Observation of Ellerman Bomb emission features in He I D3 and He I λ10830

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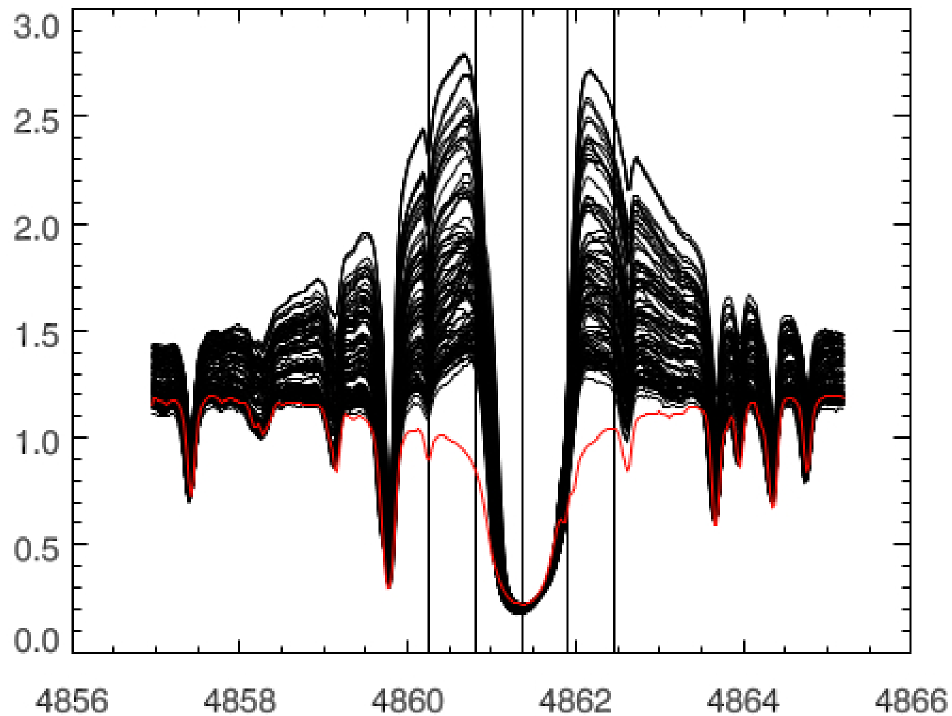
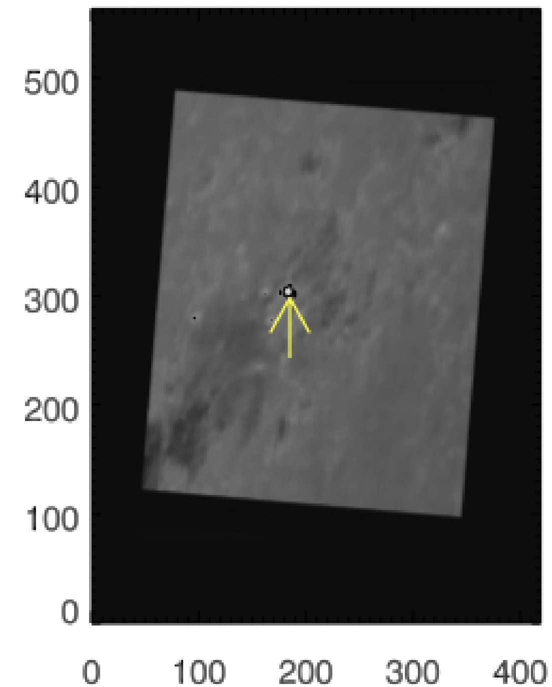
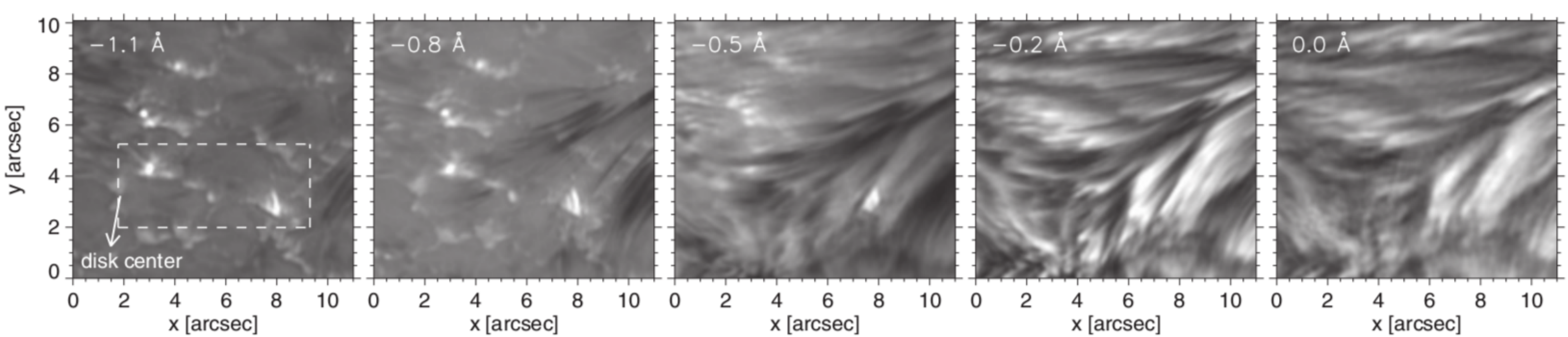
Ellerman Bombs

