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Photospheric origin of bright dots in the transition Region

A.A. Cilla, L.P. Chitta, A. Lagg, H. Peter

IRIS-9 Meeting

Göttingen, 27-06-2017

IRIS-9, Göttingen, 25-29 June 2018

Contributed Talk

3. Magnetic coupling and mass flux through the atmosphere

Photospheric connection of a transition region brightening

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IRIS observations of active regions exhibit various small-scale (1″) extreme UV bursts heated to $\sim 10^5$ K. The transition region (TR) spectroscopic diagnostics of these brightenings display non-Gaussian, often double-peaked emission profiles, indicative of outflows of heated plasma from the reconnection site. Recent studies suggest that these bursts are triggered deep in the solar atmosphere, i.e. in or even below the chromosphere.

Here we present photospheric and chromospheric spectropolarimetric observations from GREGOR of a TR burst observed with IRIS. Our data show that the TR Si IV signal from this burst carries a clear counterpart in the polarisarion of the photospheric Si I line. Spectropolarimetric inversions reveal the presence of small-scale magnetic concentrations that are co-spatial with the Si IV emission (to within 0.5″). More interestingly, we detect no peculiar polarimetric signal in the He I emission from this region. Instead the He I data show a smooth (horizontal) magnetic canopy covering a larger area. This suggests that the TR Si IV brightening should originate from below a chromospheric canopy where He I forms, and is well connected to the photosphere. This implies that the Si IV emission in the burst indeed originates deep in the atmosphere, and it is not coupled to the higher layers. Our observations offer better insights into the physics of the TR bursts.

This case is another example that magnetic reconnection deep in the chromosphere or even in the photosphere heats small pockets of gas to high temperatures such that they are visible in the TR diagnostics. This leads to an interesting question: do most of the TR brightenings (viz. explosive events, bursts) actually originate at low heights, much deeper than we thought so far?

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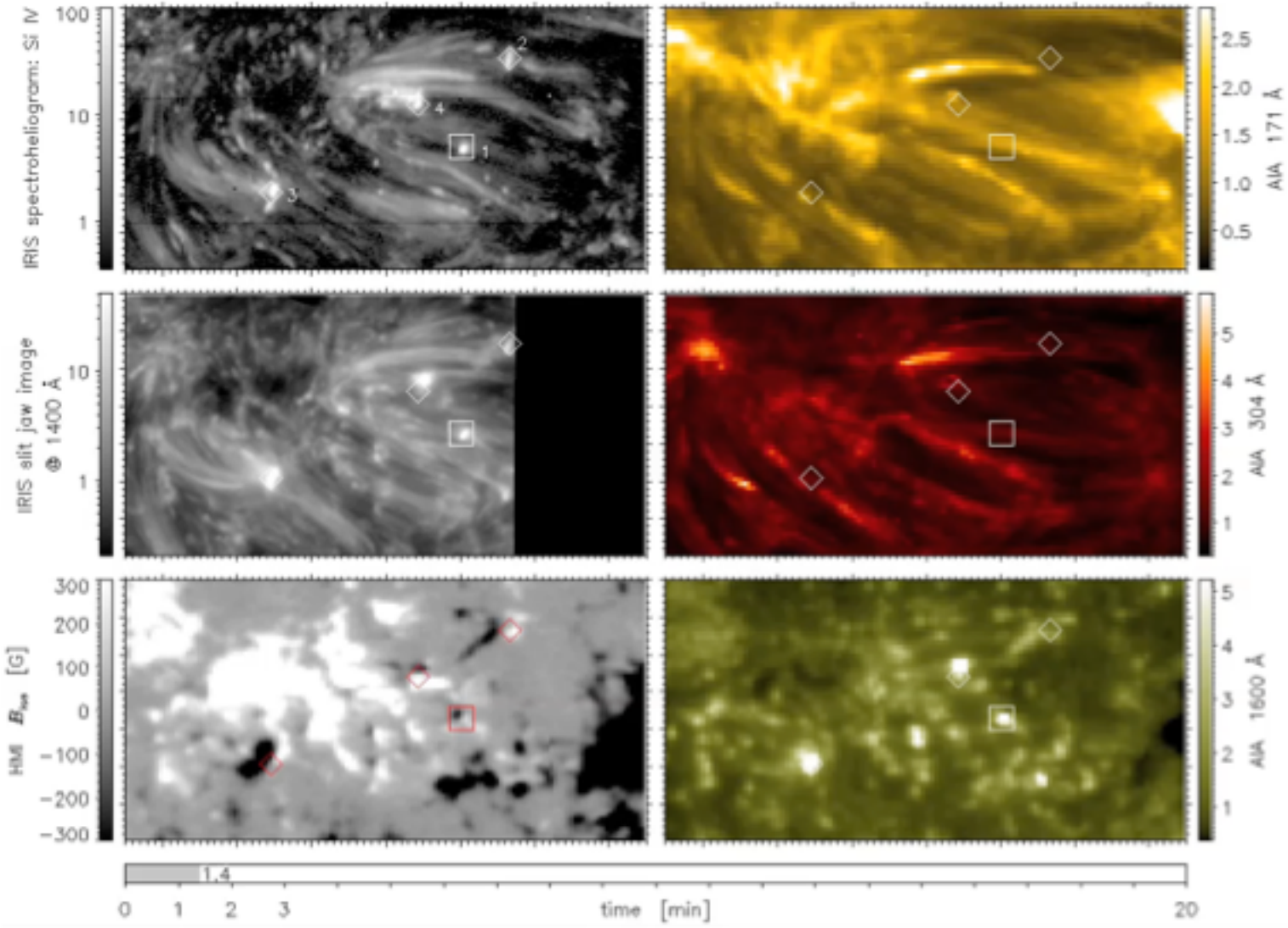
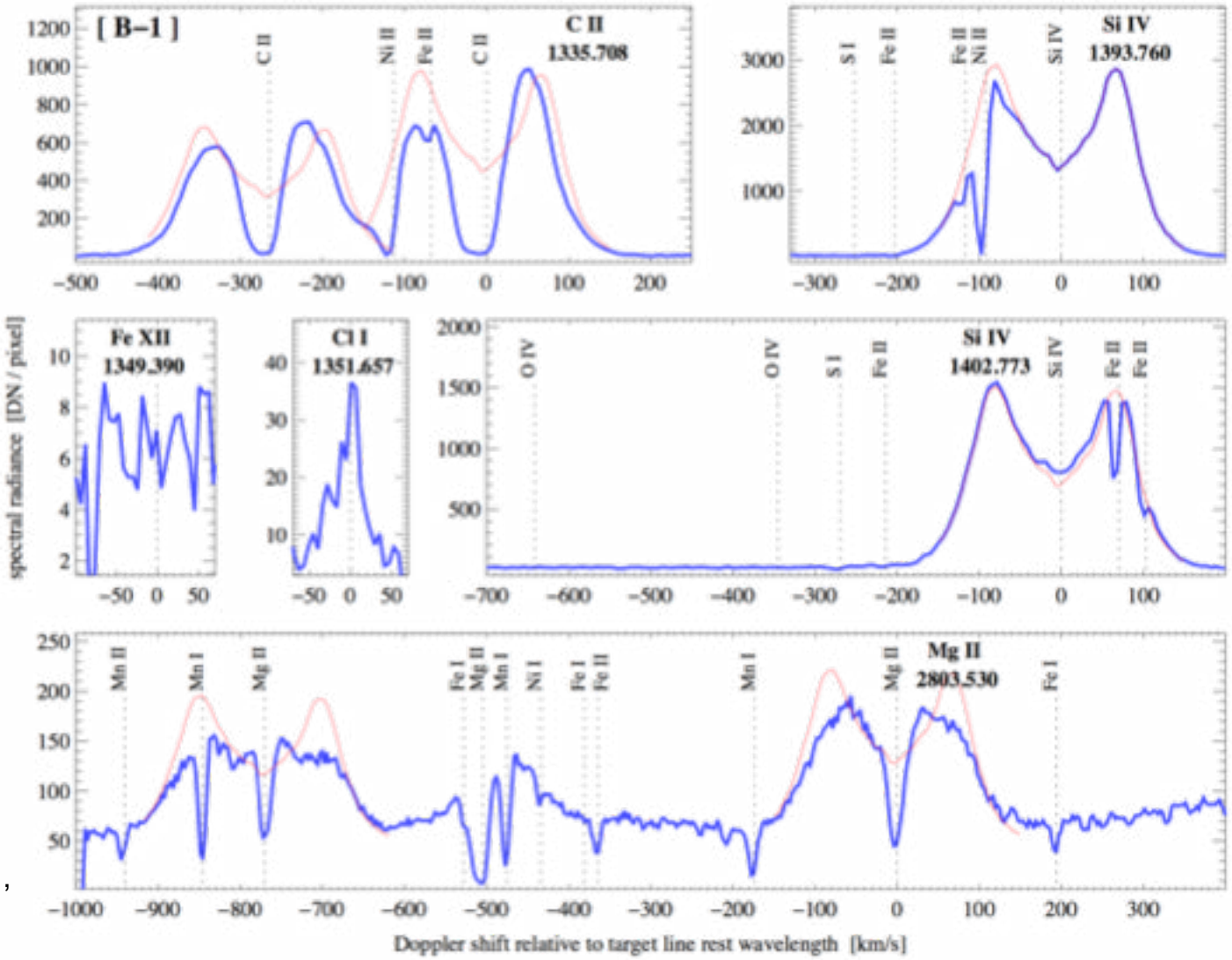
EUV burst in the transition region



