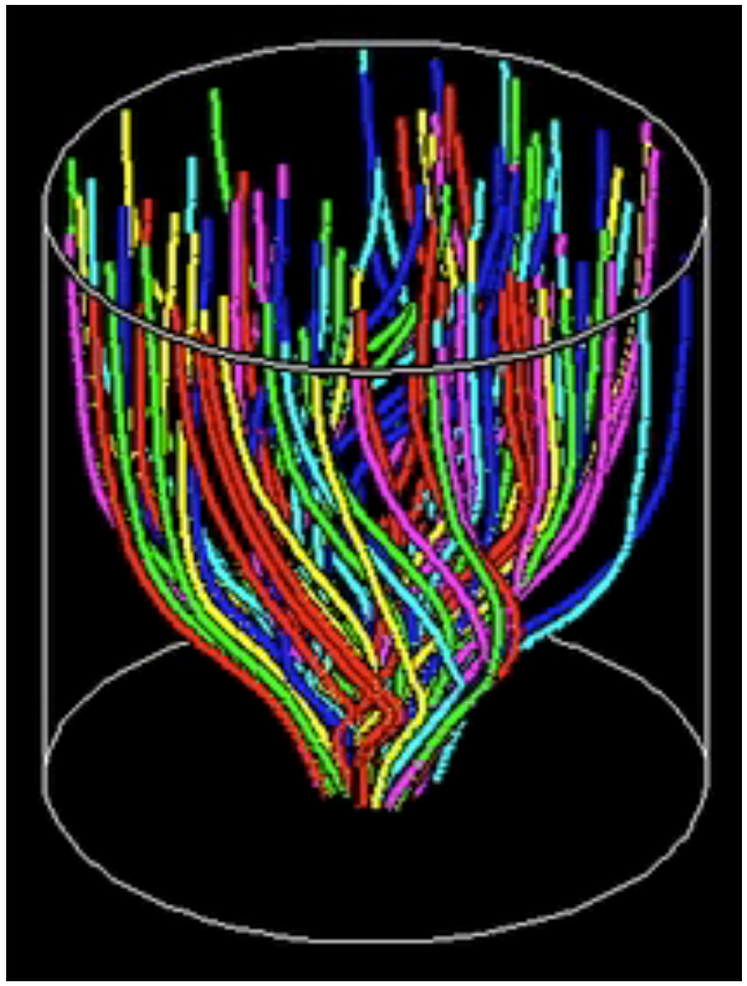
Scope of this talk...



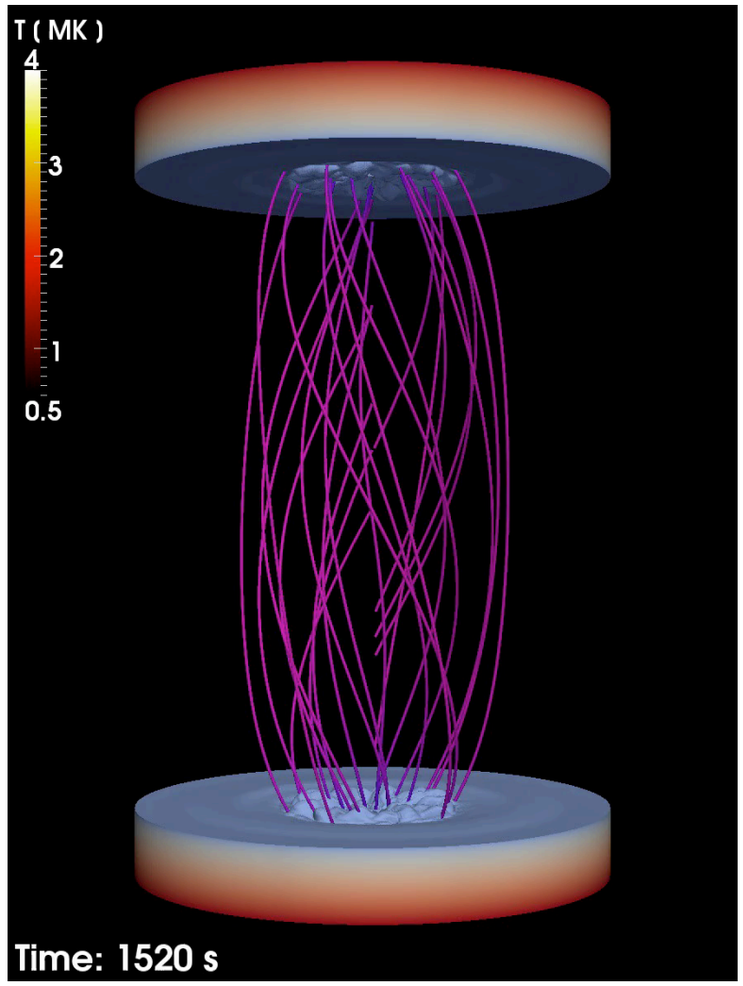
To probe the connection between photospheric magnetic field and coronal structures

Better understanding of mass and energy cycle

Numerical models of coronal loops



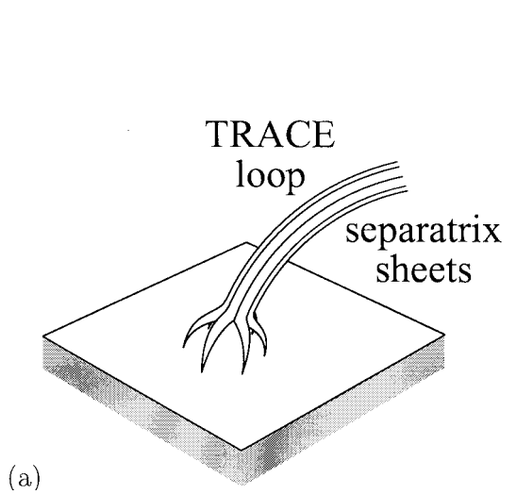
van Ballegooijen et al. (2011)

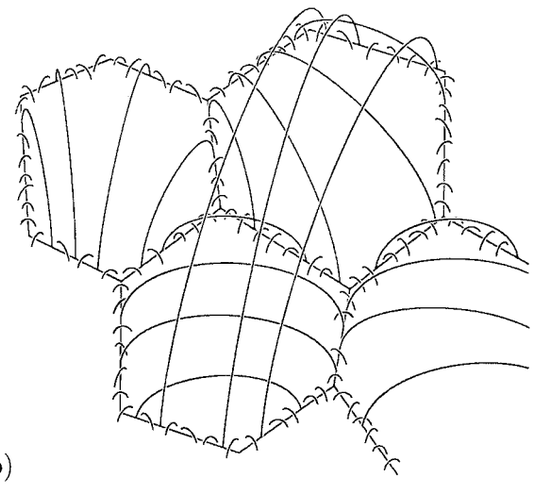


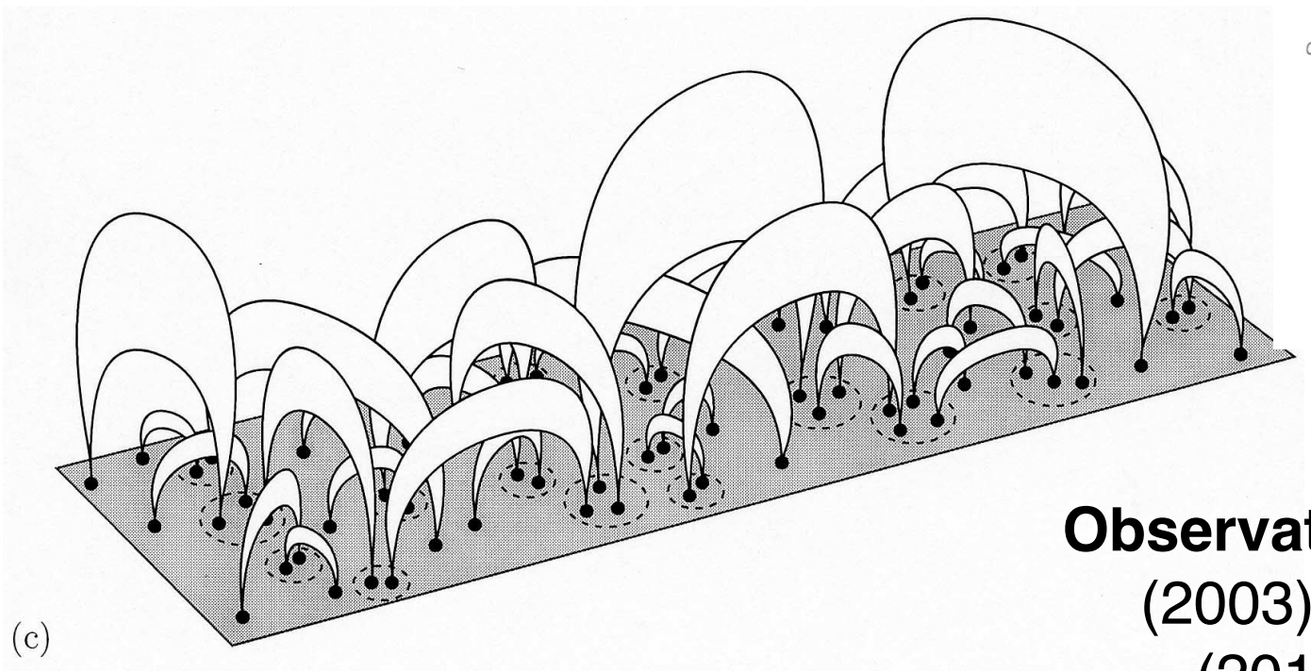
Reale et al. (2016)

footpoint motions shake, stress, and braid the magnetic field —> generate waves/ develop current sheets —> dissipation

