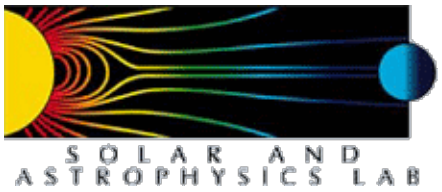
Emergence of internetwork magnetic fields through the solar atmosphere

Milan Gošić
B. De Pontieu, L. R. Bellot Rubio



IRIS-9, Göttingen, 25-29 June 2018

Contributed Talk

2. Chromospheric heating and dynamics

Emergence of internetwork magnetic fields through the solar atmosphere

M. Gošić[1,2], B. De Pontieu[1,3,4] L. R. Bellot Rubio[5]

[1] *Lockheed Martin Solar and Astrophysics Laboratory, Palo Alto, CA 94304, USA*
[2] *Bay Area Environmental Research Institute, Moffett Field, CA 94035, USA*
[3] *Institute of Theoretical Astrophysics, University of Oslo, P.O. Box 1029 Blindern, NO-0315 Oslo, Norway*
[4] *Rosseland Centre for Solar Physics, University of Oslo, P.O. Box 1029 Blindern, NO-0315 Oslo, Norway*
[5] *Instituto de Astrofísica de Andalucía (IAA-CSIC), Apdo. 3004, E-18080 Granada, Spain*

Internetwork (IN) magnetic fields are highly dynamic, short-lived magnetic structures that populate the interior of supergranular cells. Since they emerge all over the Sun, these small-scale fields bring a substantial amount of flux, and therefore energy, to the solar surface. Because of this, IN fields are crucial for understanding the quiet Sun magnetism. However, they are weak and produce very small polarization signals, which is the reason why their properties and impact on the energetics and dynamics of the solar atmosphere are largely unknown. Here we use coordinated IRIS and SST observations of IN regions at high spatial and temporal resolution. They give us the opportunity to follow the evolution of IN magnetic loops as they emerge into the photosphere. For the first time, our polarimetric measurements provide a direct observational evidence of IN fields reaching the chromosphere. Moreover, we show that IN magnetic loops contribute to the chromospheric and transition region heating through interaction with preexisting ambient fields.

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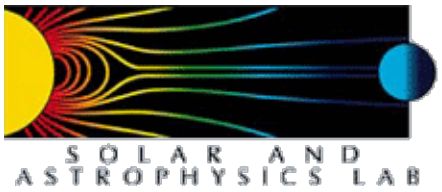
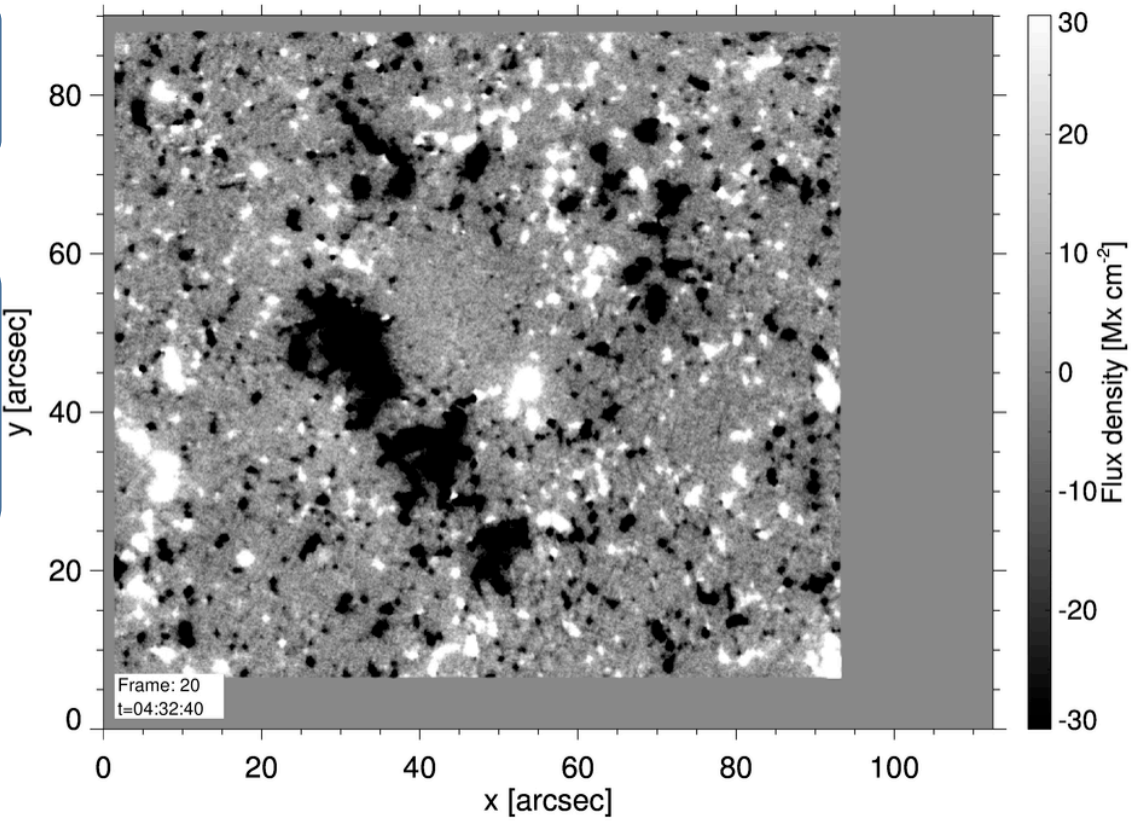