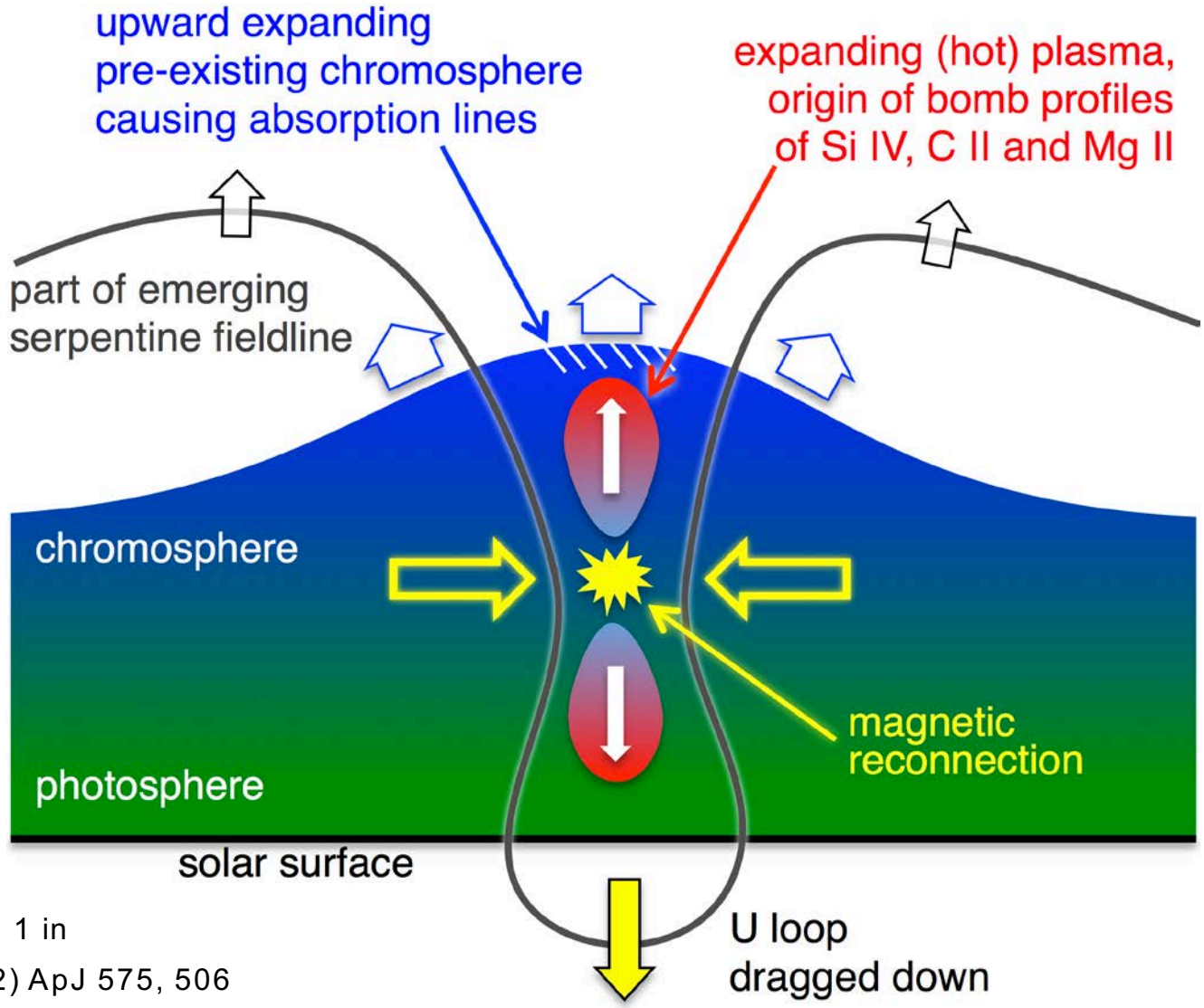
Peter et al., 2014, *Science,* 346, 1255726

EUV burst in the transition region



Peter et al., 2014, *Science*, 346, 1255726

EUV bursts: the IRIS Bomb scenario



similar to EB scenario 1 in
Georgoulis et al (2002) ApJ 575, 506

Transition region intensity maps and coalignment:

IRIS-SJI

SiIV 1400 Å

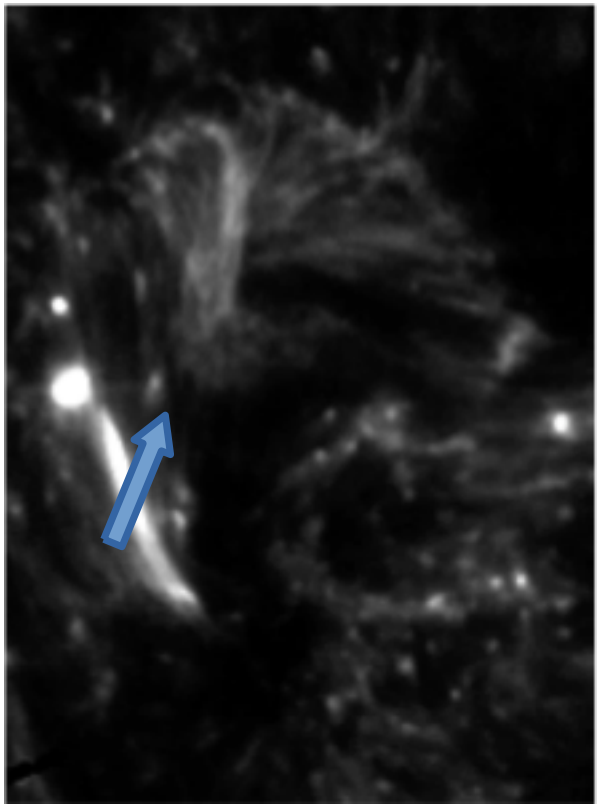
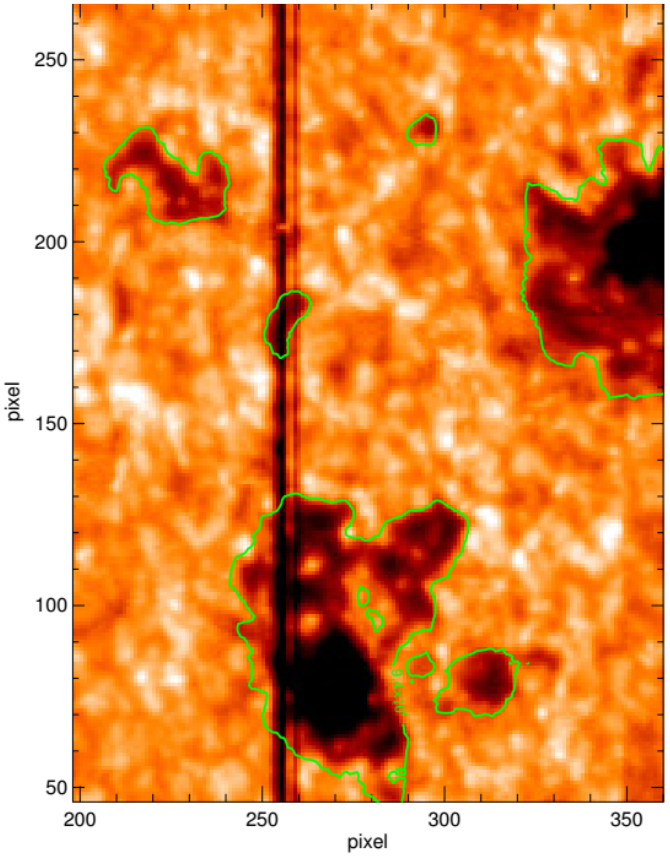