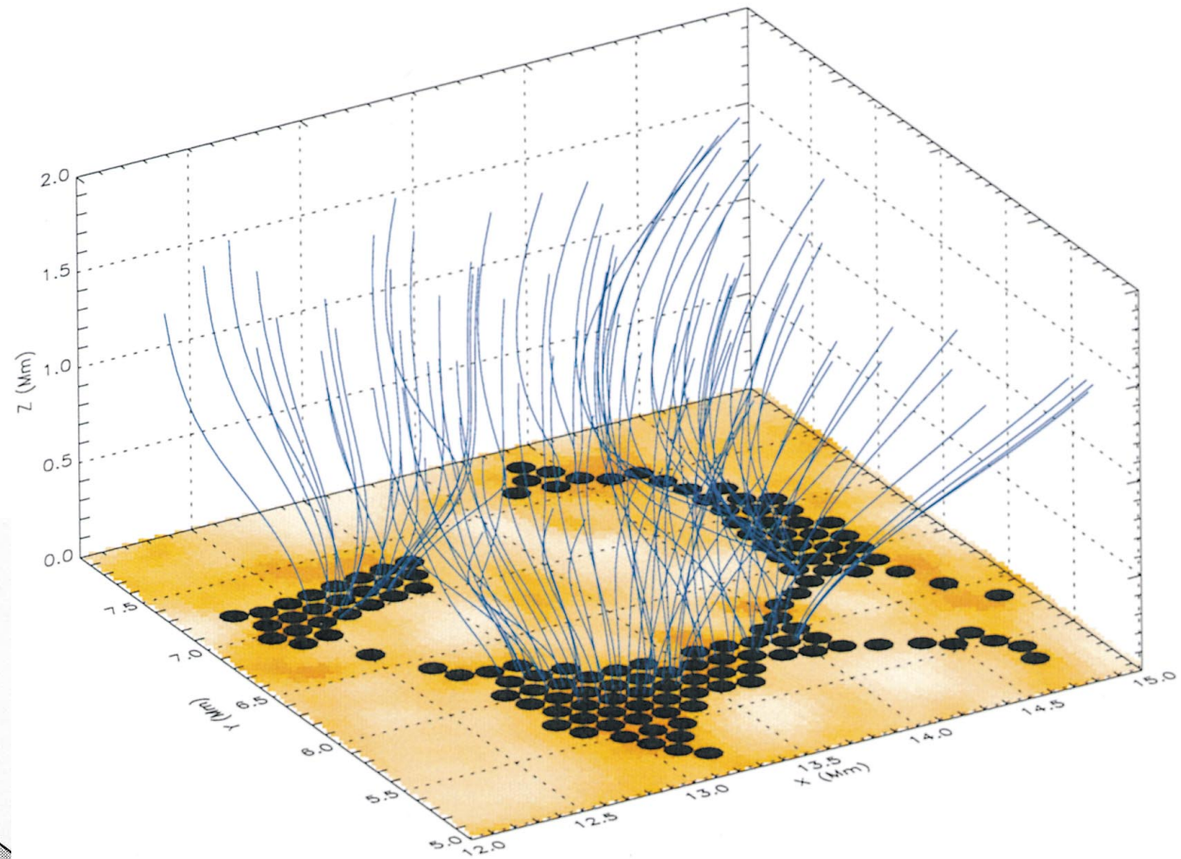
Numerical models of coronal loops







Flux-tube tectonics model of Priest et al. (2002)



van Ballegooijen et al. (1998)

Observations: Porter et al. (1994); De Pontieu et al. (2003); Aschwanden & Title (2004); Peter et al. (2013); Régnier et al. (2014); Wang (2016)

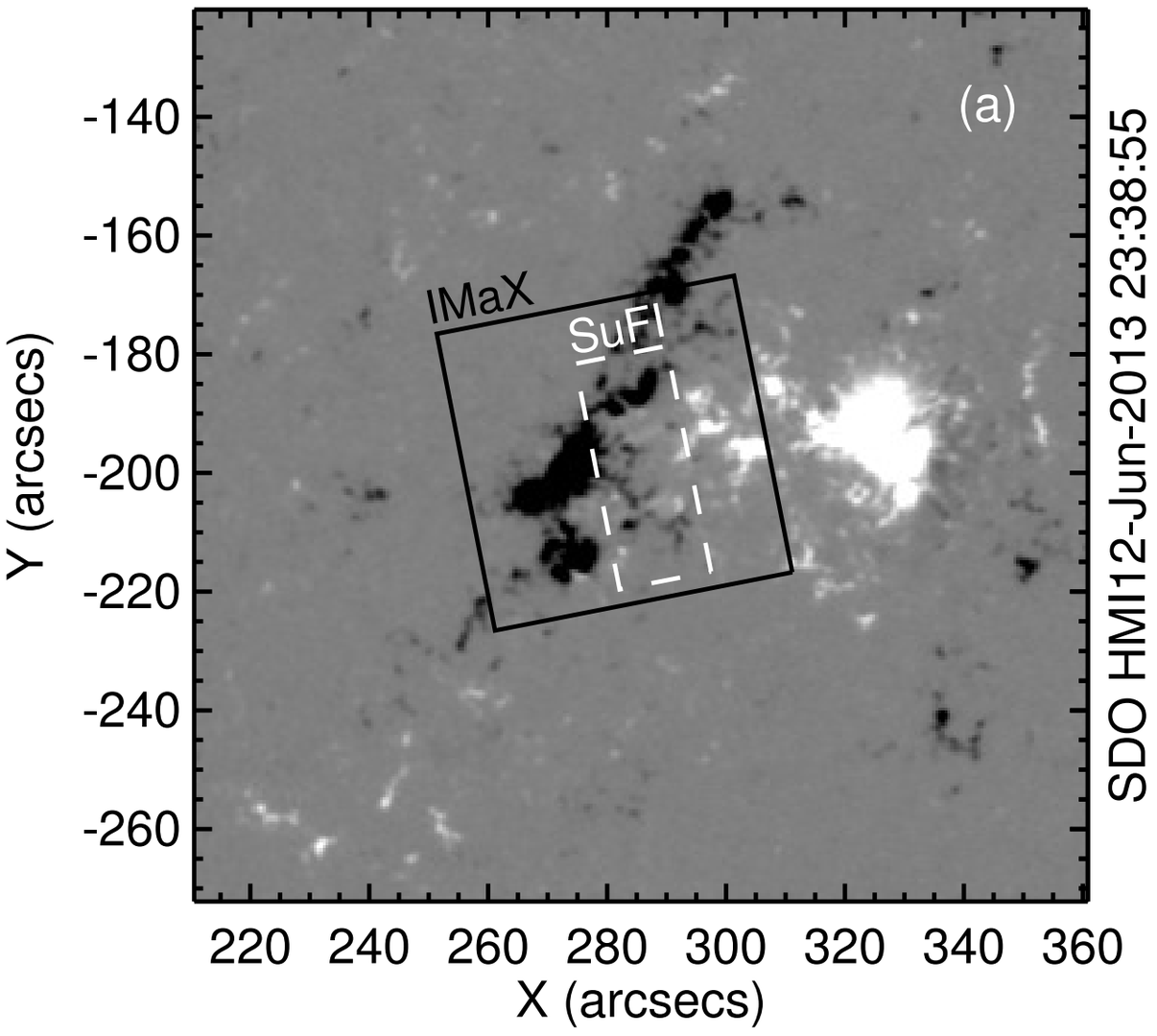
present curious cases of coronal structures and their photospheric connection