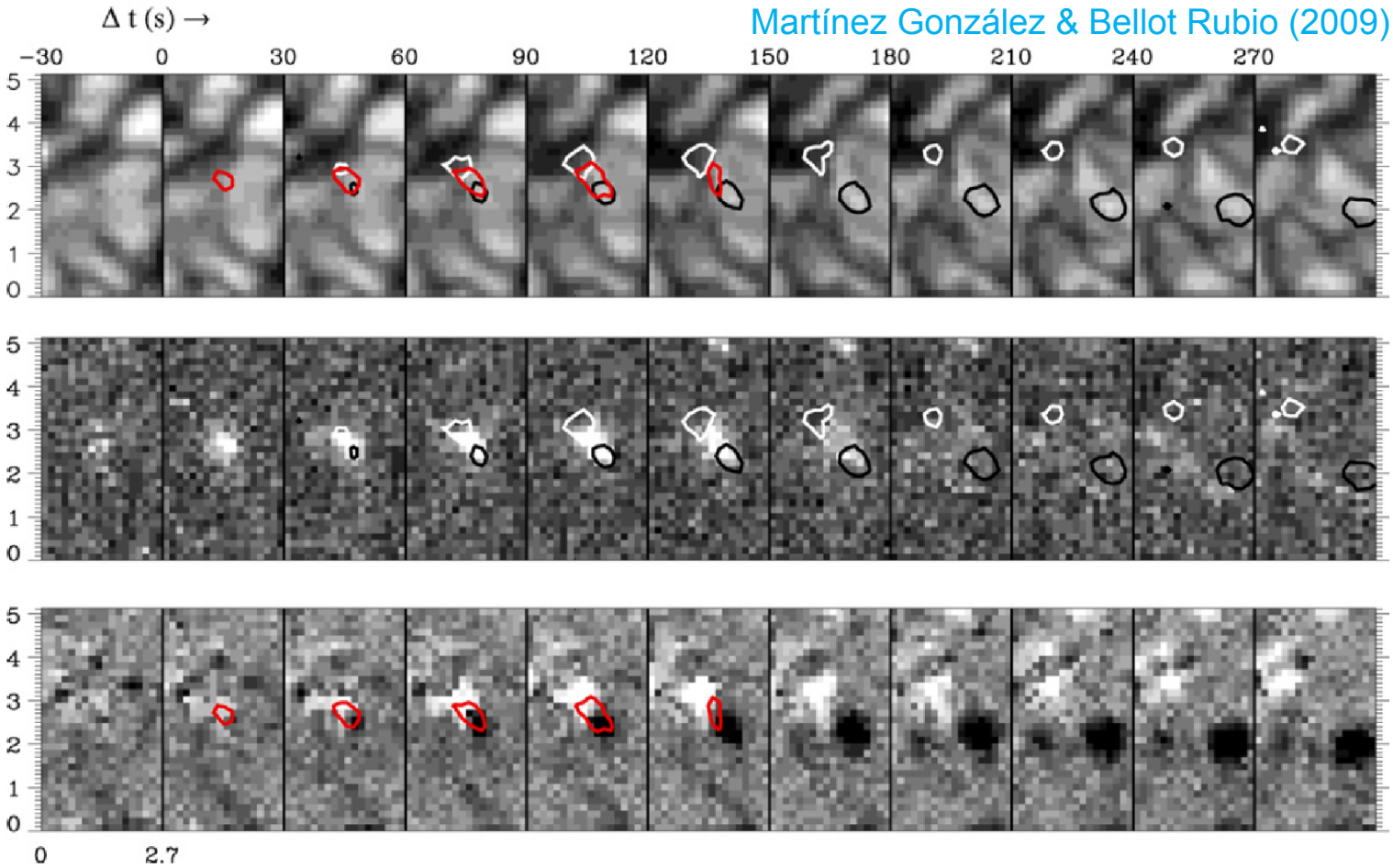
Magnetic flux on the Sun

Up to 50% of the QS flux is in the form of IN patches (Wang et al. 1995)

IN elements appear at a rate of 120 Mx cm^{-2} day^{-1} (Gošić et al. 2016)
(the rate in ARs is 1 Mx cm^{-2} day^{-2} Thornton & Parnell 2010)