- Emission in the wings of hydrogen Balmer lines
- Line core unaffected

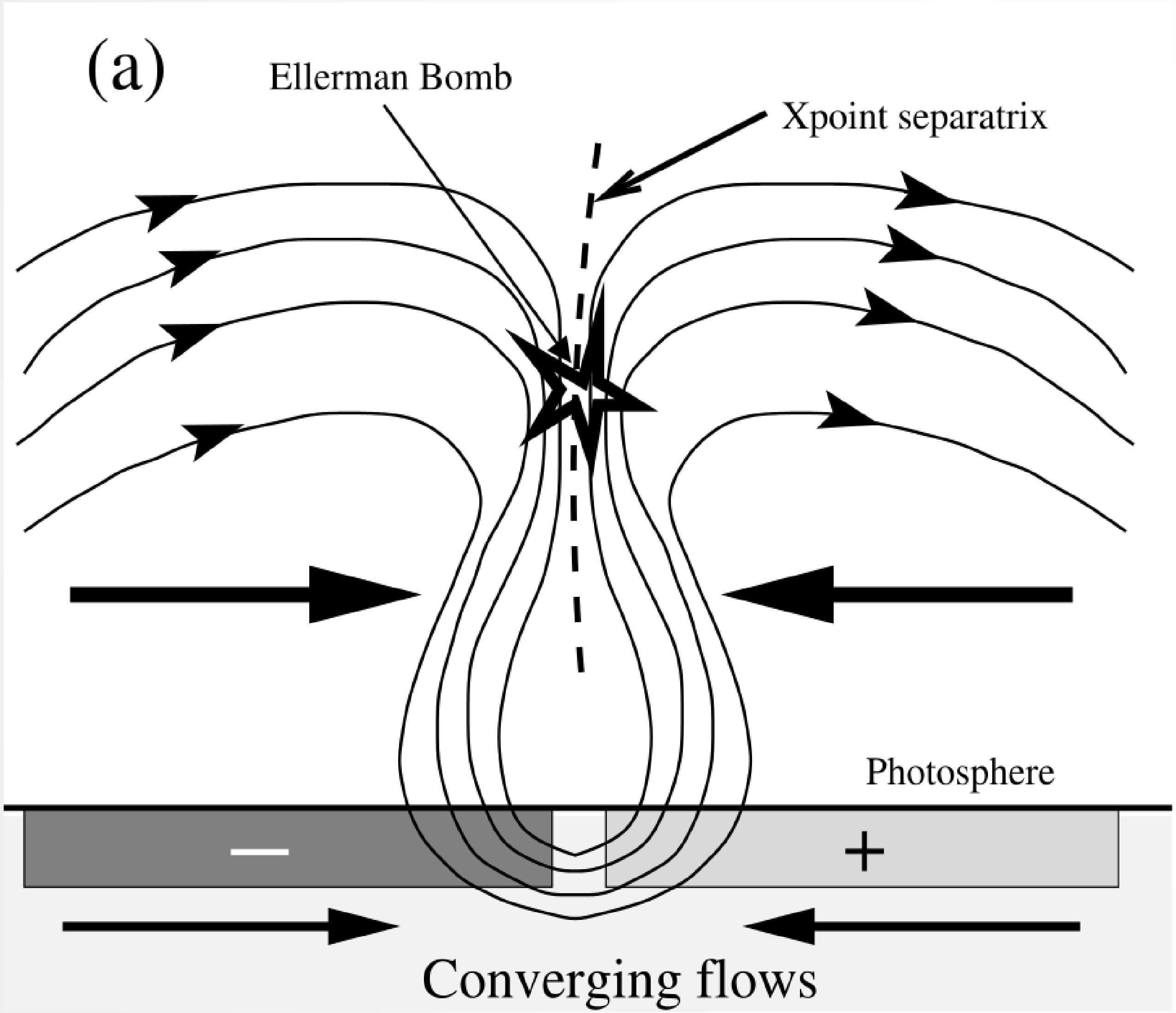




Watanabe et al. 2011



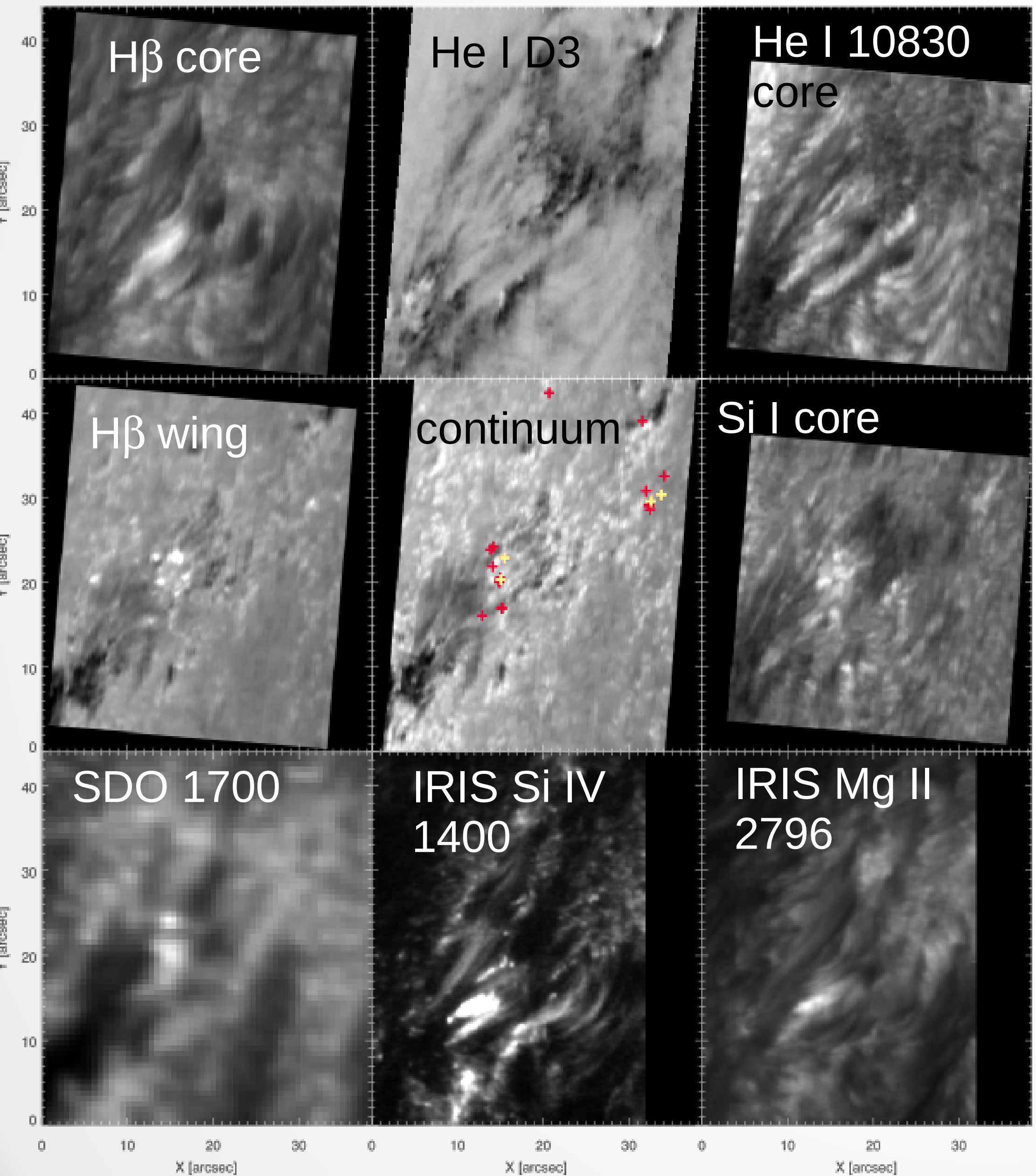
Common believes about Ellerman Bombs (until 2014)... BUT