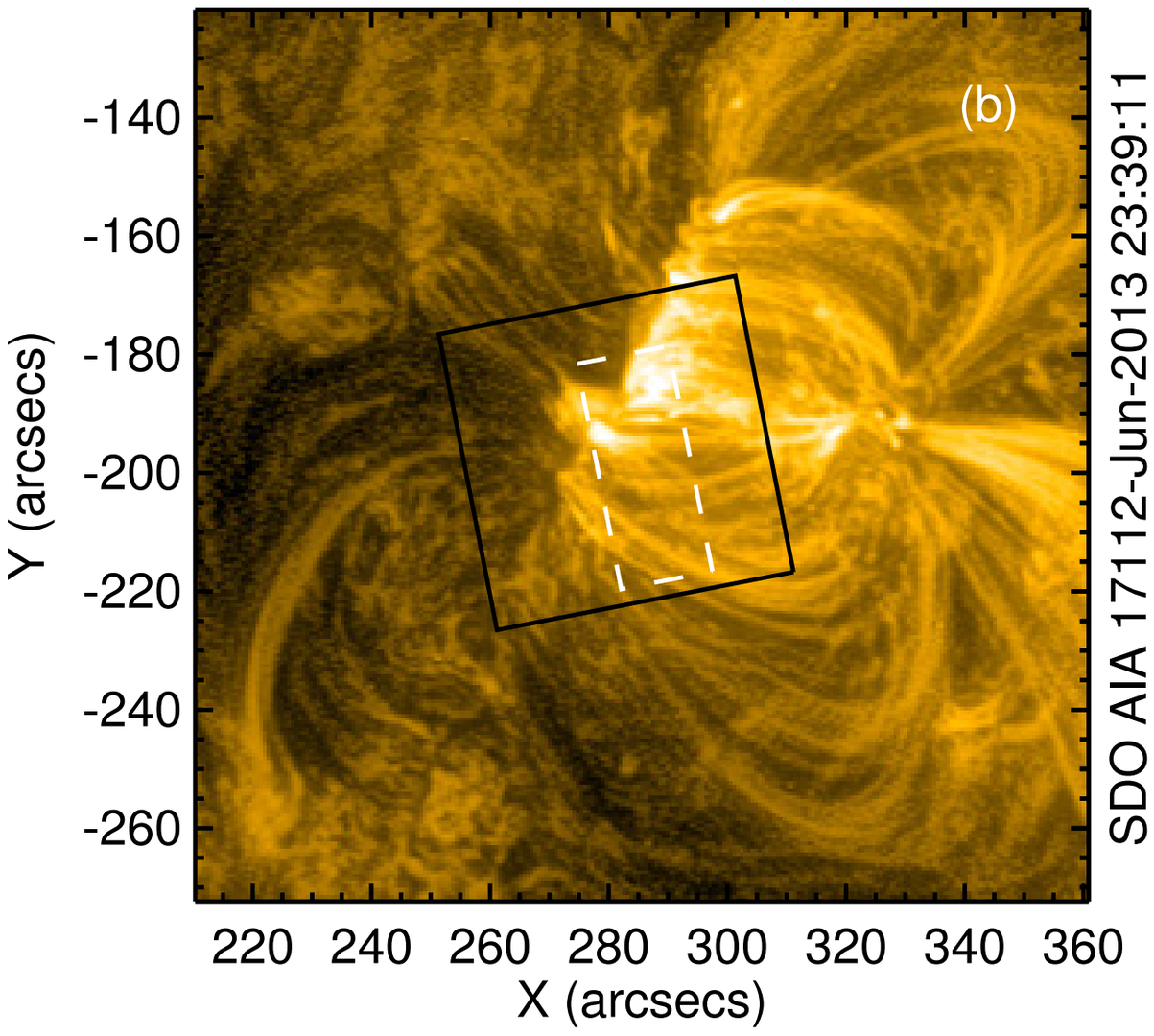
A higher resolution look at the the coronal loop footpoints

with

Sunrise - SDO - IRIS

Sunrise observations — HMI+AIA context

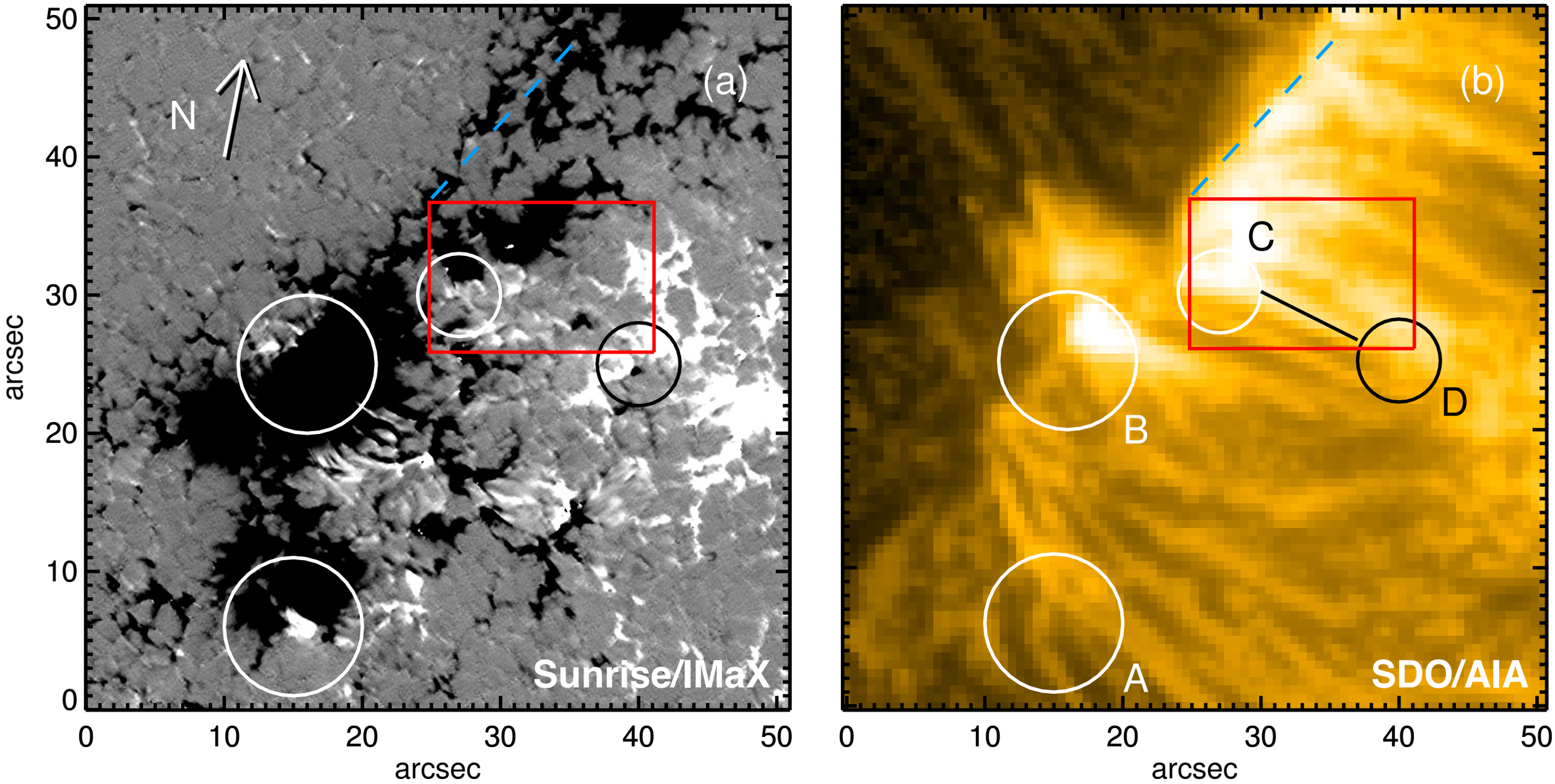




IMaX and SuFI covered the core of a new active region

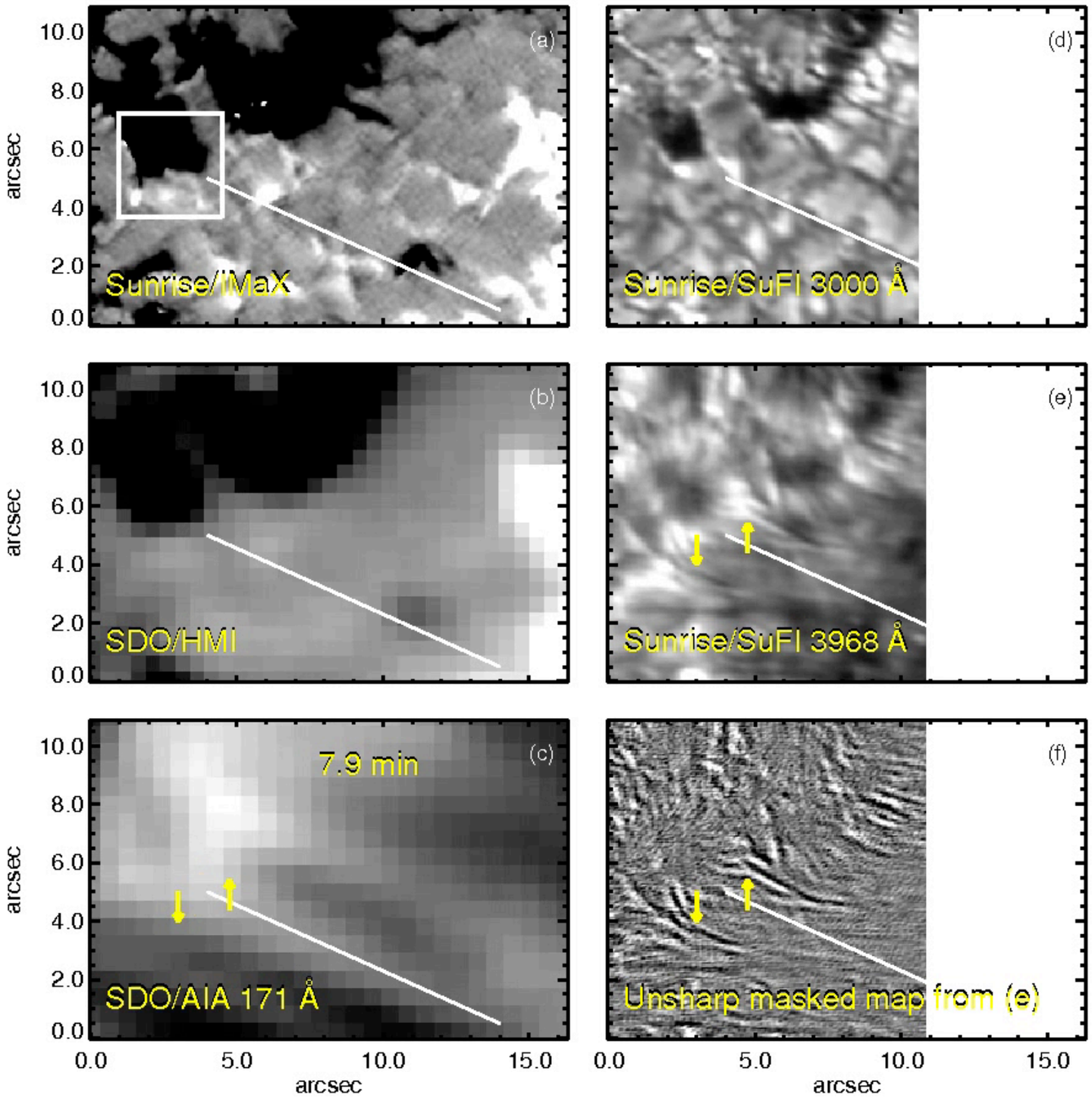
Chitta, Peter, Solanki, et al. ApJS, 2017, 229, 4