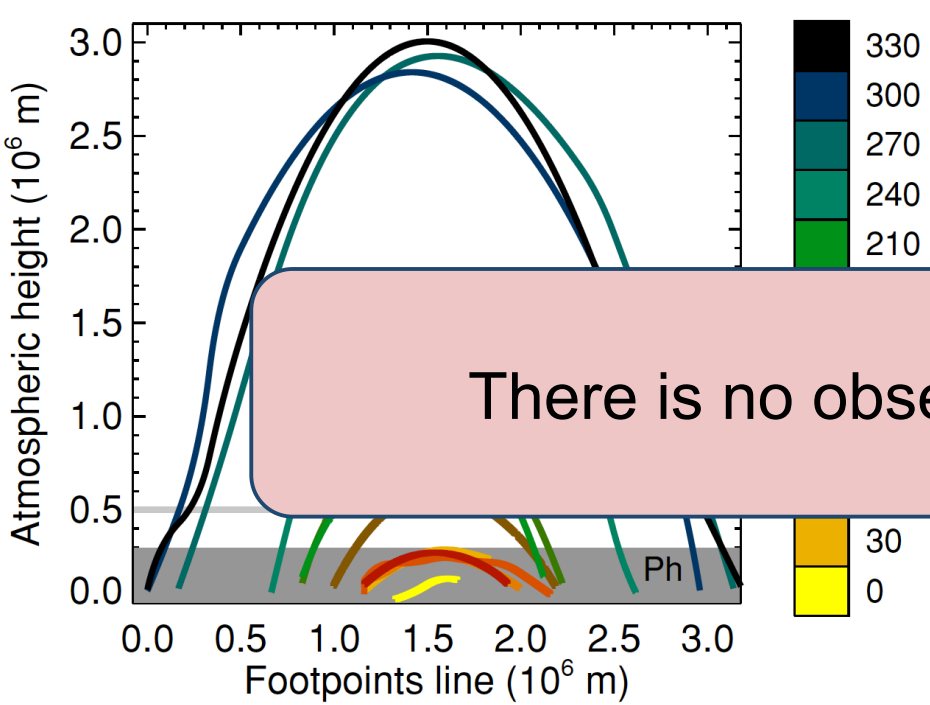


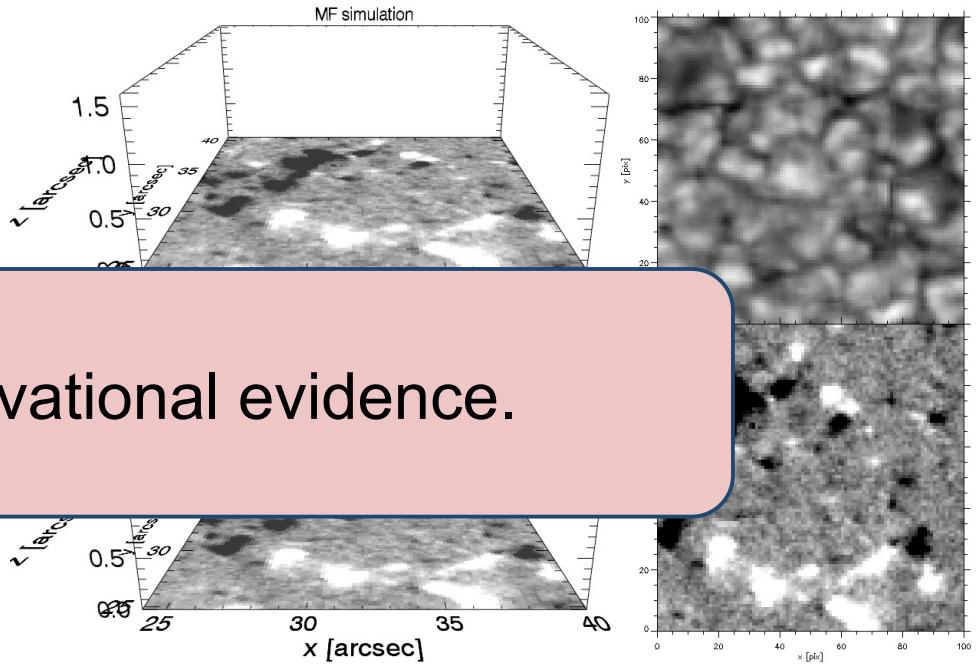
Emergence of internetwork magnetic fields



Martínez González & Bellot Rubio (2009)

Emergence of internetwork magnetic fields





There is no observational evidence.