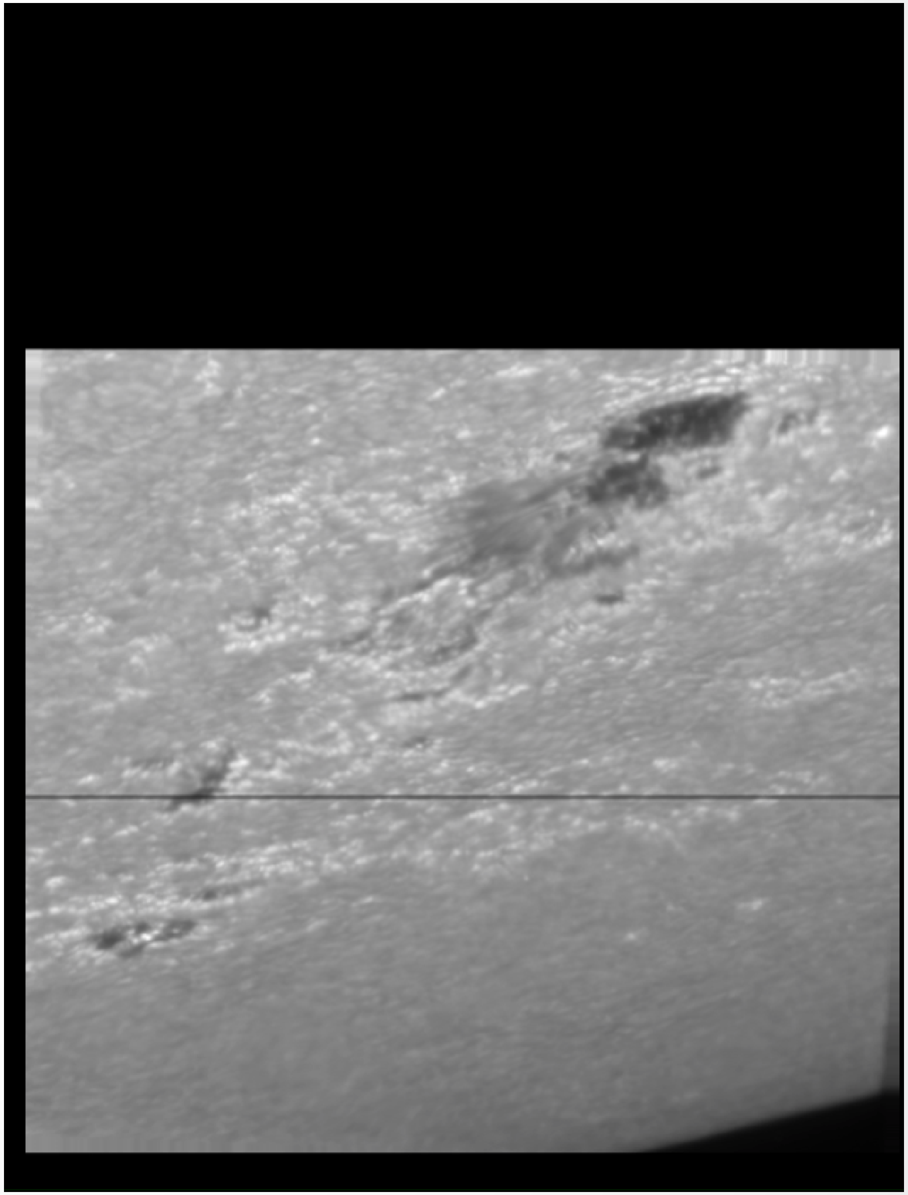


Georgoulis et al. 2002

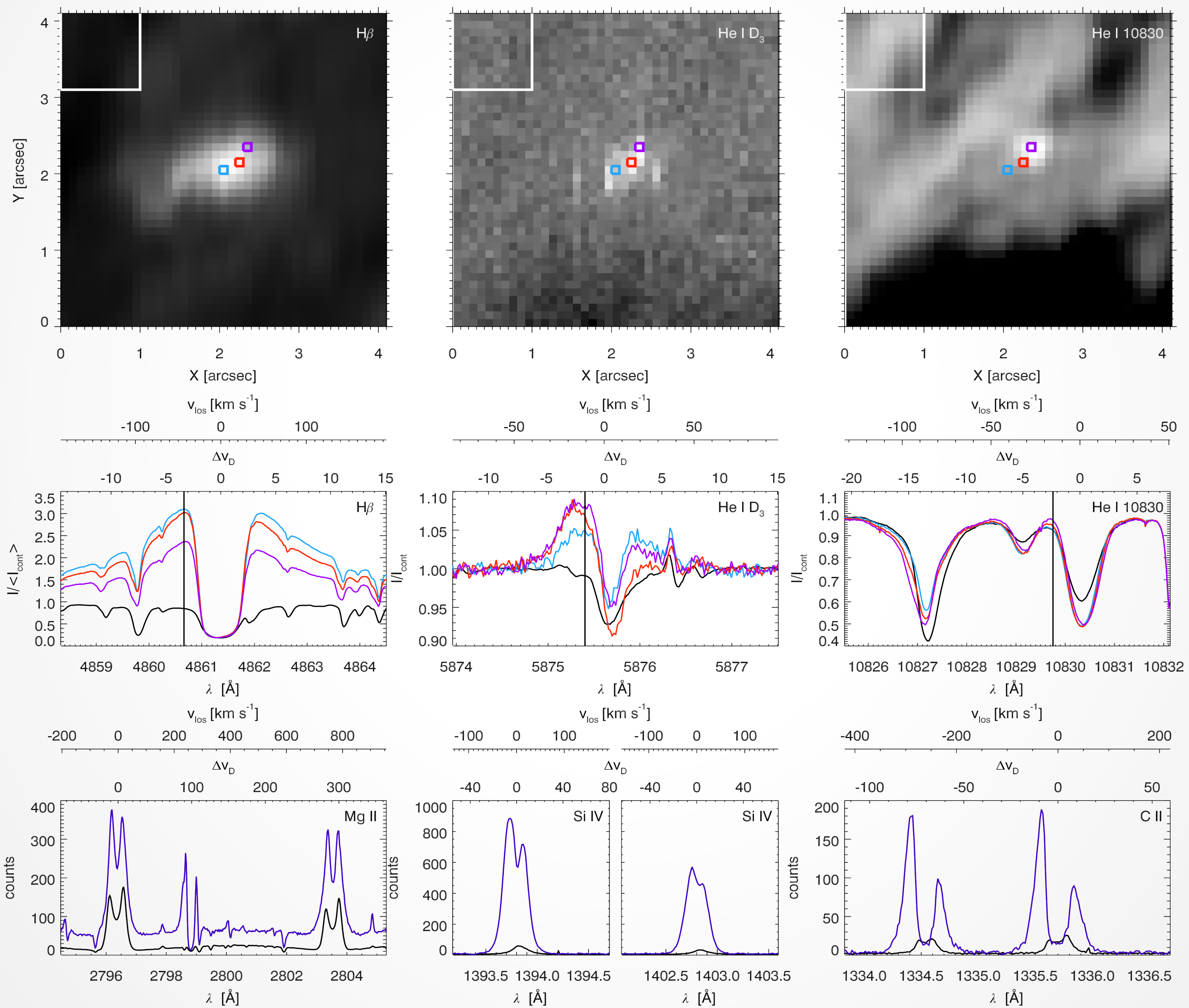
- Converging flows in the photosphere bend the magnetic field lines, reconnection
- EBs are photospheric events (Rutten et al. 2013)
- Presence of bi-directional jets
- Temperature enhancements of 1000-4000 K above photospheric 6000 K
- Debate around EBs: where, how, how hot?