Sunrise observations — IMaX+AIA context



IMaX revealed a rich structure of magnetic field in the photosphere which is not visible by HMI

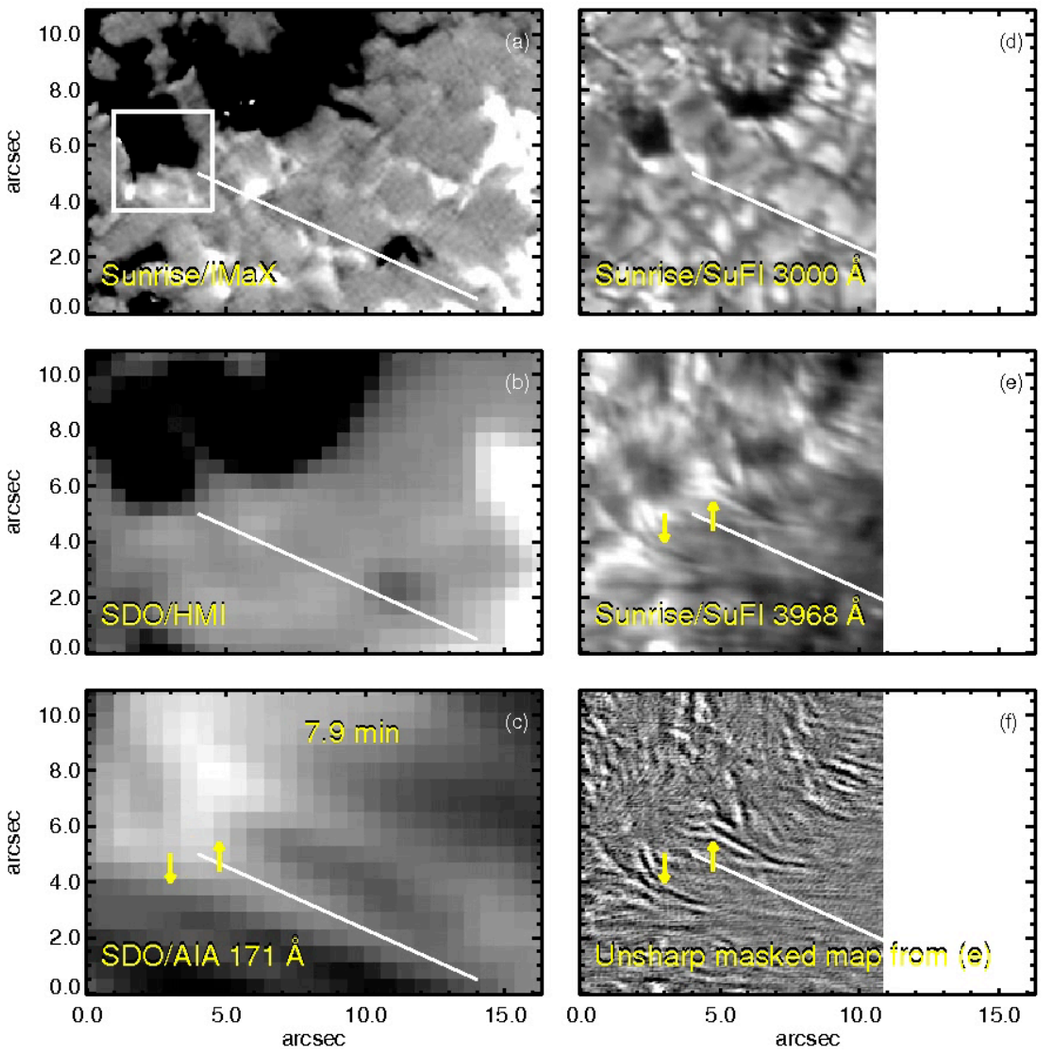
Magnetic connection: photosphere to corona