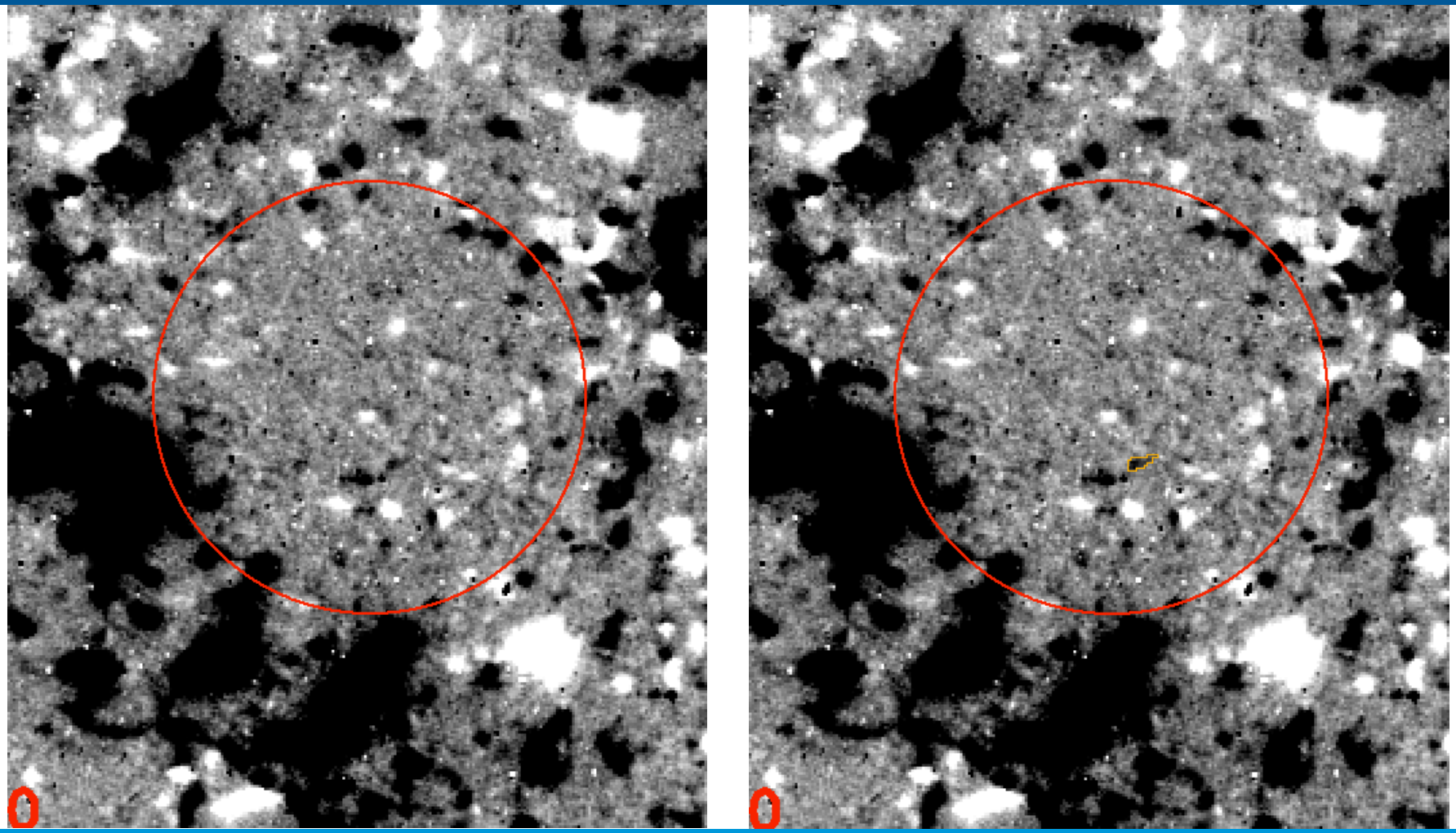
Martínez González et al. (2010)

Gošić et al., in prep.