First infrared observations at the SST

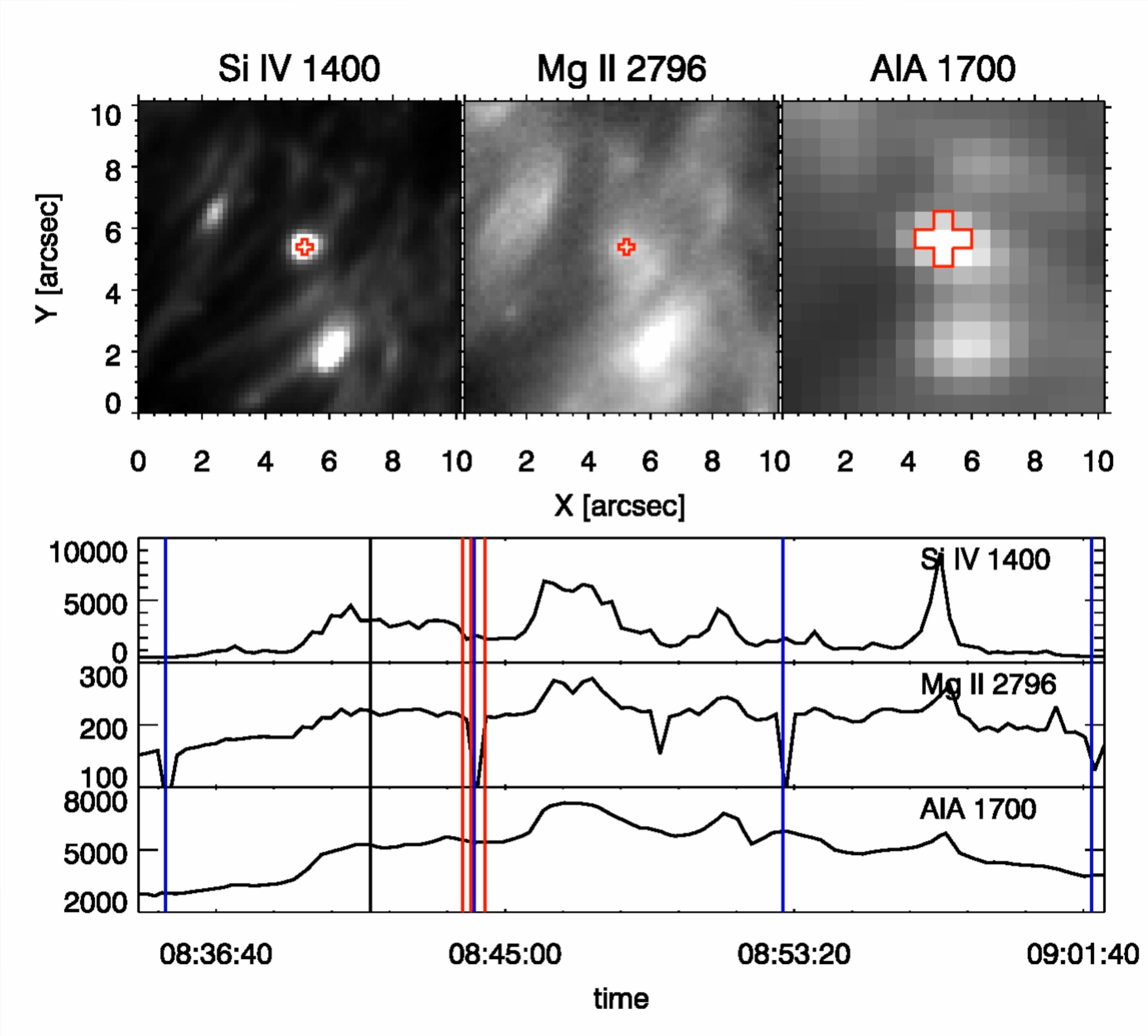




Ellerman Bomb spectra



Ellerman Bomb Light Curve