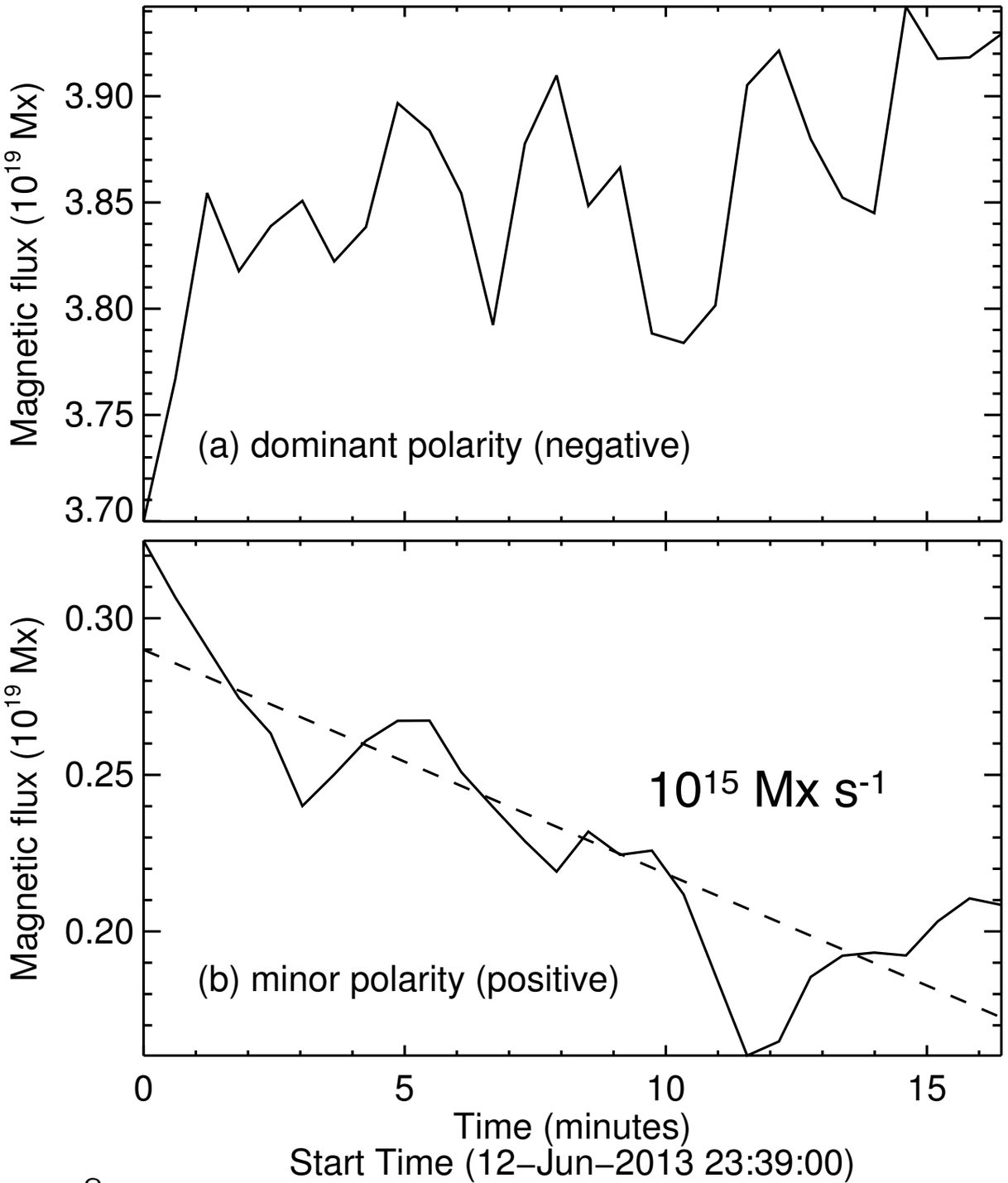


Mixed polarity field in the photosphere

Small-scale jets aligned with overlying coronal loop as dynamic signatures

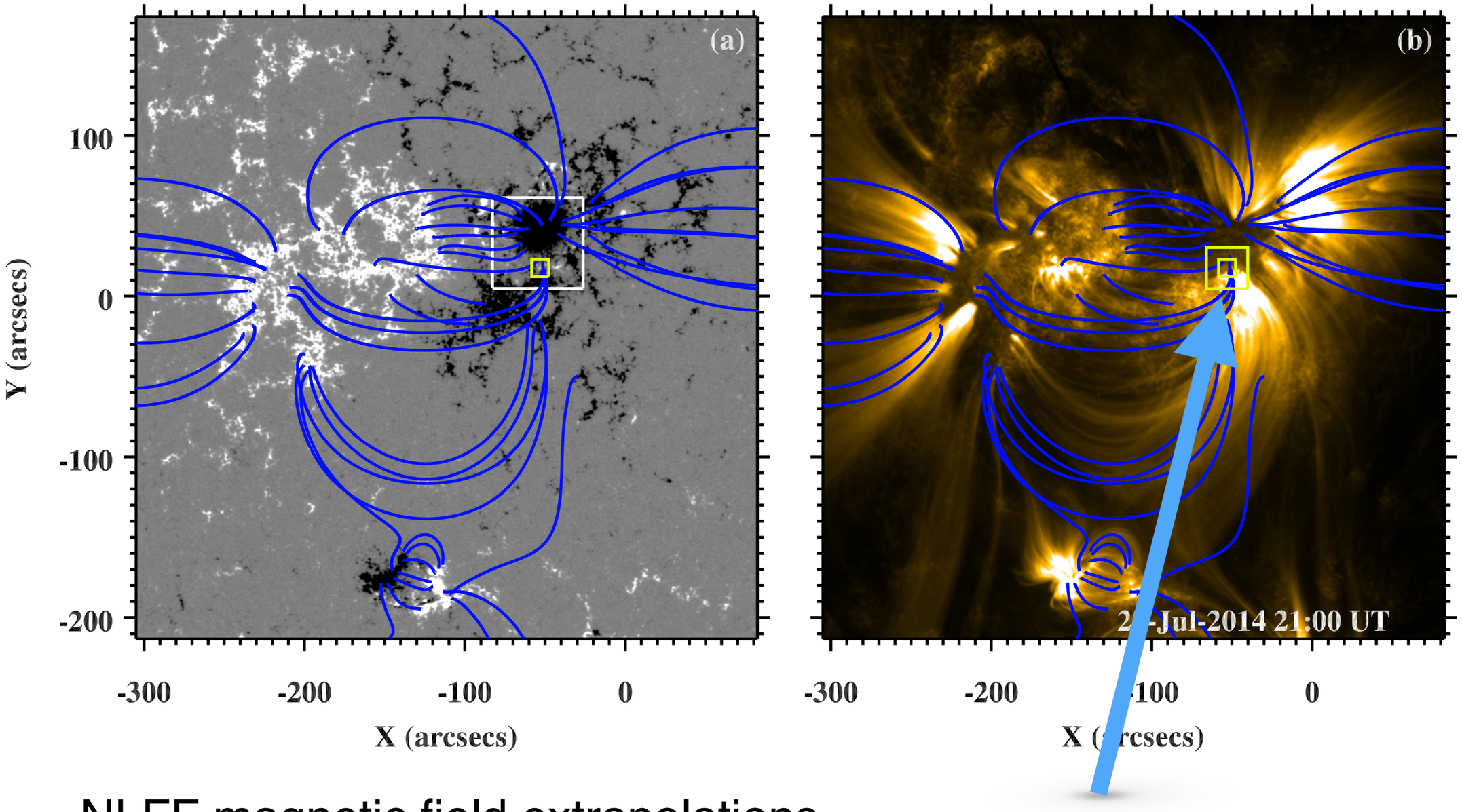
Magnetic connection: photosphere to corona





Magnetic field topology based on observations

Magnetic connection: photosphere to corona



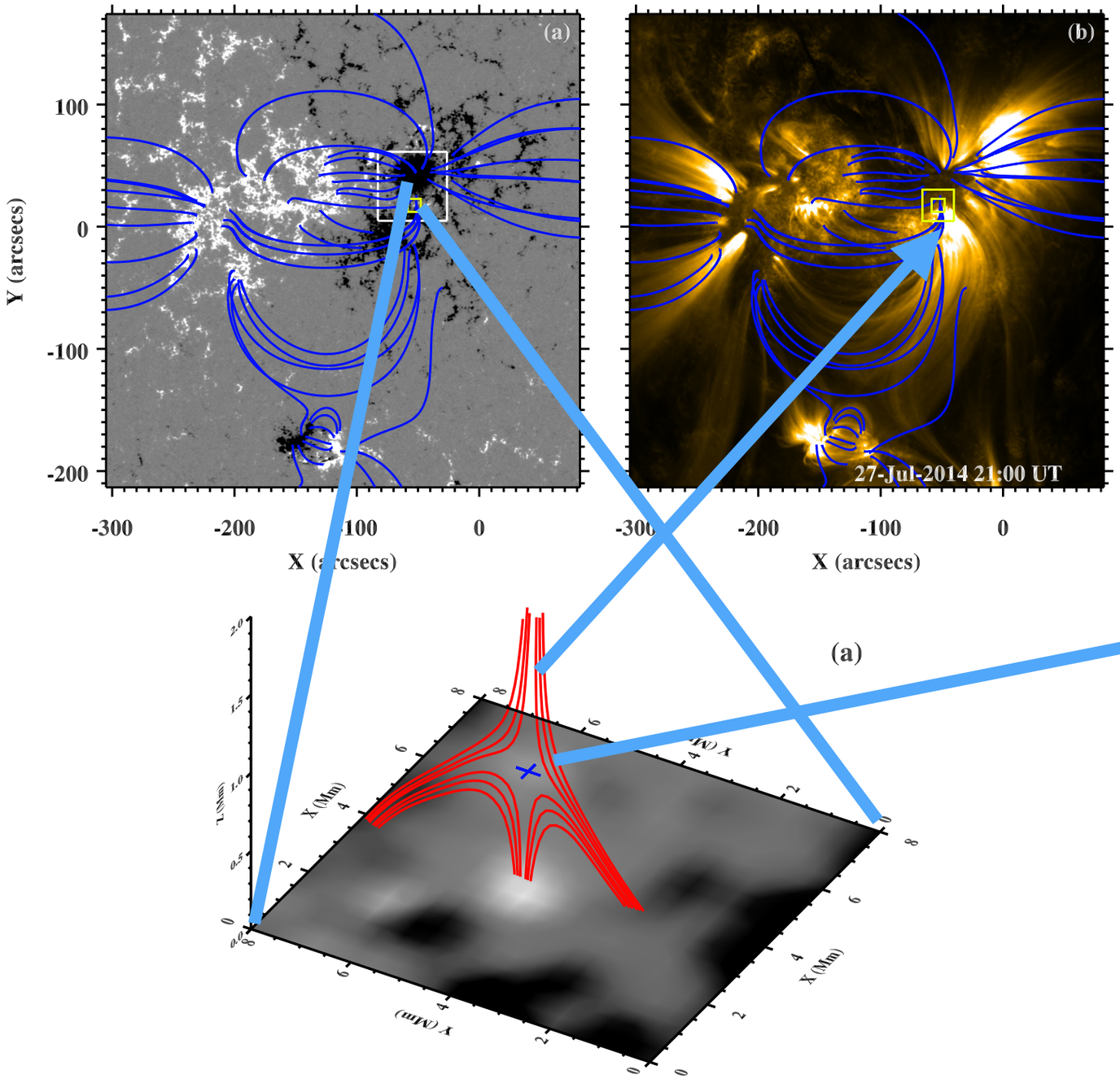
NLFF magnetic field extrapolations based on a magnetofrictional relaxation technique