Image: IRIS 2832 continuum

contour: continuum He I 10830



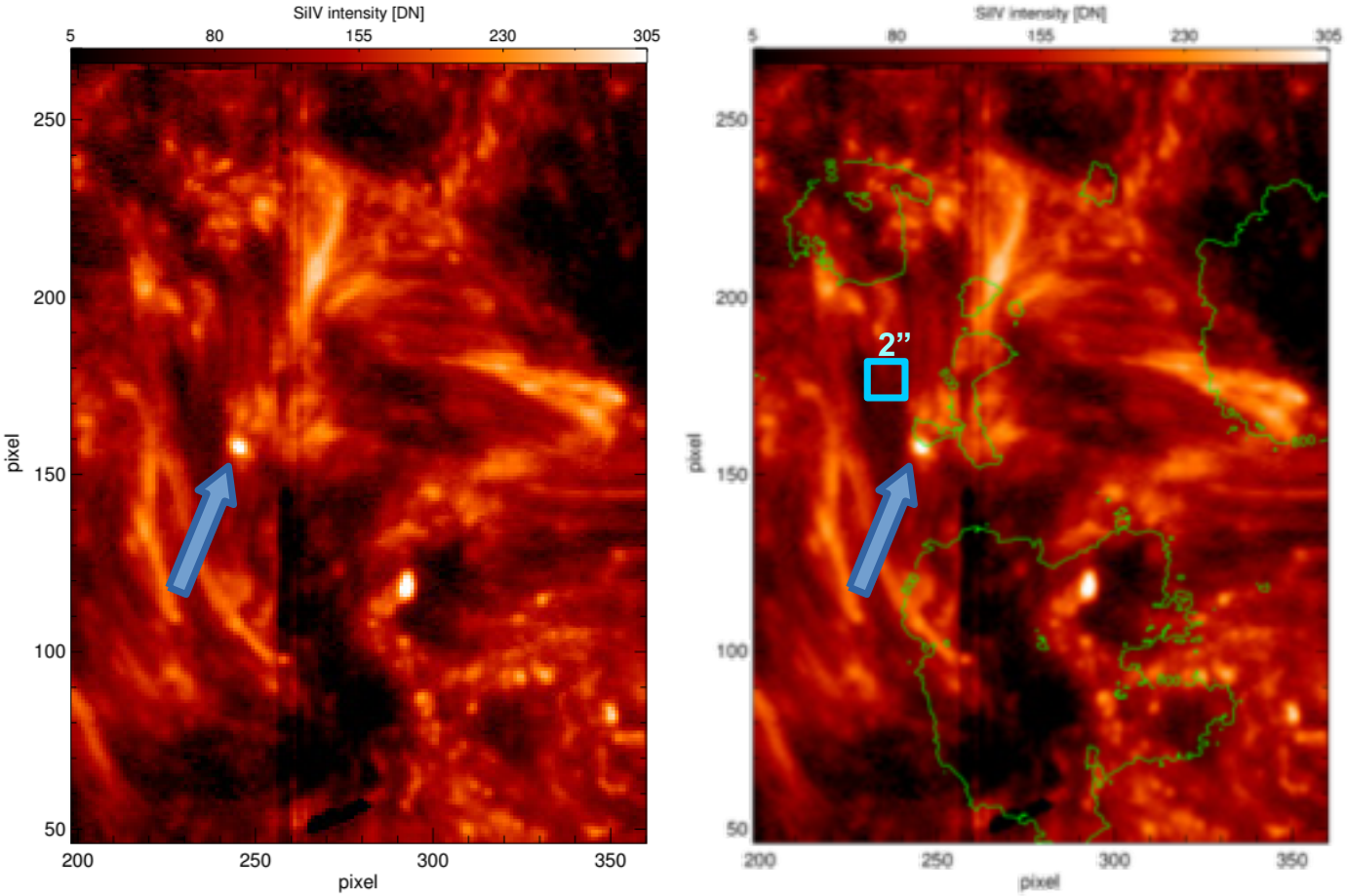
[Sub-pixel alignment, better than 0.5”]

- Transition region emission (Si IV):
- Ubiquitous presence of small bright dots in the active region;
- Some dots seem to be recurrent.

WHAT’S THEIR ORIGIN?

We combine IRIS and GREGOR observations to find out.

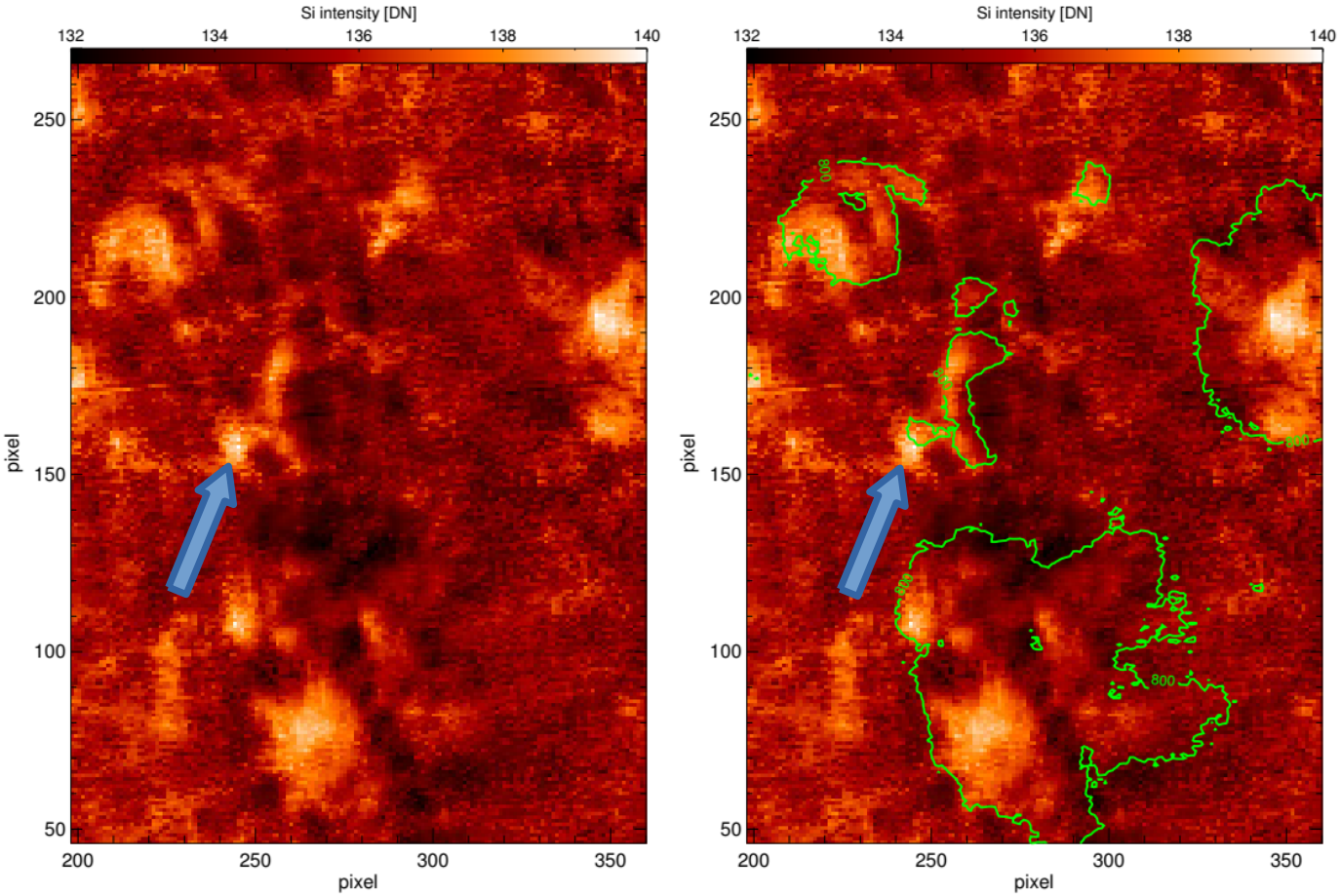
Transition region intensity maps:



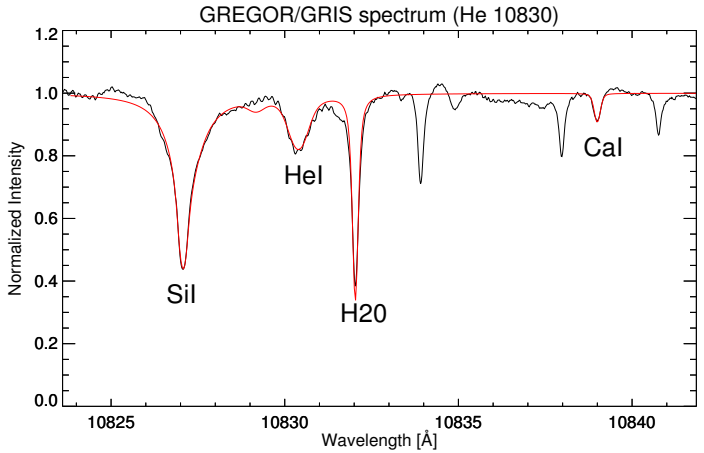
- The comparison between IRIS Si IV and the photospheric magnetic field shows that some bright dots (one in this case) are adjacent to concentration of magnetic flux, while others are not;
- Do they have the same origin?

Contours highlight the 800G magnetic flux region in deep photospere (Ca I line inversion)

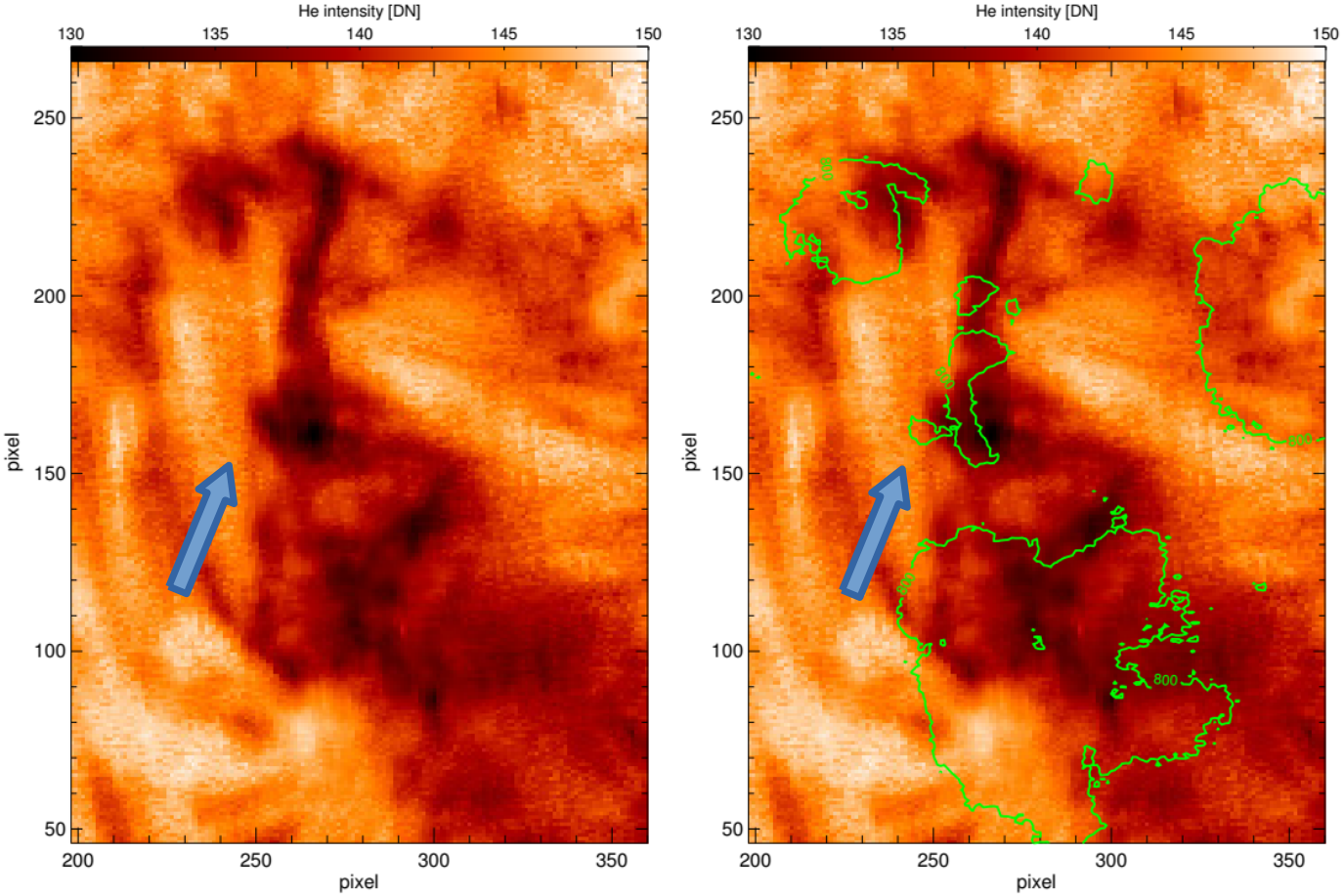
Upper photosphere intensity maps:



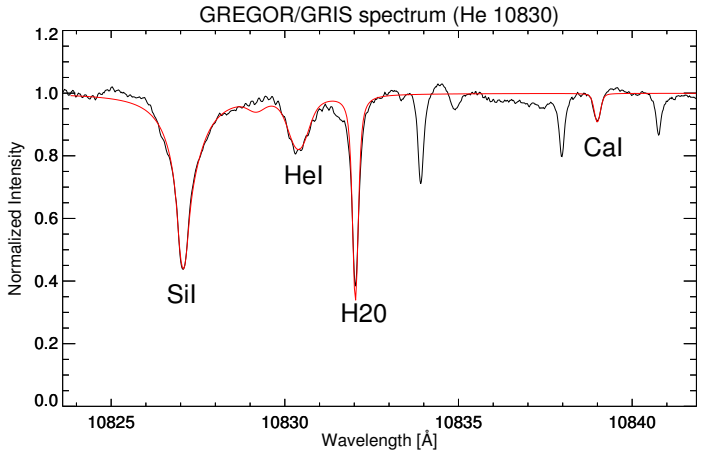
- Si I intensity maps show a mildly structured upper photospheric layer;
- Less absorption in Si I where Si IV is bright.