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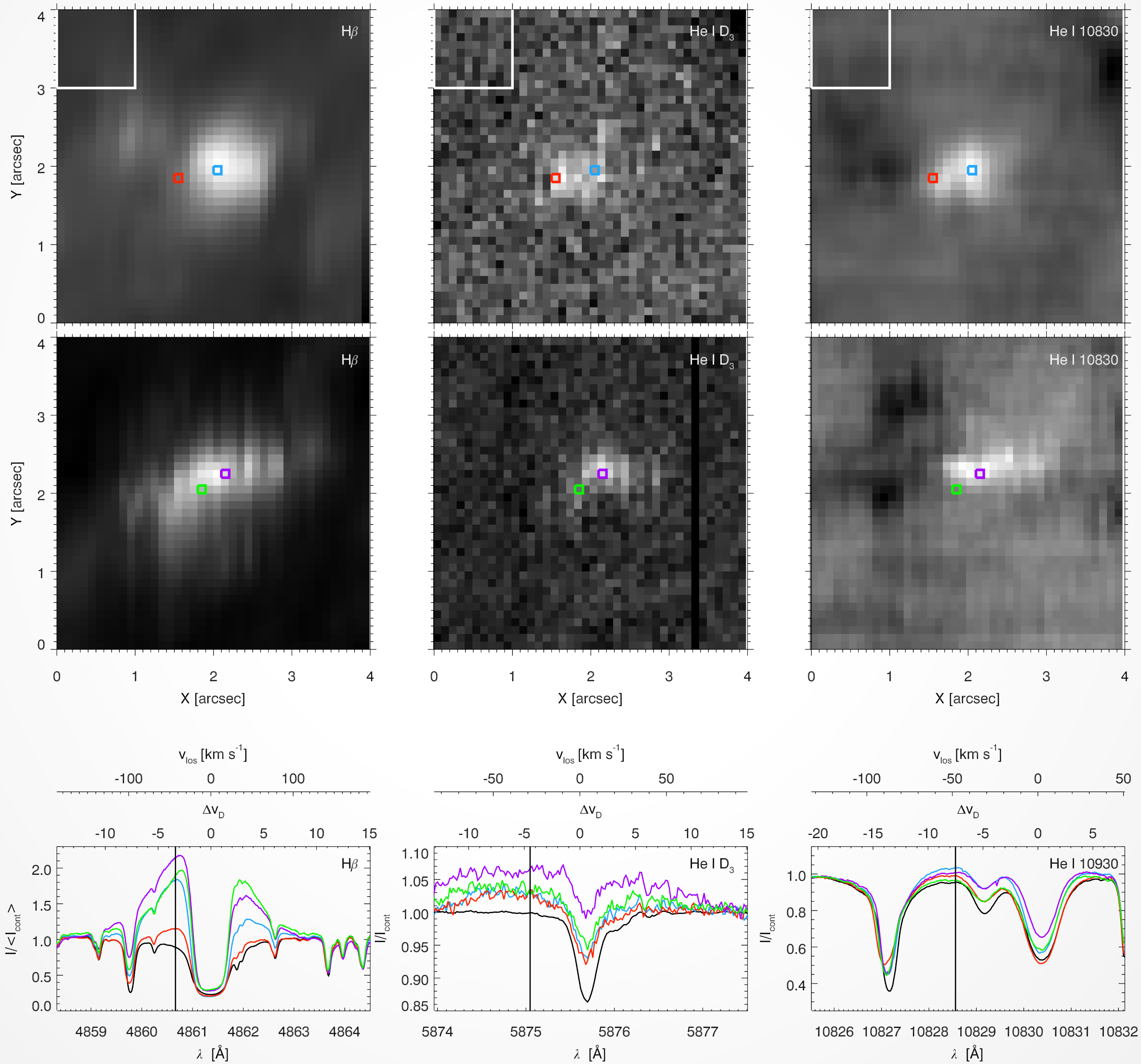
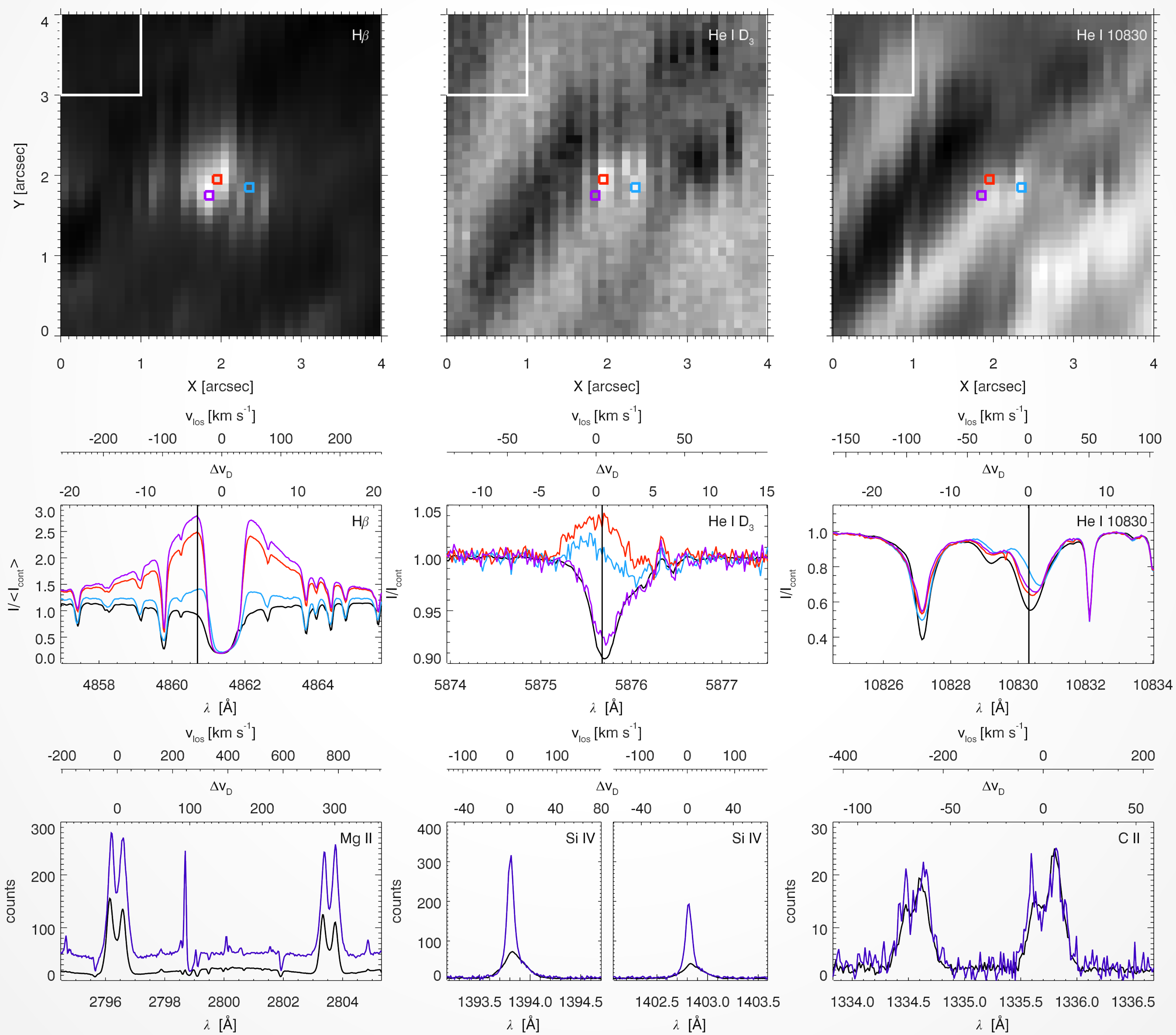
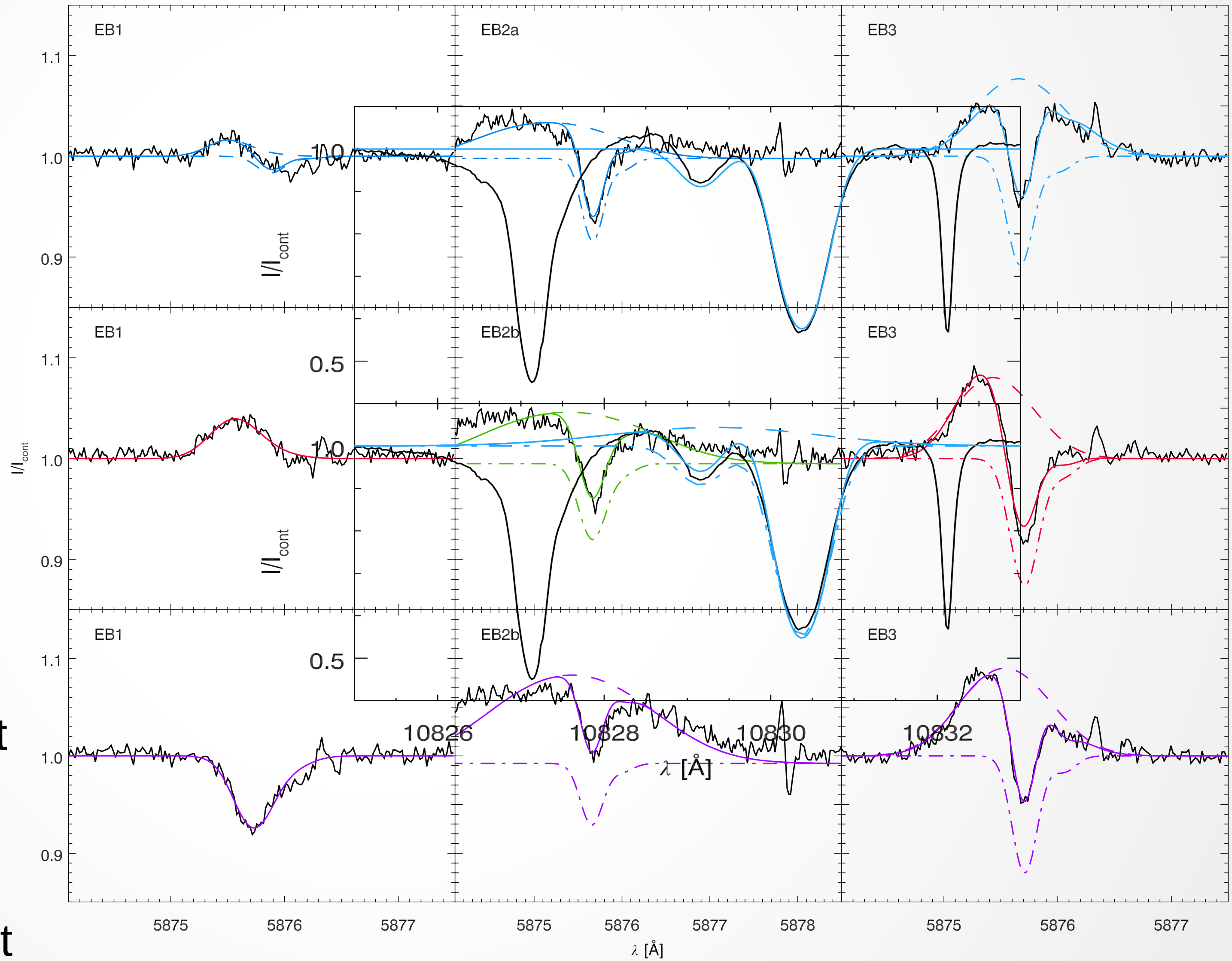