everyday coronal fan loops

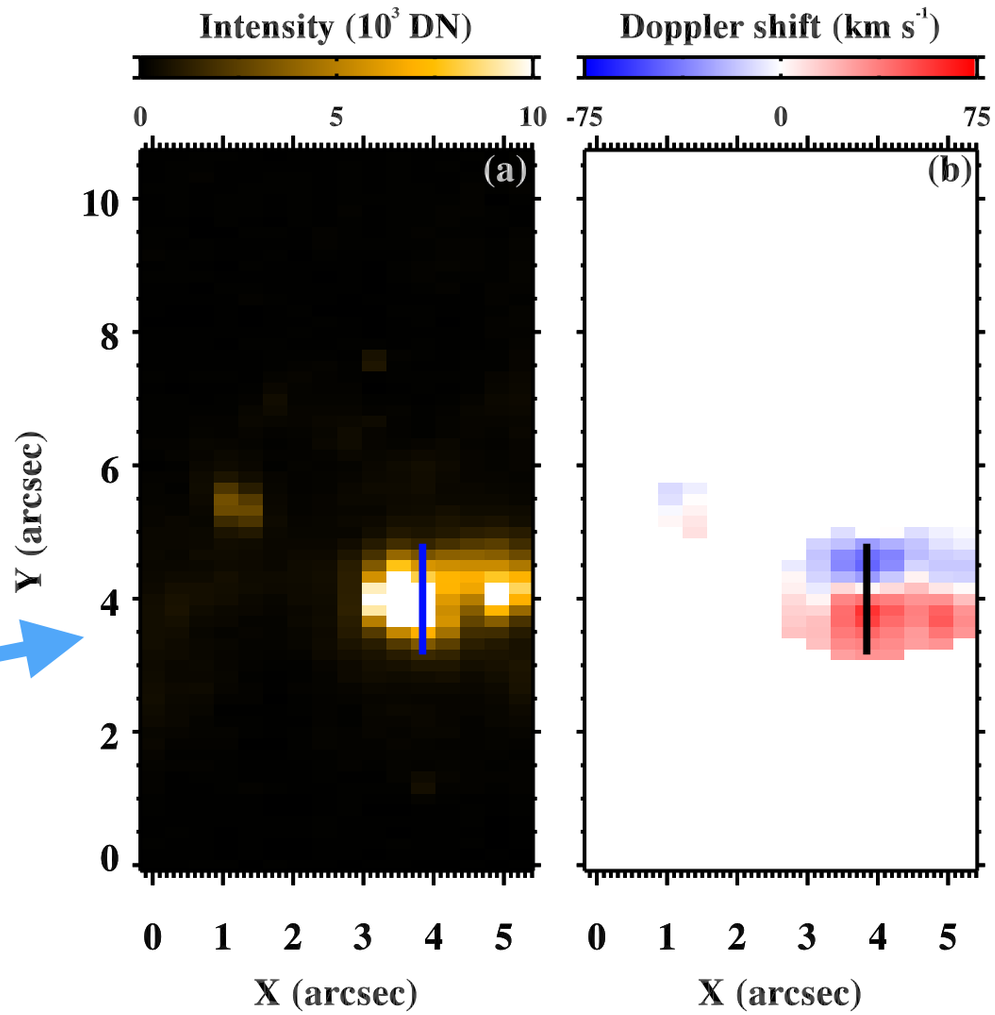
arXiv: 1706.08059

Chitta, Peter, Young, et al. A&A, 2017 (accepted)

Magnetic connection: photosphere to corona

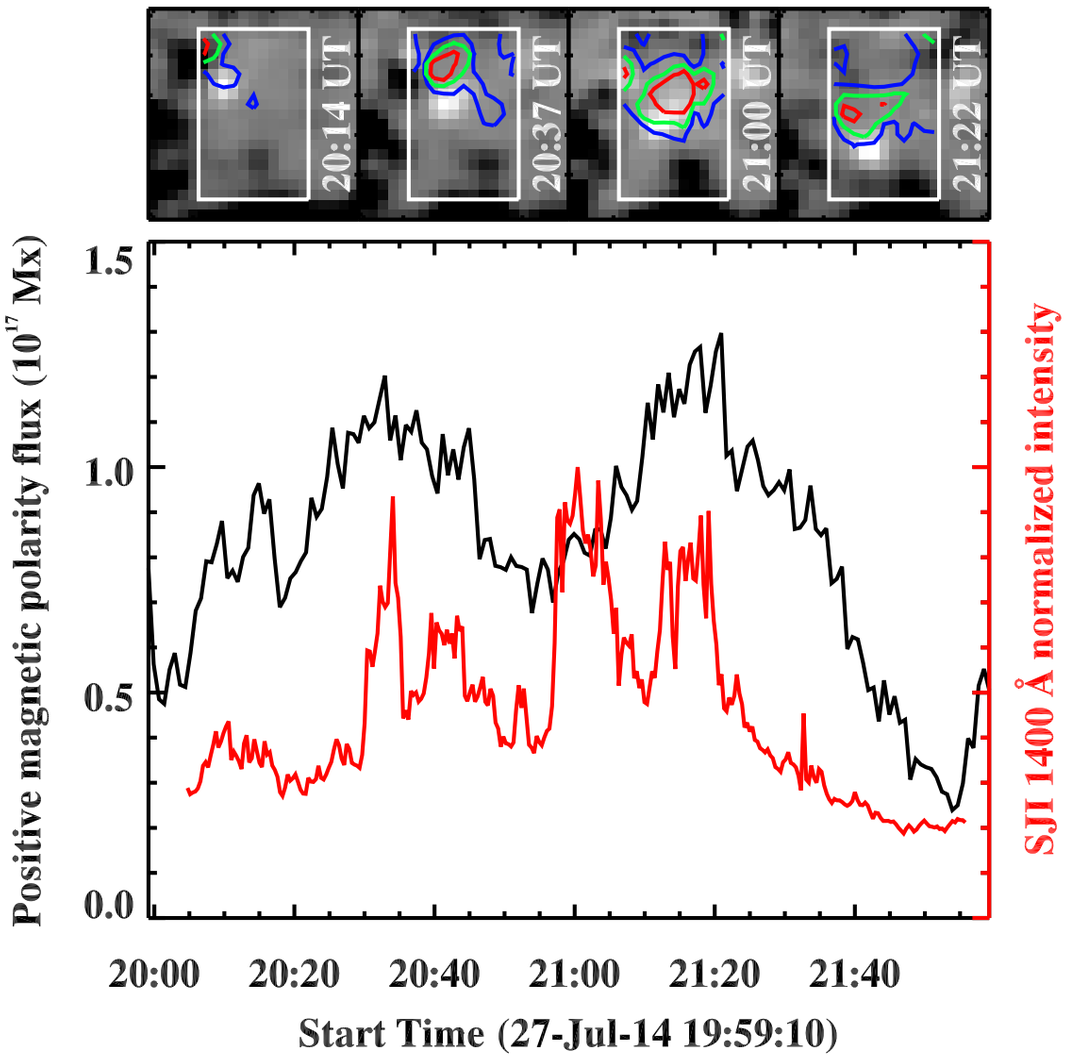


a fan-spine magnetic topology at the base of coronal loops

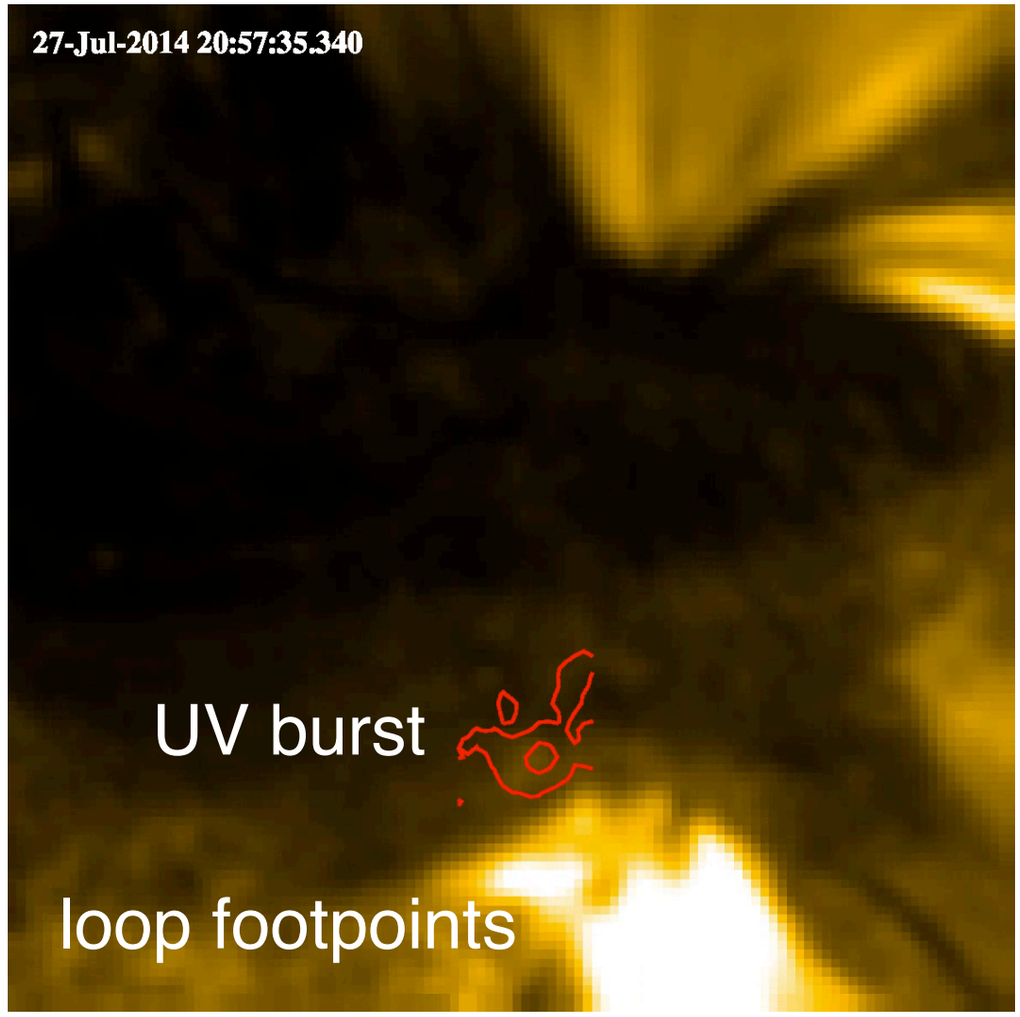


UV burst triggered at the magnetic null point

Magnetic remote connection



magnetic flux emergence and cancellation led to an impulsive UV burst that evolved over 1 hr