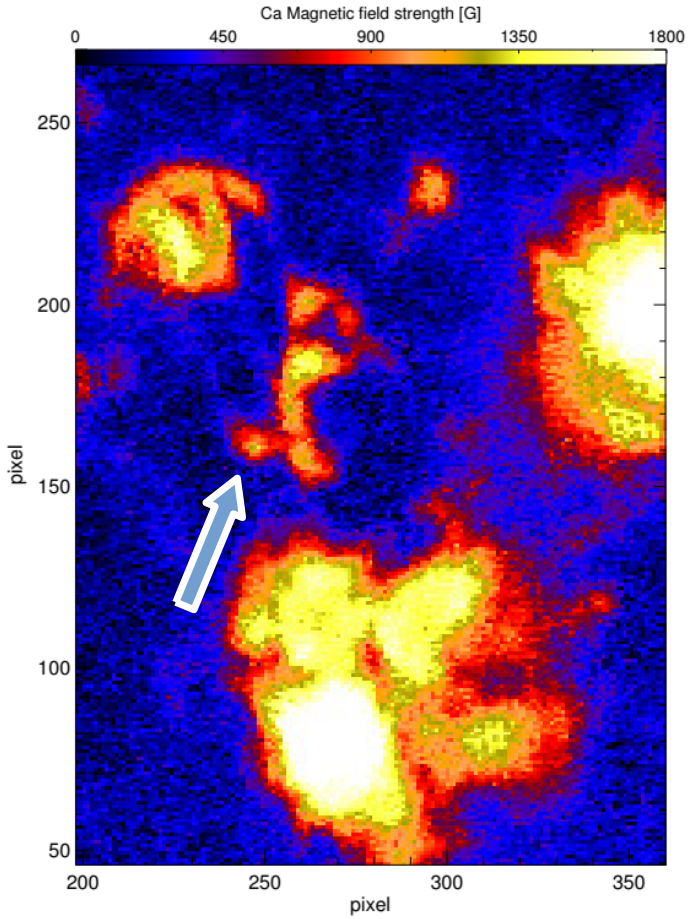
Chromospheric intensity maps:



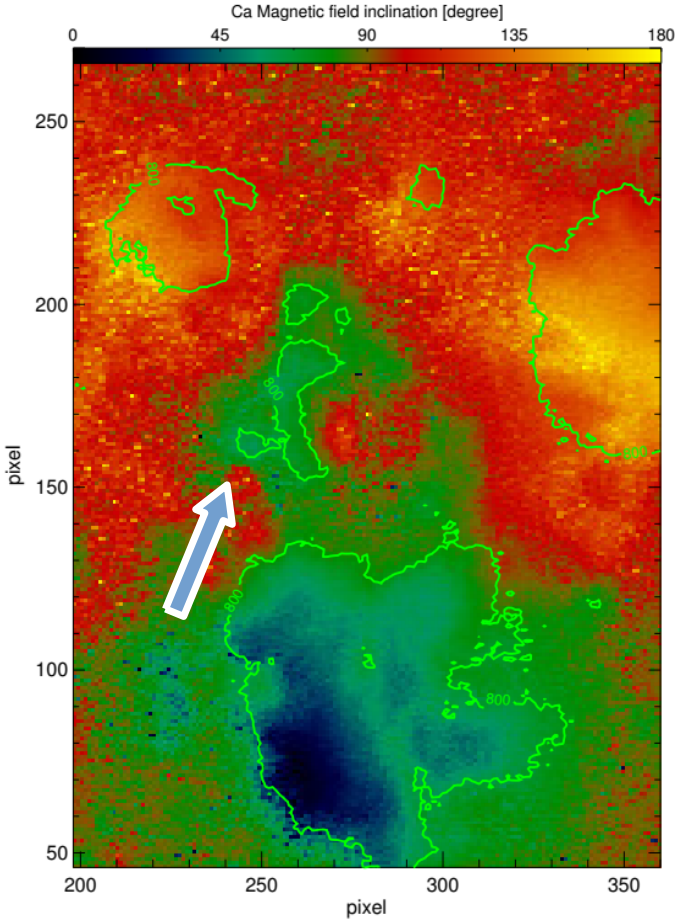
- He I intensity maps also show a structured chromosphere;
- Presence of loop-like structures in He I;
- No particular feature in He I near the bright dot.



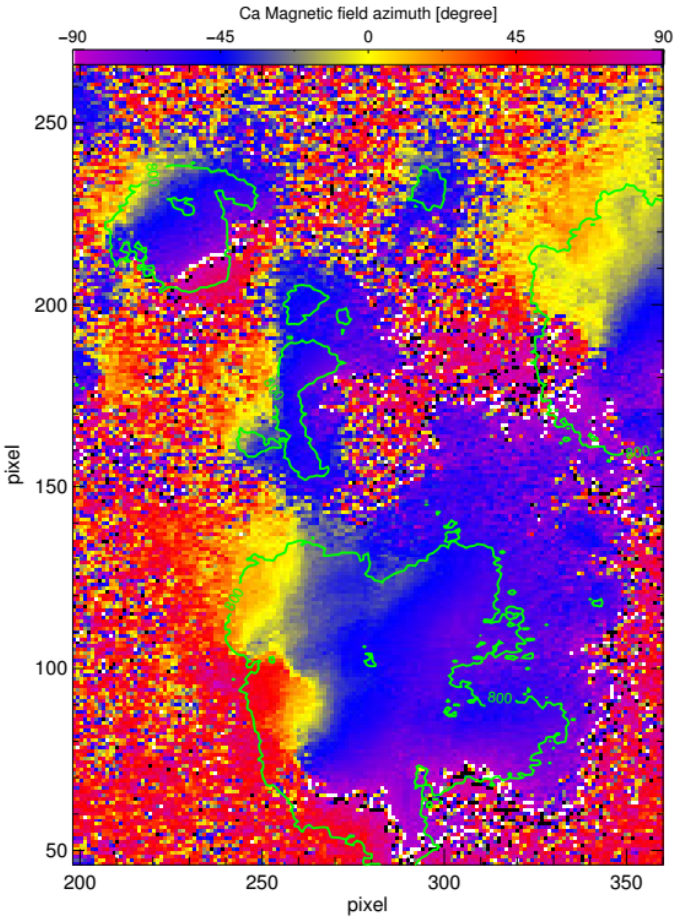
Deep photosphere magnetic field properties (Ca I):