Emergence of internetwork magnetic fields

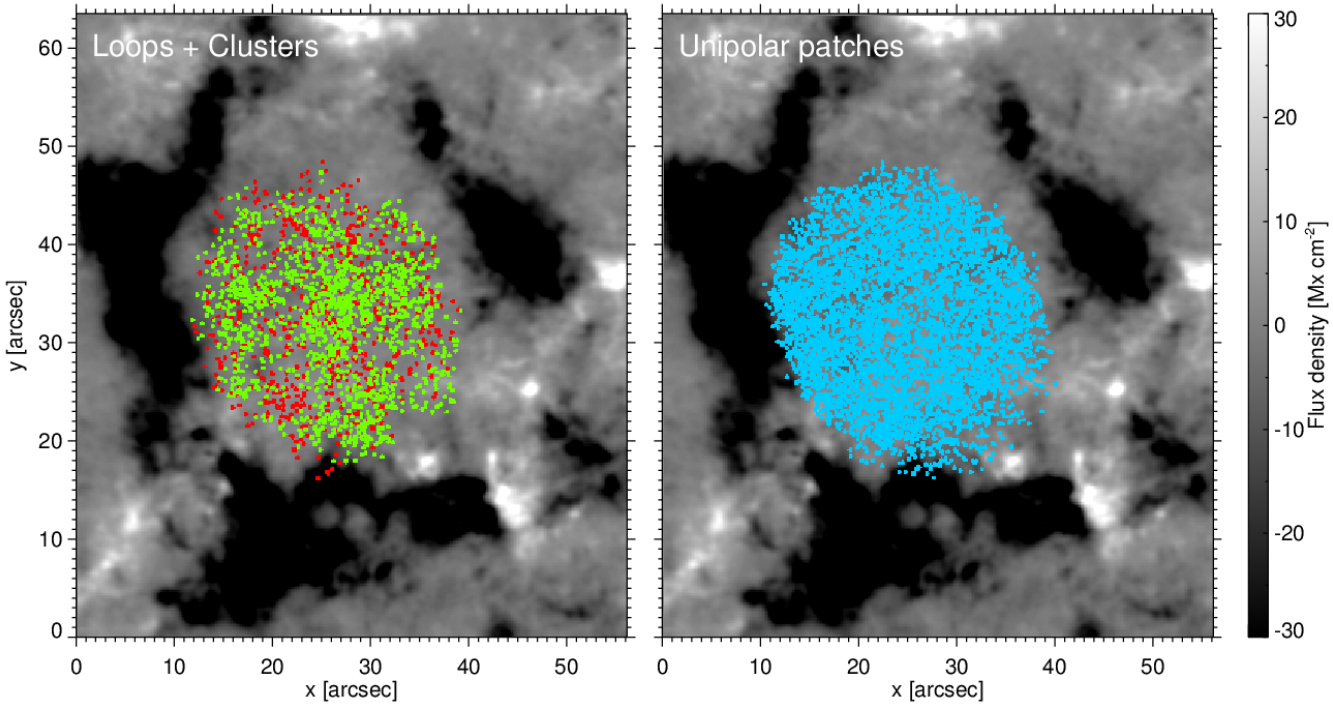
Aim: To determine how IN loops affect the energetics and dynamics of the upper quiet Sun atmosphere.

Emergence of internetwork magnetic flux



Emergence of internetwork magnetic flux

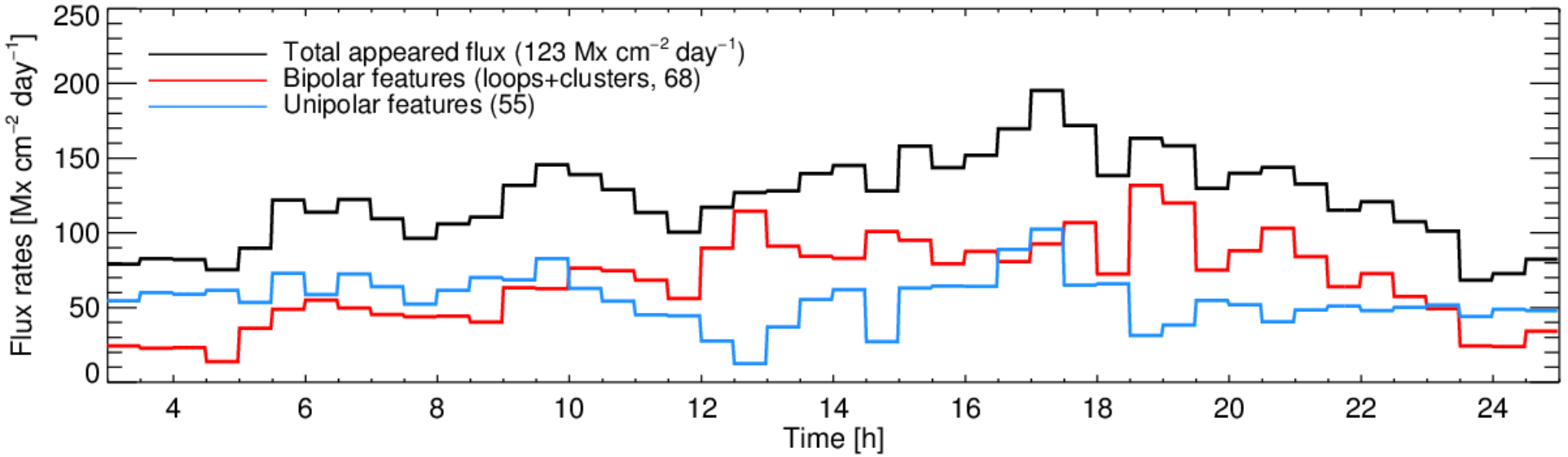
Bipolar structures appear more or less uniformly inside the supergranular cell



Gošić et al., in prep.