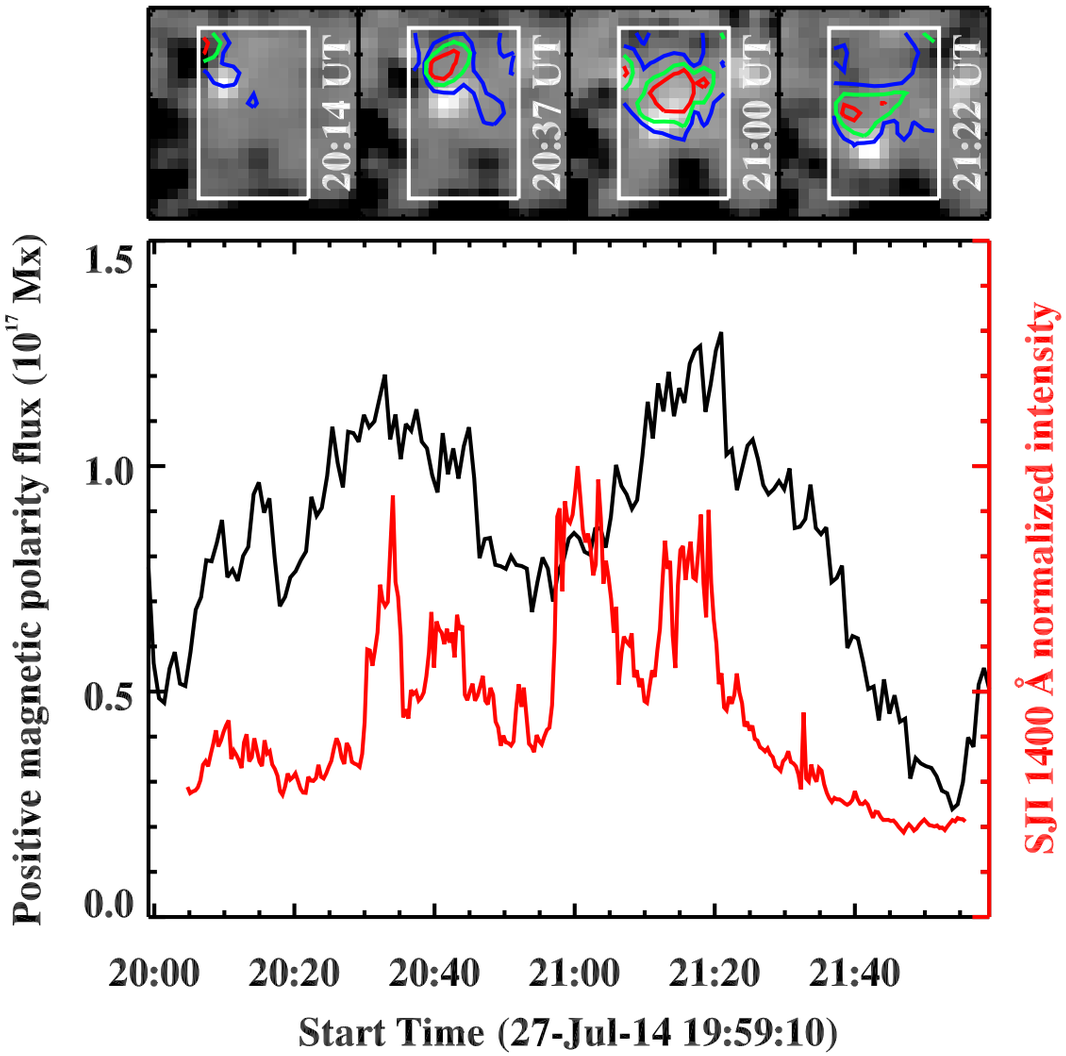


UV burst shows no direct signal in the corona

arXiv: 1706.08059

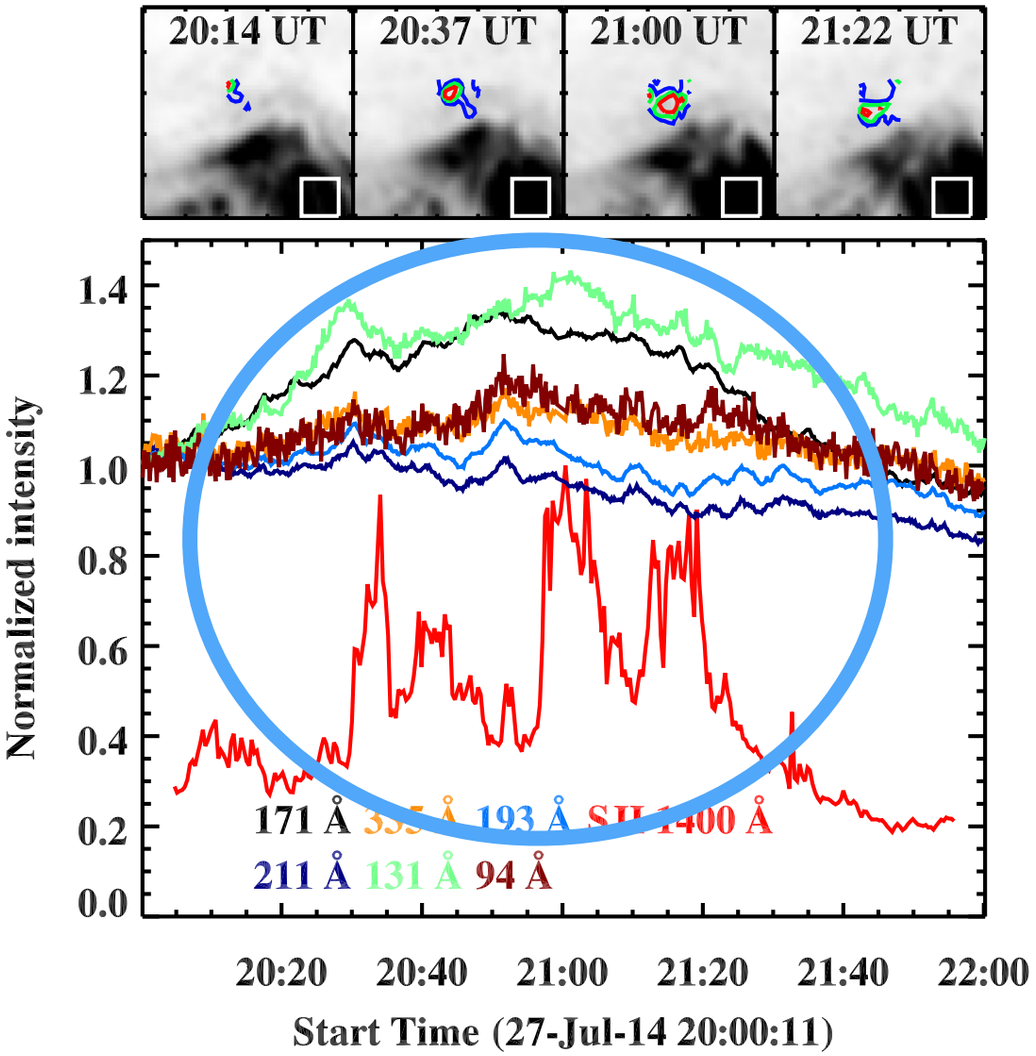
Chitta, Peter, Young, et al. A&A, 2017 (accepted)

Magnetic remote connection



magnetic flux emergence and cancellation led to an impulsive UV burst that evolved over 1 hr