Magnetic field strength

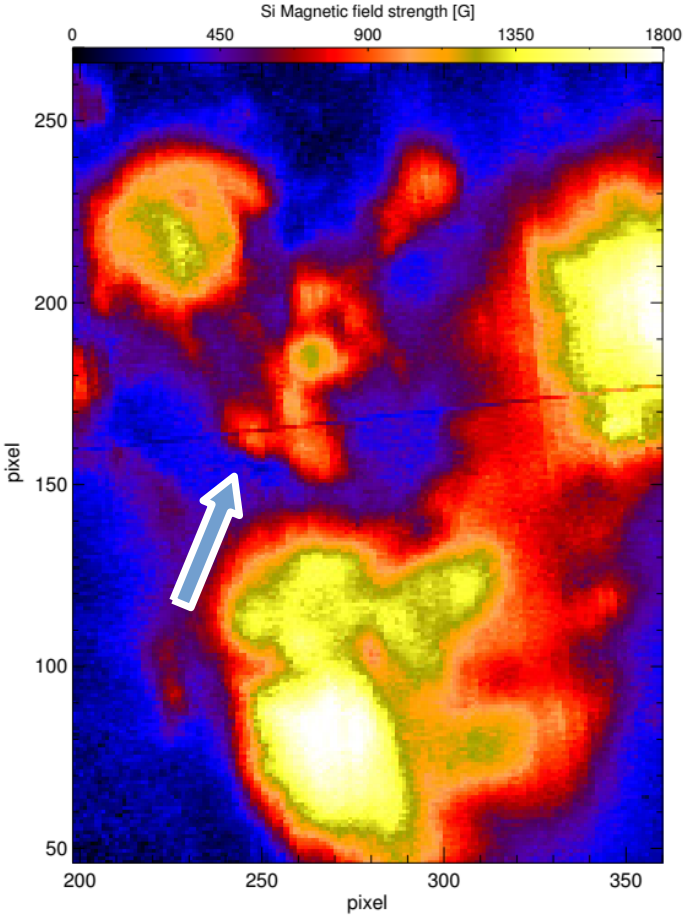


Inclination

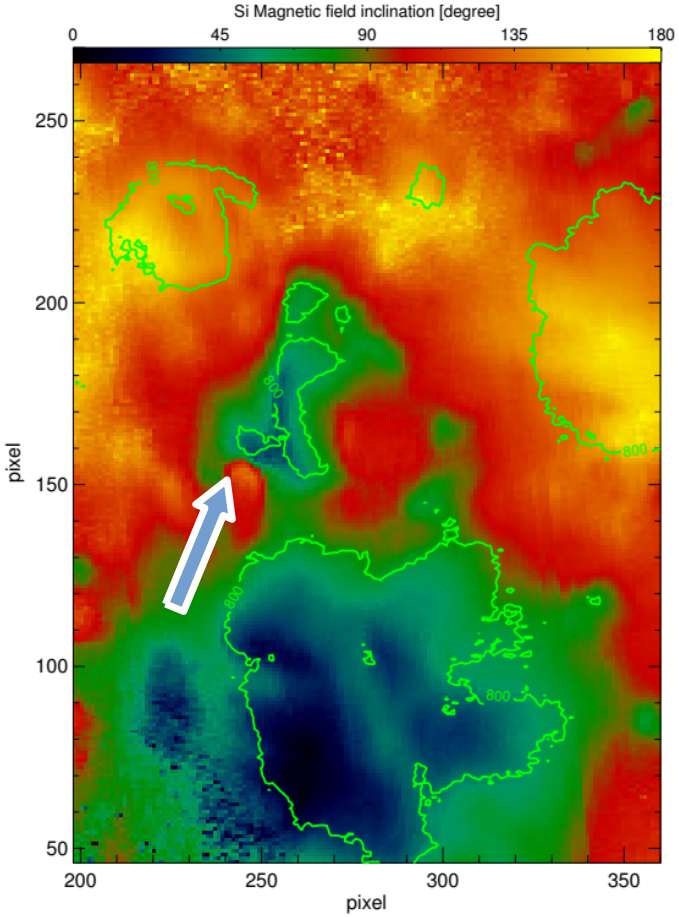


Azimuth

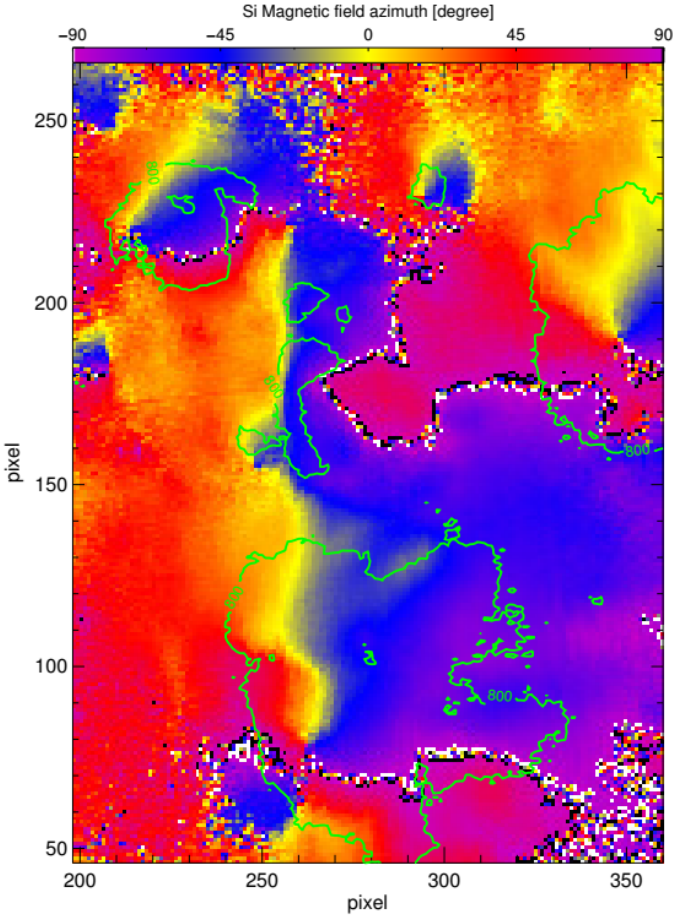
Upper photosphere magnetic field properties (Si I):