Ellerman Bomb spectra



Fit components with Hazel

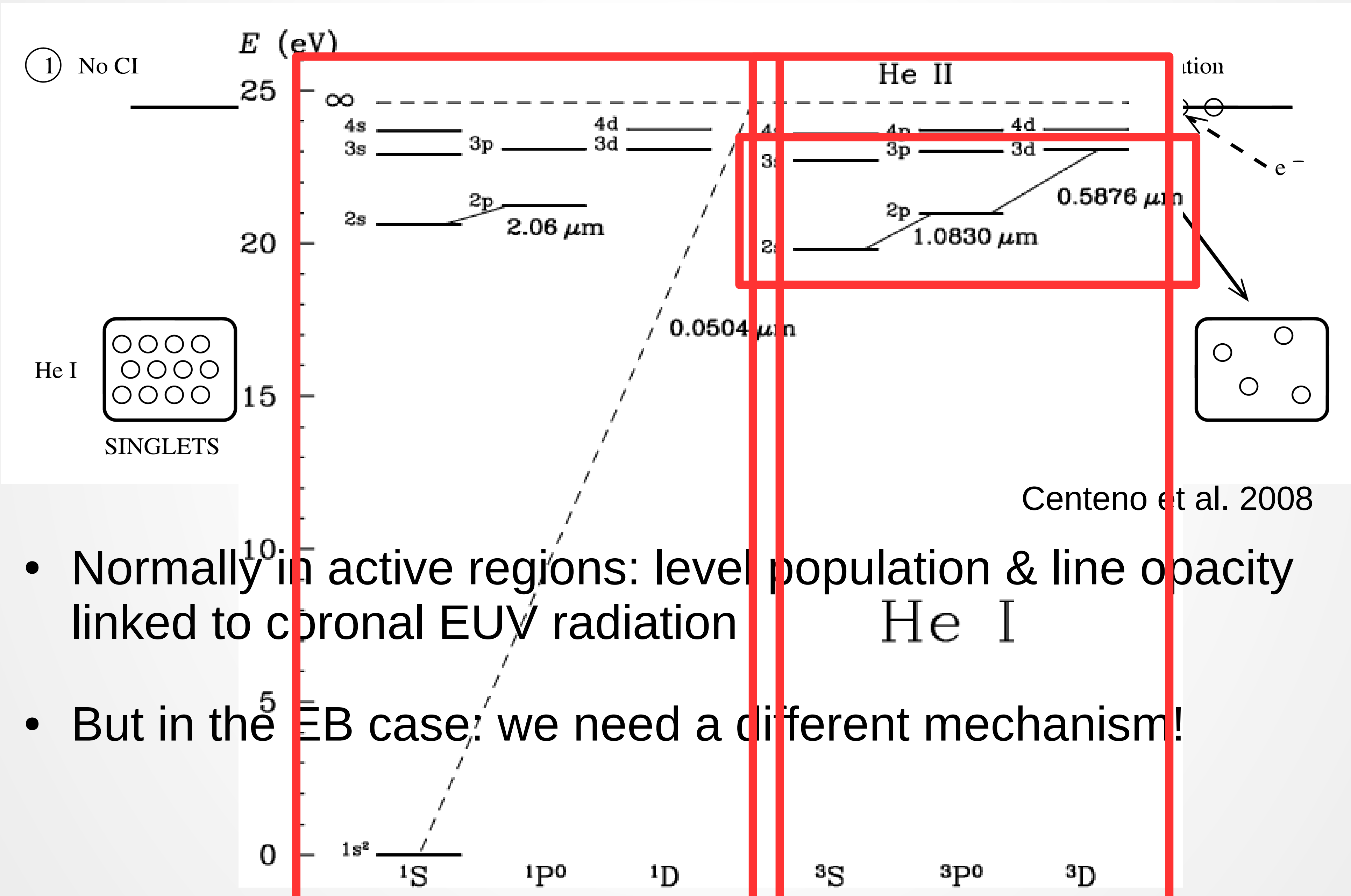
- HeLiX+ vs. Hazel
- Milne-Eddington vs. slab geometry
- Filling factor vs. stacked slabs
- Degeneracy!
- Generally: very broad and slightly blueshifted emission component, “normal” absorption component
- Some of the profiles can be fitted with only 1 emission component



Why does the emission occur?

We have to populate the neutral helium triplet levels!

Line formation



Centeno et al. 2008

- Normally in active regions: level population & line opacity linked to coronal EUV radiation
- But in the EB case: we need a different mechanism!

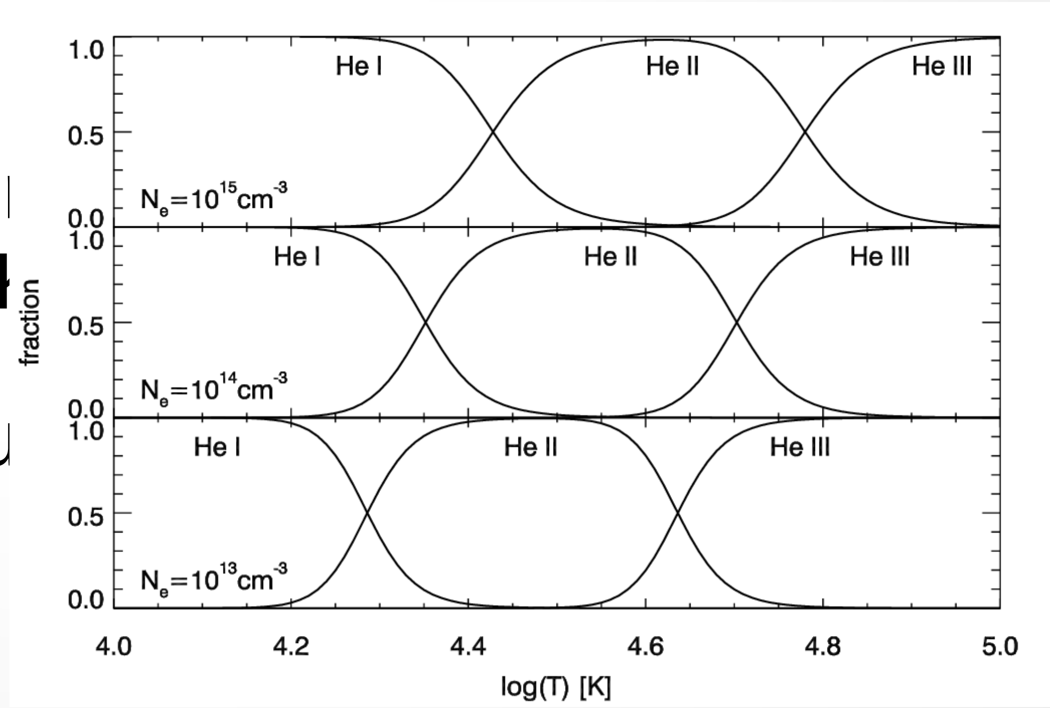
Why does the emission occur?

We have to populate the neutral helium triplet levels!

- Not due to EUV from corona or transition region
- The levels have to be populated either by locally produced EUV radiation
- Or by collisions
- In both cases → we need very high temperatures (and/or density) !