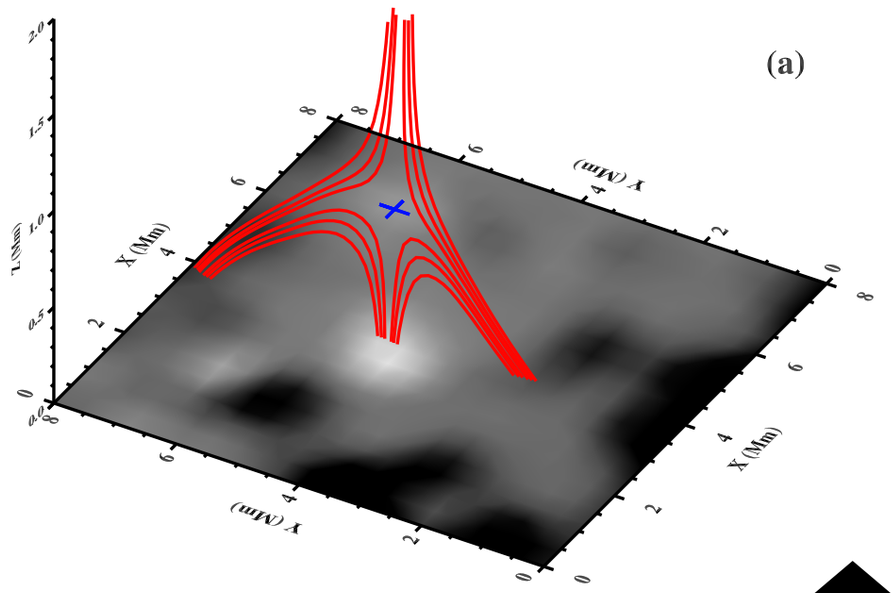
Footpoints of the loops respond to the UV burst at a projected distance of several Mm away

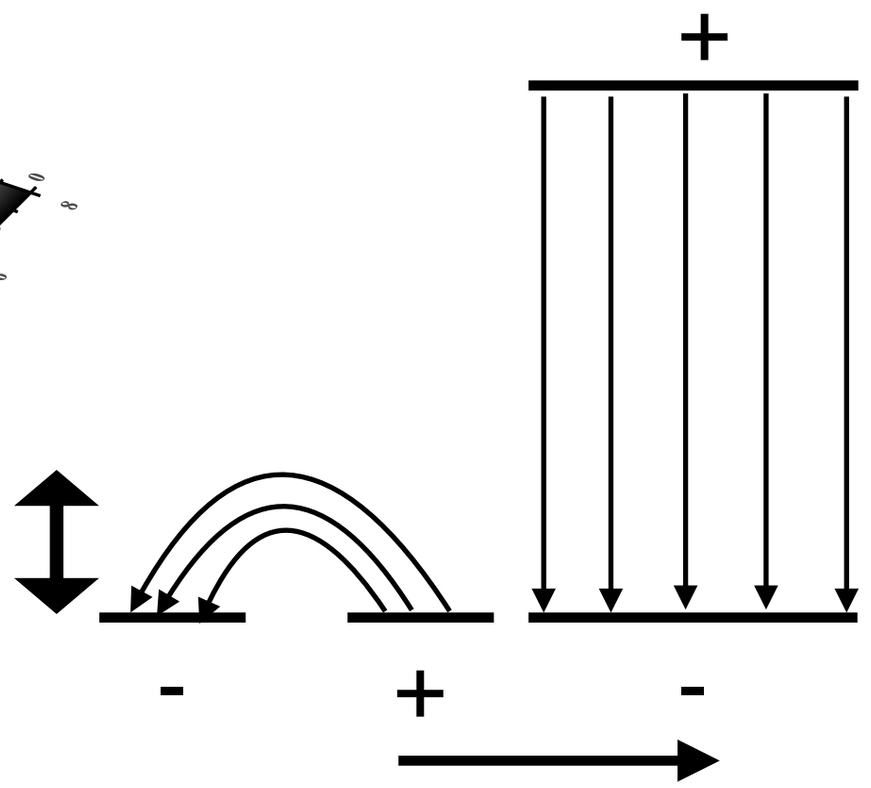


arXiv: 1706.08059

Chitta, Peter, Young, et al. A&A, 2017 (accepted)

Magnetic topology





Heating scale height ~ 500 km

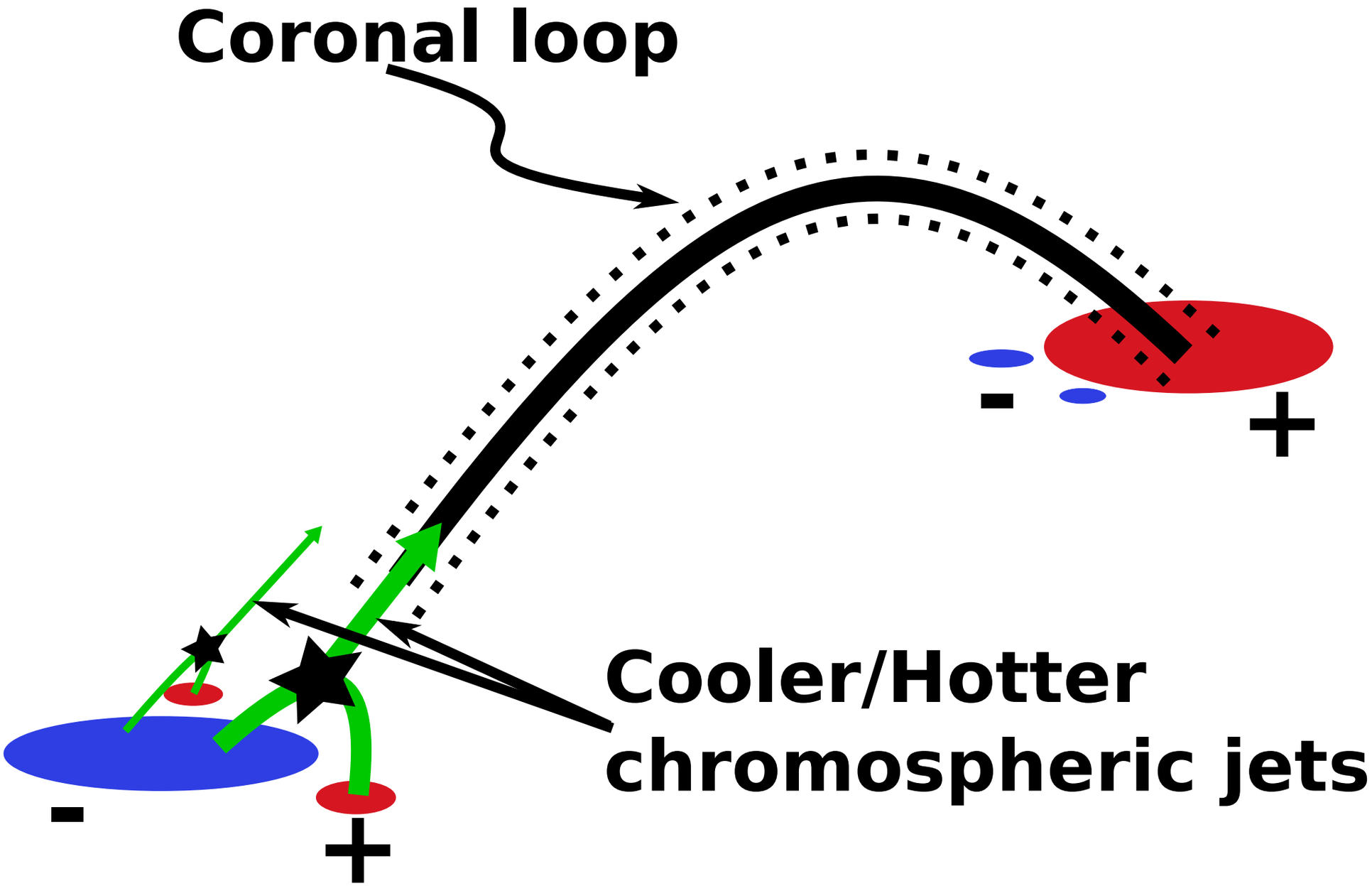
Flux emergence/ cancellation (10^{15} Mx s^{-1})

Average magnetic energy flux ≈ 10^{9} erg cm^{-2} s^{-1}

Photospheric Poynting flux due to convective motions

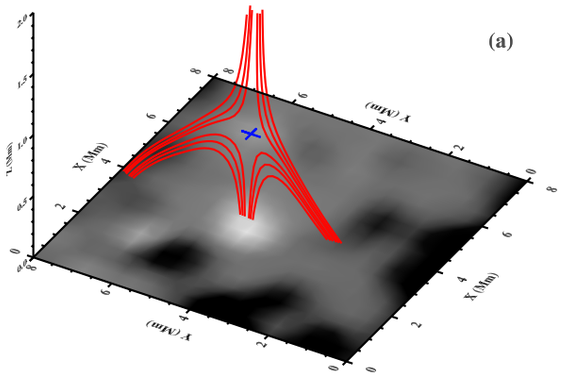
≈ 5×10^{7} erg cm^{-2} s^{-1} (e.g. Welsch 2015)

Illustration of a coronal loop



Chitta, Peter, Solanki, et al. ApJS, 2017, 229, 4

Conclusions



- High resolution observations reveal a complex distribution of small-scale mixed polarity field near coronal loop footpoints in active region cores

- Observed flux emergence/ cancellation rates of ~10^{15} Mx s^{-1} can provide a large reservoir of magnetic energy at the base of coronal loops

- **Topological changes in the underlying magnetic field likely trigger impulsive response in the overlying loops — even remotely**

- Plasma jets resulting from this energy release at the base could supply mass to coronal loops