Magnetic field strength

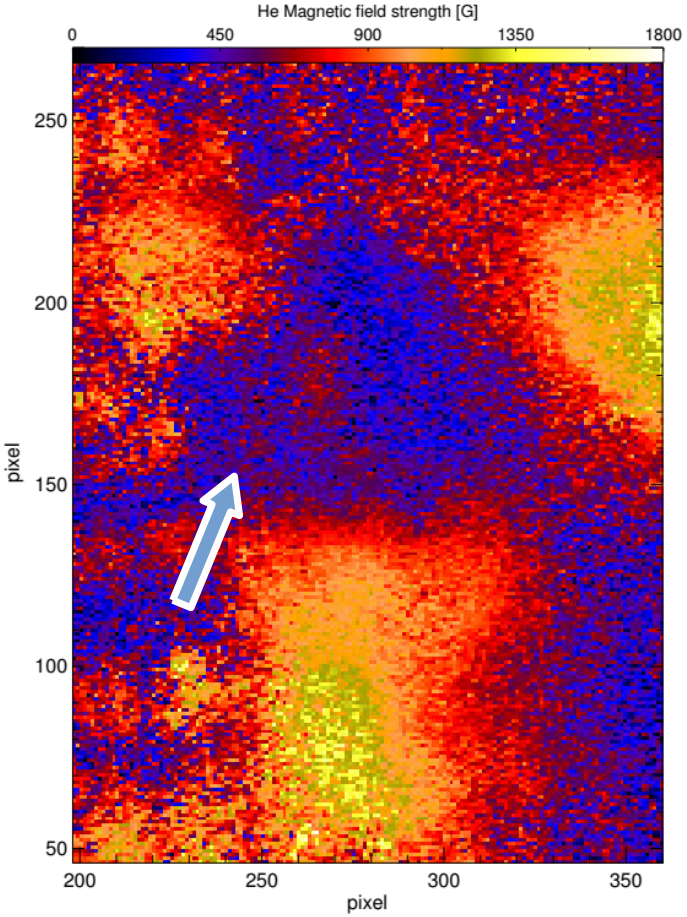


Inclination

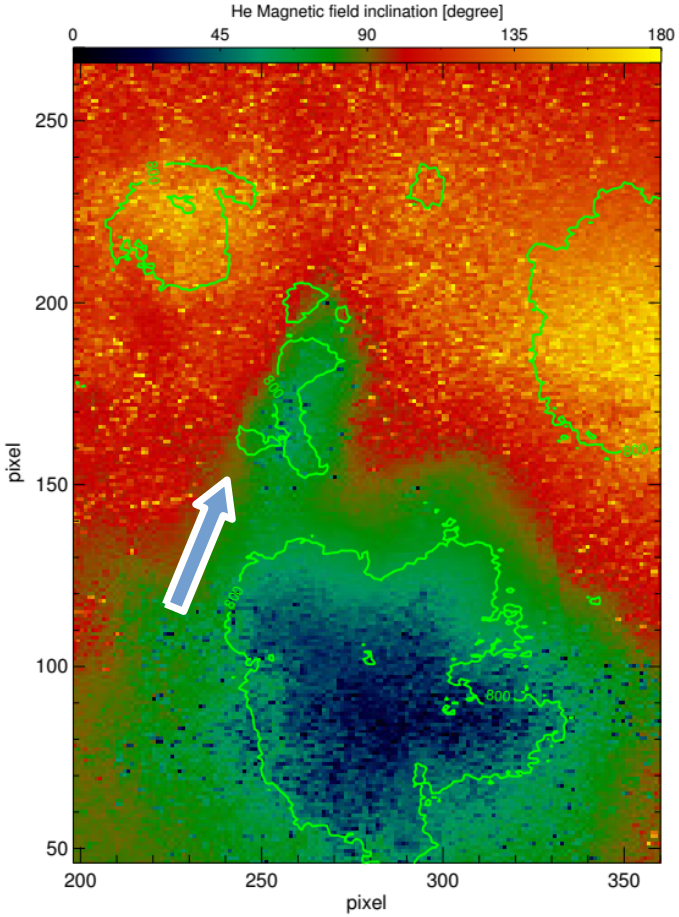


Azimuth

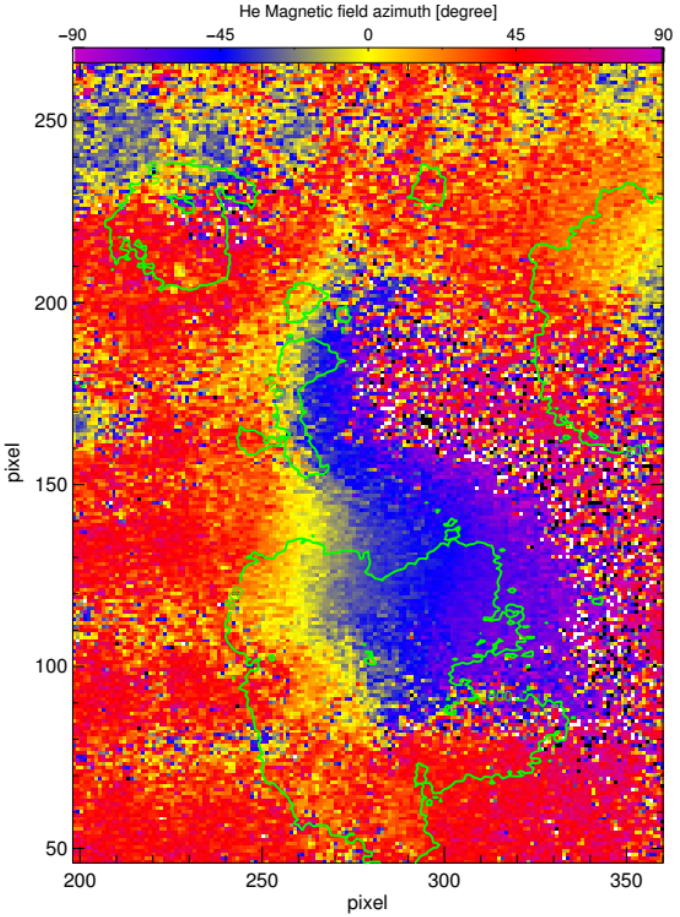
Chromospheric magnetic field properties (He I):