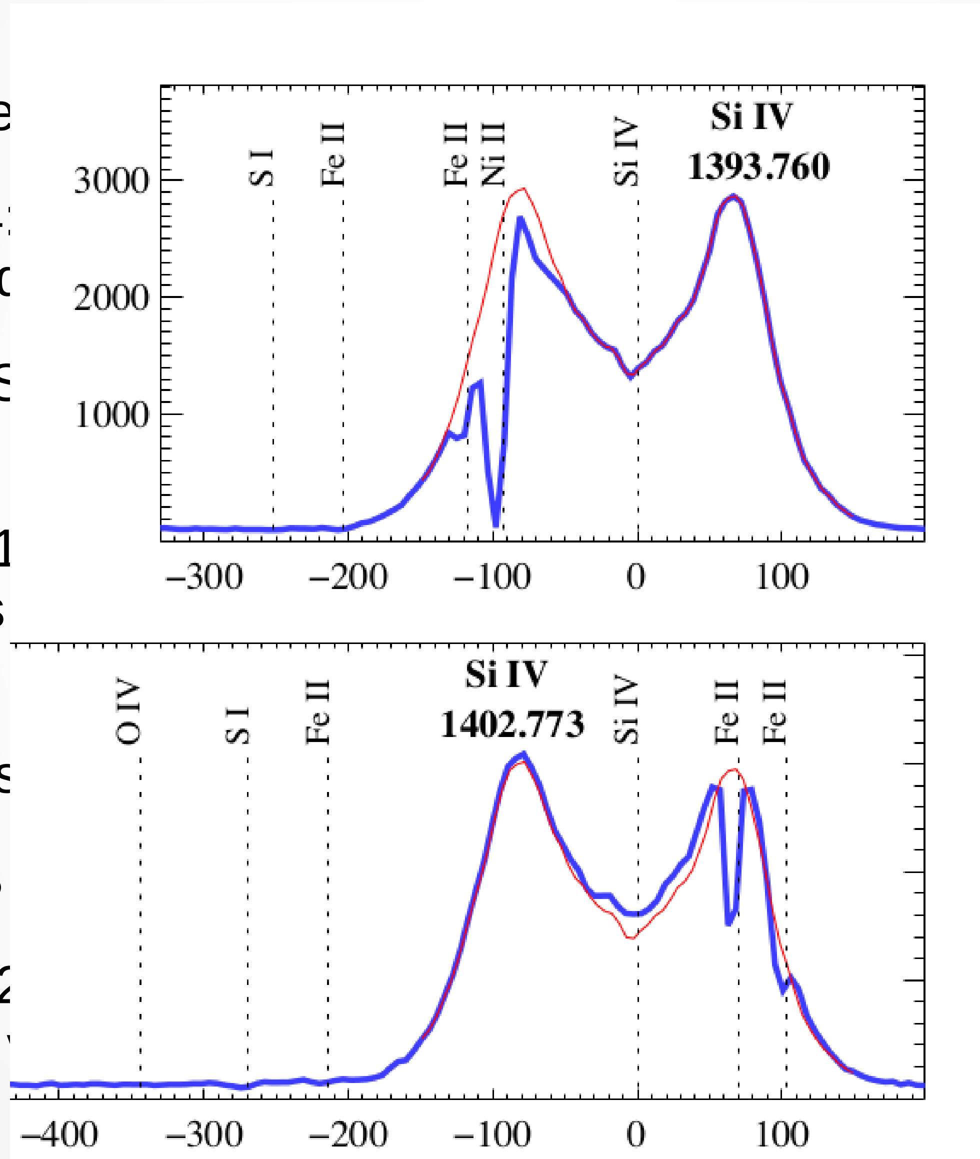
Why does the emission occur?

- In both cases → we need very high temperatures (and/or density) !
- Upper limit for temperature estimate from assuming all broadening is due to thermal doppler motions : T~10^5 K
- Lower limit for temperatu
e.g. LTE, Saha, T~2.10^4
- Are these high temperatu



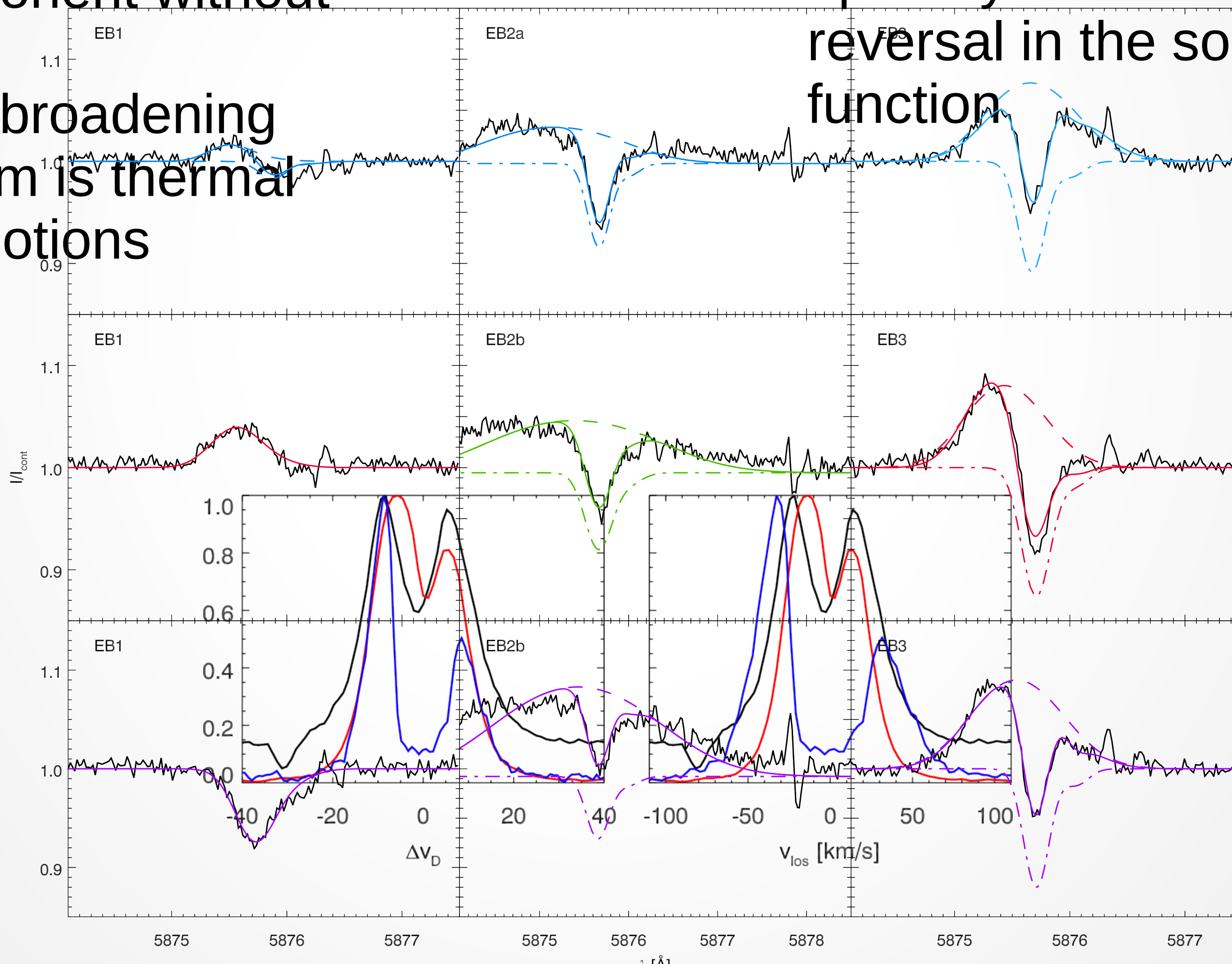
Why does the emission occur?

- Are these high te
- Peter et al. 2014: interprets broadening of Si IV lines as bi-c
- Judge 2015: IRIS adening as Alfvenic turbulence
- Vissers et al. 201 c Ellerman bombs, very high T, interprets
- Tian et al. 2016: llerman bombs, very high T, interprets
- Rutten 2016: EB ble T~10 000 – 20 000 K
- Libbrecht et al. (2 in IRIS AND in He I D3 and He I 10830, I and interpretation Si IV lines?