Appearance rates of internetwork magnetic flux

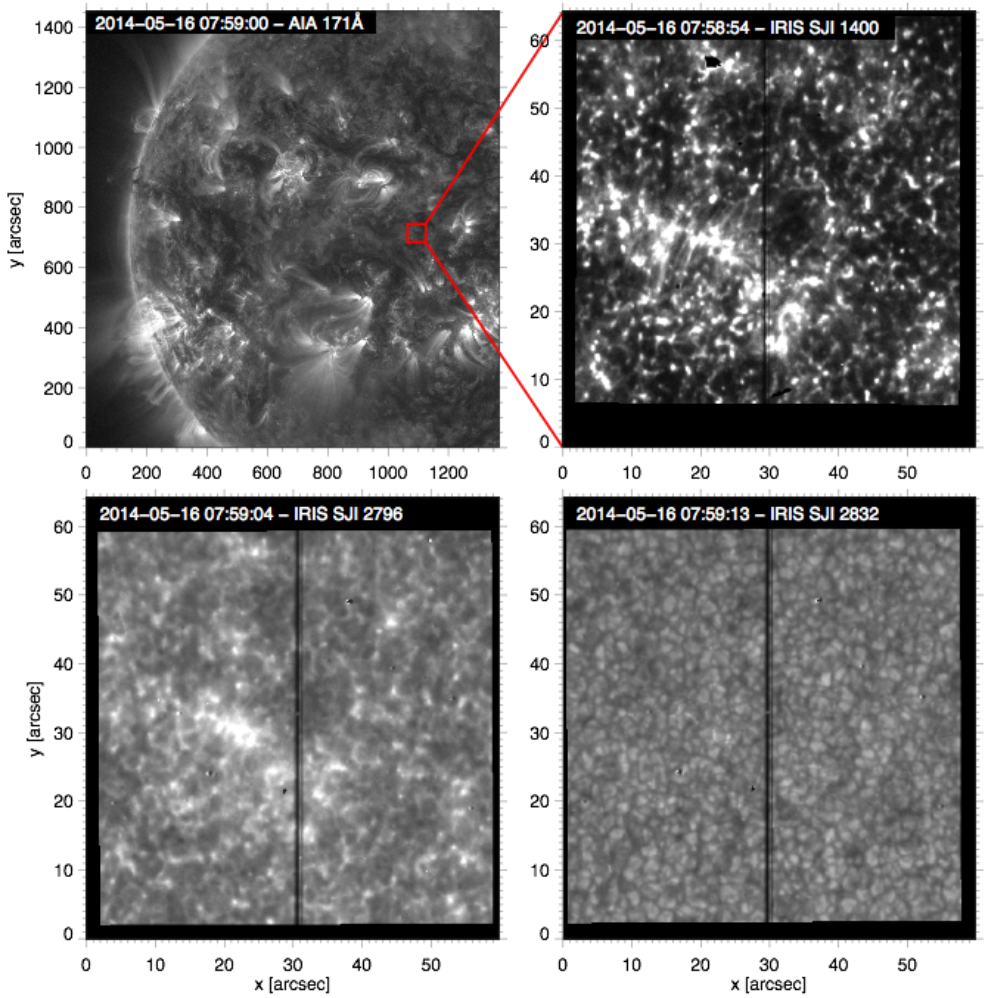
Emergence rate of bipolar structures is 68 Mx cm^{-2} day^{-1}
This is 55% of the total appeared flux in the IN



Gošić et al., in prep.