Magnetic field strength

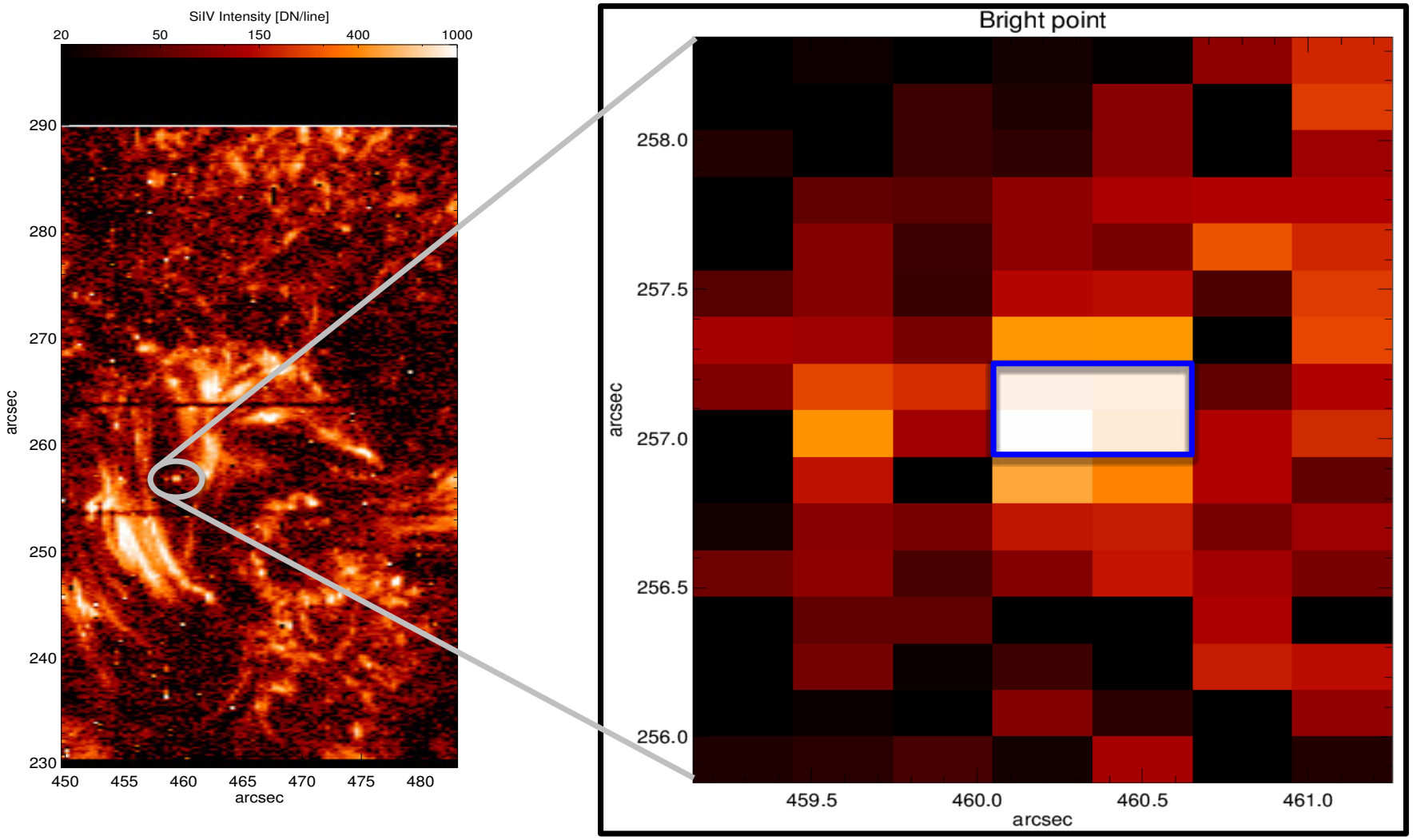


Inclination

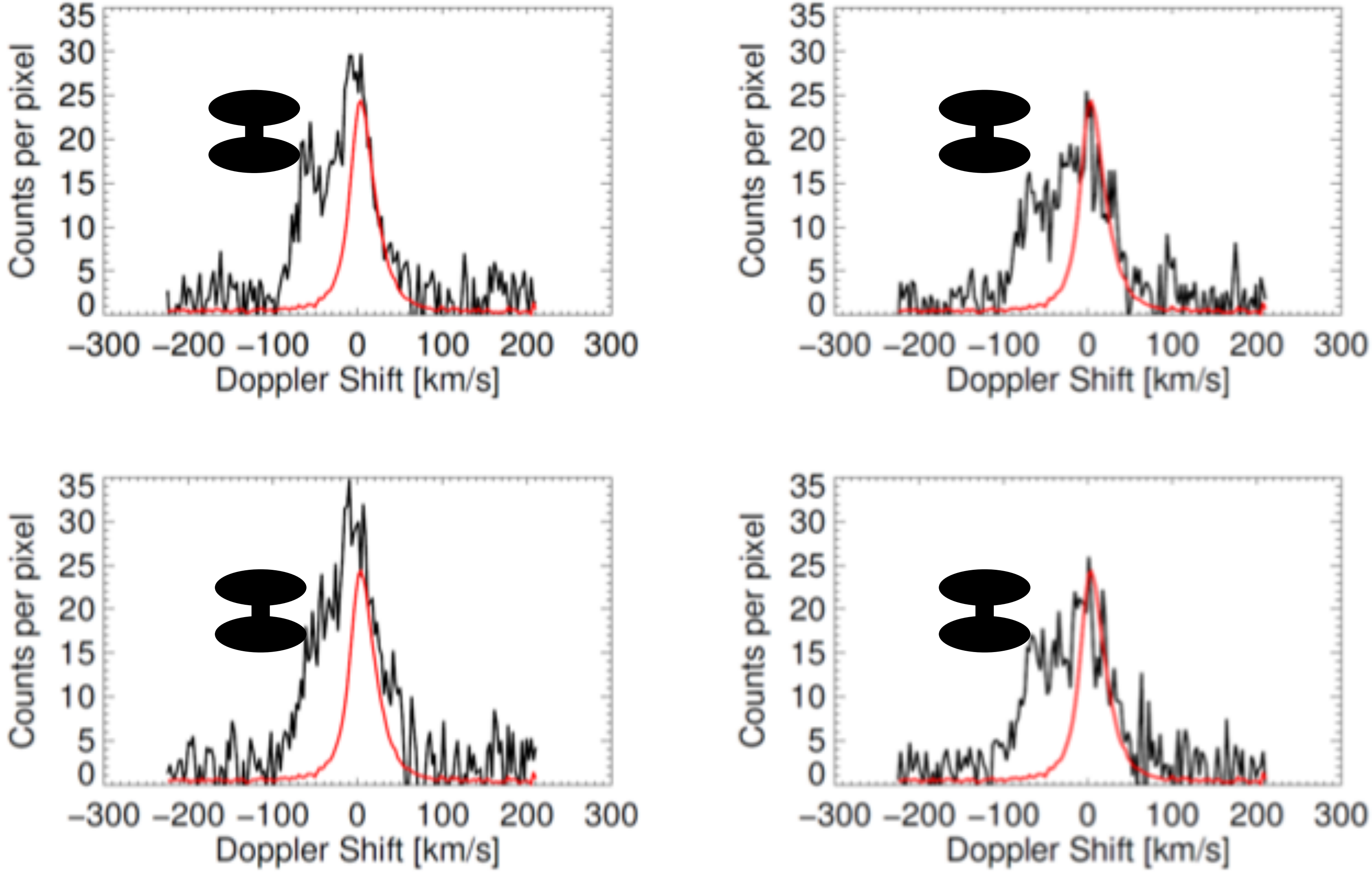


Azimuth

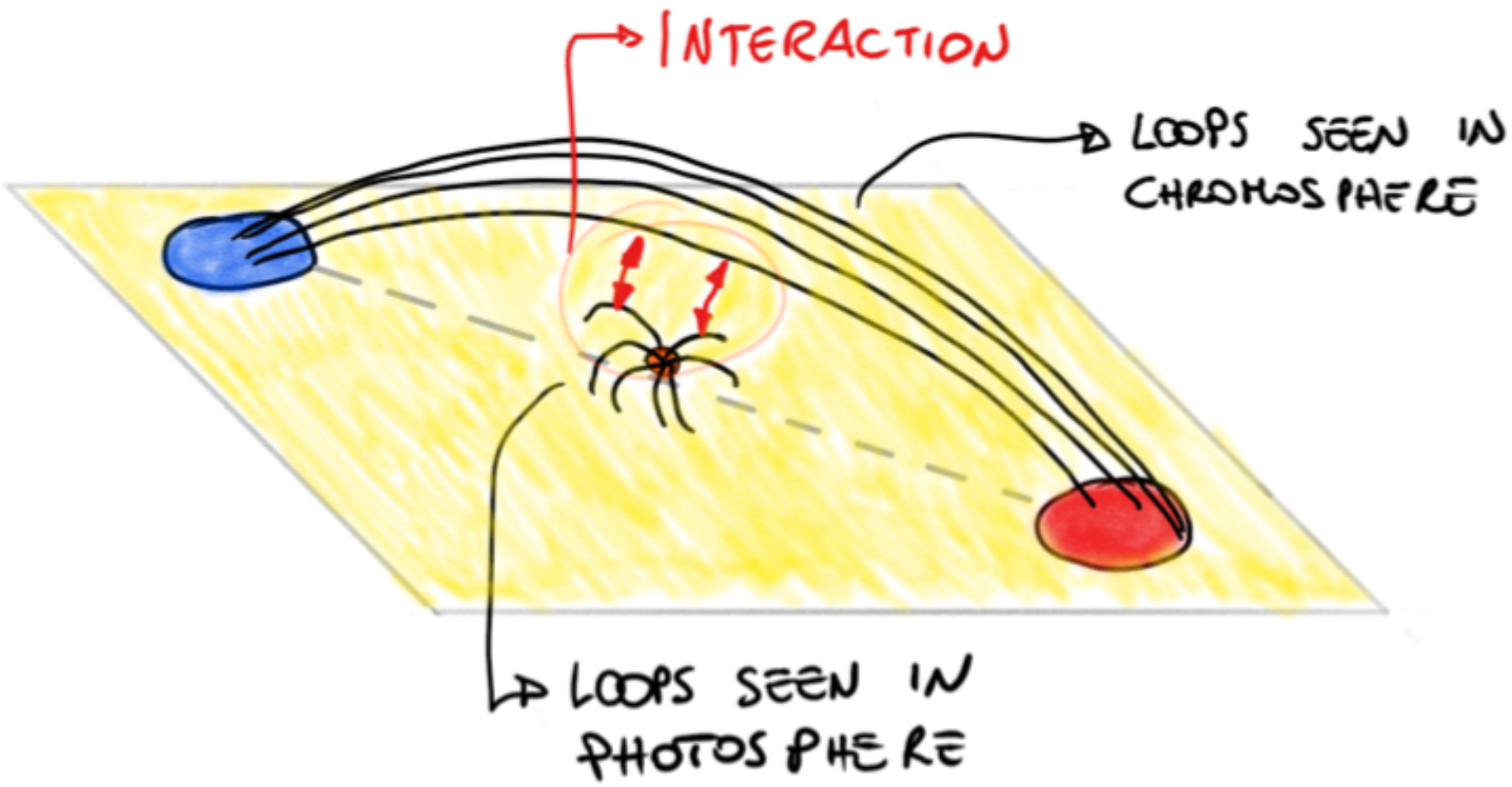
Si IV emission from a bright dot:



Si IV emission from a bright dot:



Bright spot scenario:



Conclusions:

- We found transition region brightenings in SiIV (~10^5 K) that have a clear counterpart of enhanced *B* in the photosphere;
- At that location no peculiarities are seen in chromosphere (HeI);
- Evidence for small-scale magnetic loops at very low heights interacting with overlying chromospheric field;
- Reconnection could power brightenings in Si IV;
- So: further evidence of pockets of hot gas in (or below) the chromosphere;
- Are hot pockets in the chromosphere more usual than we thought?