Broadening of He I and interpretation of Si IV

- Since the He I D3 emission component can be fitted with one component without velocities: dominant broadening mechanism is thermal doppler motions
- Si IV line central dip is due to the lines not being optically thin and a reversal in the source function



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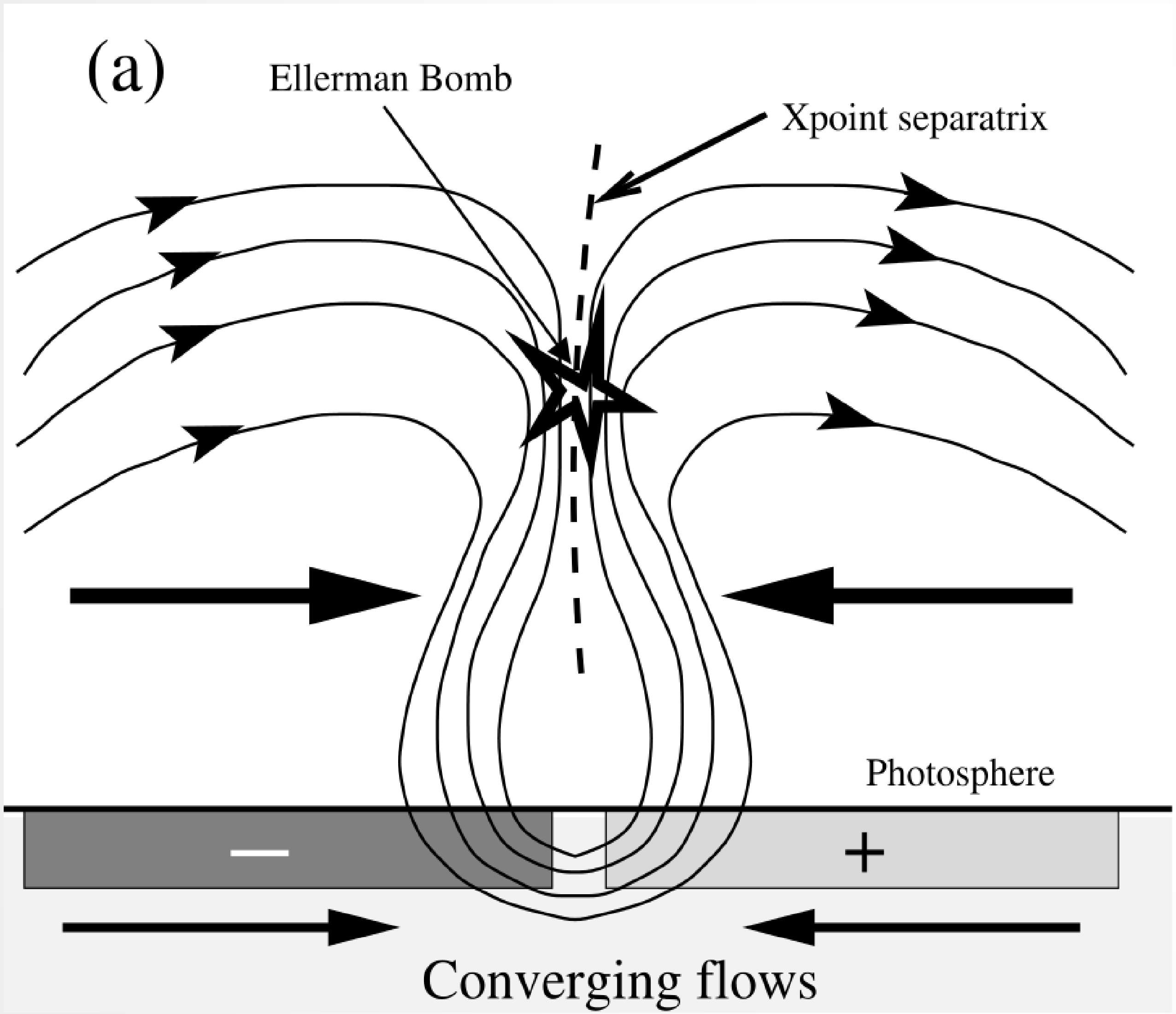

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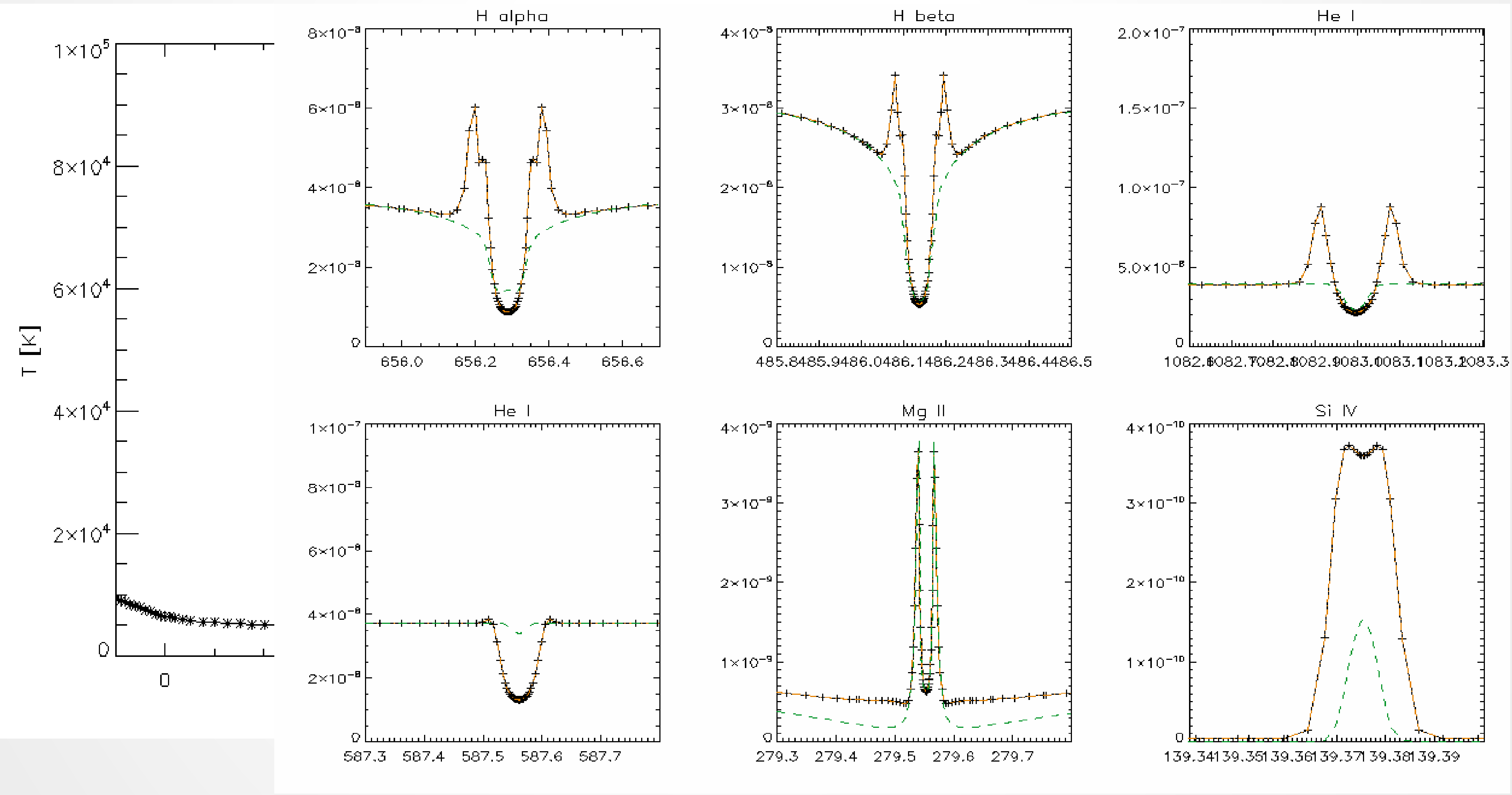
Next step: modelling

Observing neutral helium in emission, and Si IV, adds a strong constraint to modelling!



Summary

- We observe EB emission in He I D3 and He I 10830
- The emission component is very broad and slightly blue-shifted
- Dominant broadening mechanism: thermal doppler motions
- We roughly estimate the EB temperatures between 20 000 – 100 000 K

Thank you for your attention!

When does the emission occur?