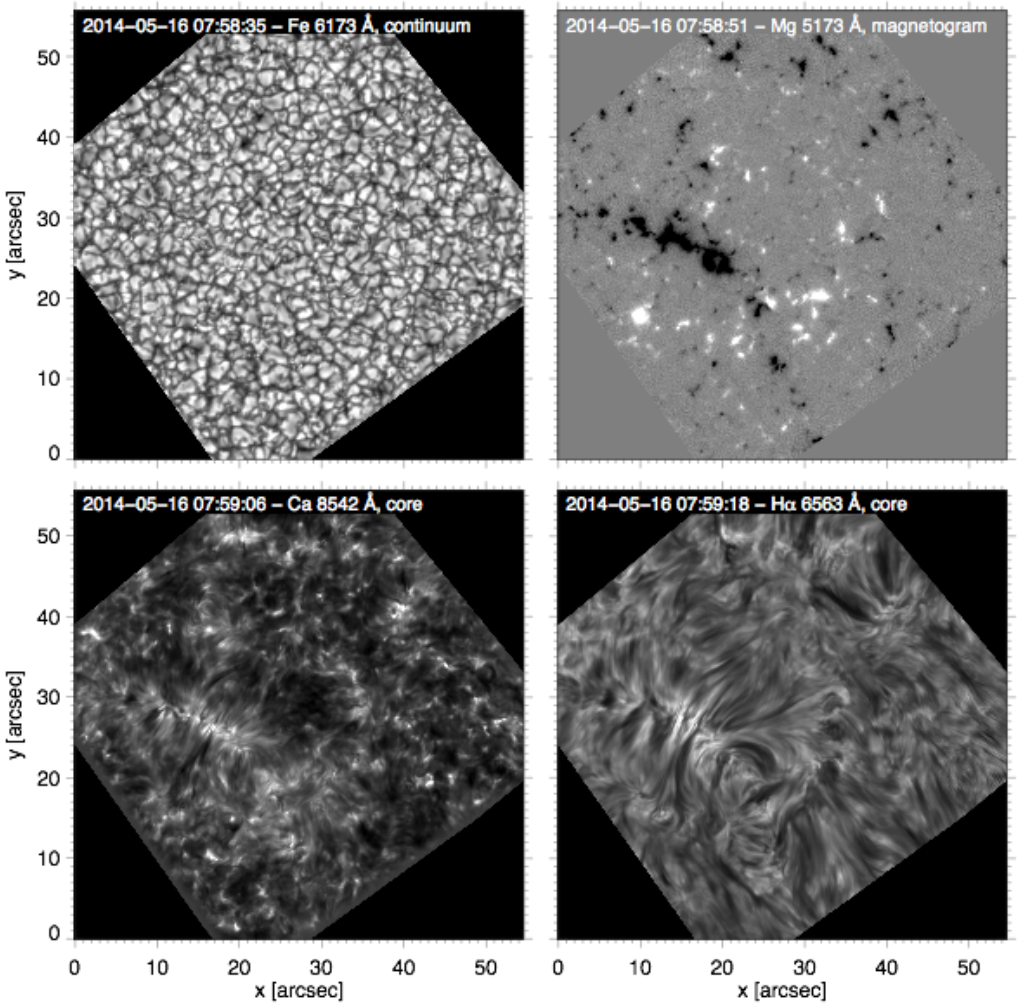
Data

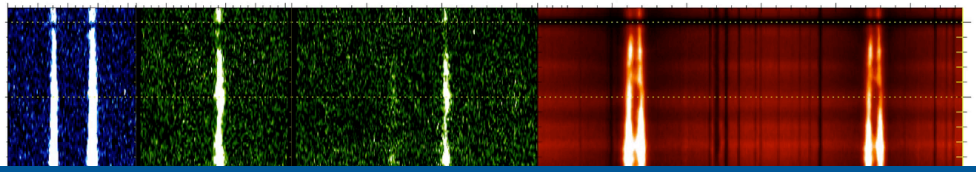
- IRIS time sequences:
  - medium sparse 2-step rasters
  - SJI 1400, SJI 2796, SJI 2832
  - quiet Sun at the disk center
  - high raster cadence: 18.6 sec
  - SJI cadence: 19 sec
  - duration: 3 hr



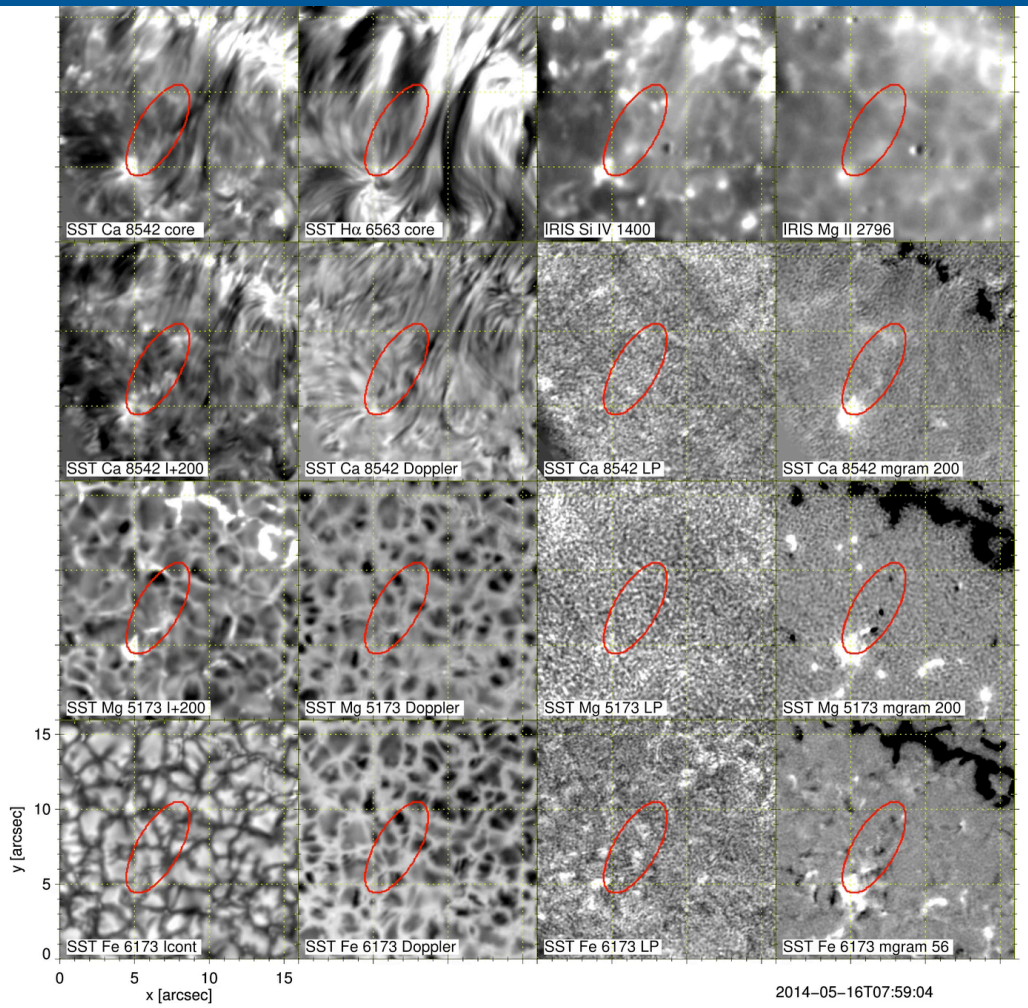
Data

- SST time sequences:
  - Lines: Fe I 6173 Å, Mg 5173 Å
    Ca II 8542 Å and Hα 6563 Å
  - cadence: 55 sec
  - duration: 3 hr

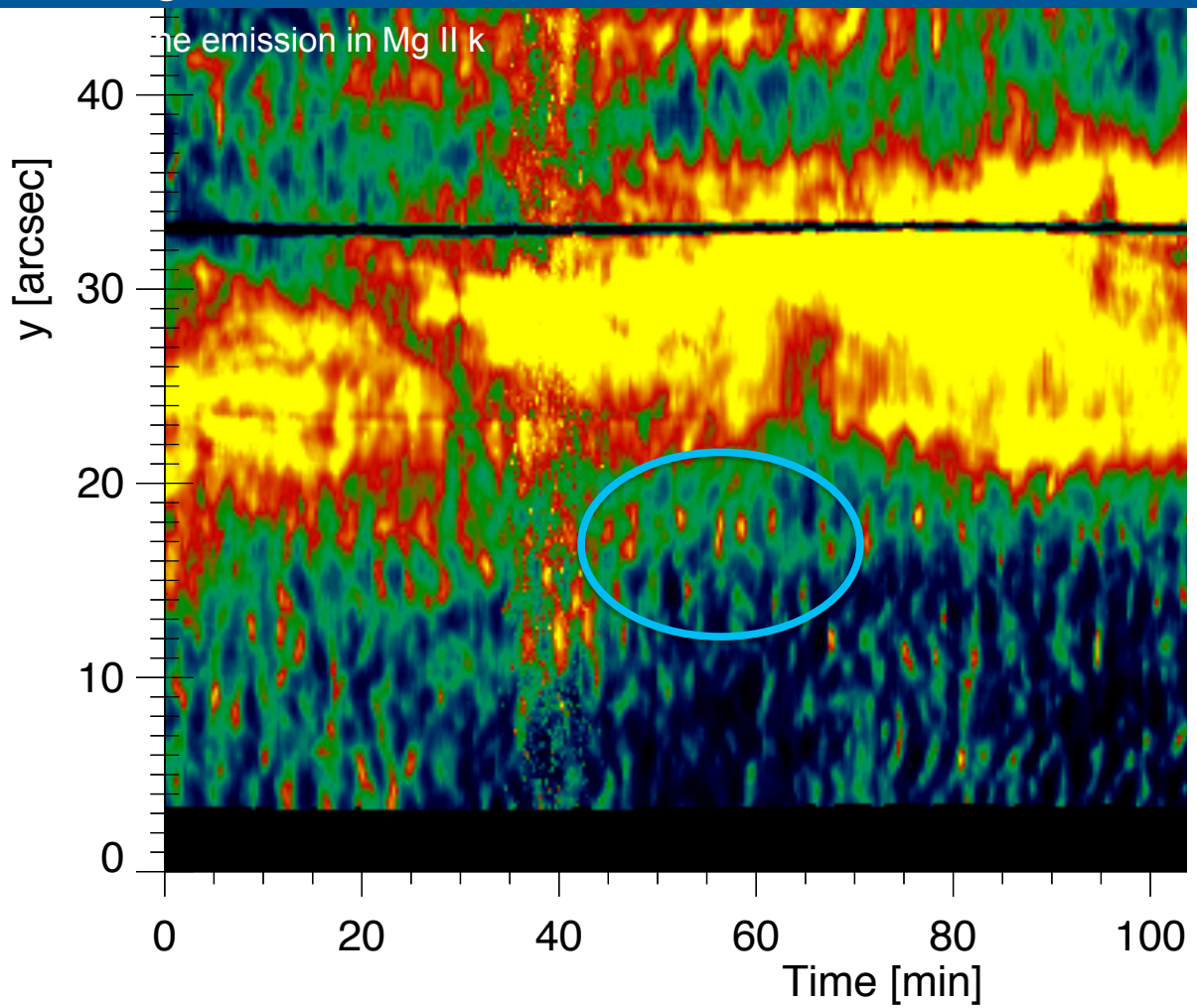




Internetwork magnetic fields reach the chromosphere



Chromospheric heating



Conclusions

New flux is brought to the solar surface by bipolar elements that appear everywhere within a supergranular cell and contain 72% of the total detected IN flux.

IN magnetic loops can reach the chromosphere and heat the upper solar atmosphere.

This may be an important mechanism of transporting energy and magnetic flux to the chromosphere and transition region.