A disturbance propagating from the chromosphere into a heated coronal loop

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Contributed Talk

2. Chromospheric heating and dynamics

A disturbance propagating from the chromosphere into a heated coronal loop

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The origin of propagating disturbances in the solar corona is still an open issue. Here, we present observations of disturbances clearly showing a coupling of the solar atmosphere from the low chromosphere into the heated coronal loop. These observations provide clues about the role of magnetic field dynamics in generating the detected disturbances. We use imaging diagnostics of the solar atmosphere (IRIS, SDO/AIA) and photospheric magnetic field maps (HINODE, SDO/HMI) to investigate the temporal and spatial evolution of propagating disturbances and their relation to the underlying magnetic field.
We detect a clear time delays between the intensity maxima of the propagating disturbances that increase with the plasma temperature. The speeds of the propagating disturbances in the highly inclined loop increase from the transition region ($\sim$20 km s^{-1}) to the hot corona ($\sim$220 km s^{-1}), suggesting that these disturbances are subsonic. The relation between magnetic field evolution and intensity changes requires further investigation, but preliminary results show that the evolution of small-scale magnetic field concentrations at the base of the loop play an important role in the generation of propagating disturbance.
We suggest that the propagating disturbances are governed by reconnection of magnetic field in the lower solar atmosphere. The energy released in the process is transported upwards, and the apparent motion of the heat-front is then observed as a propagating disturbance.

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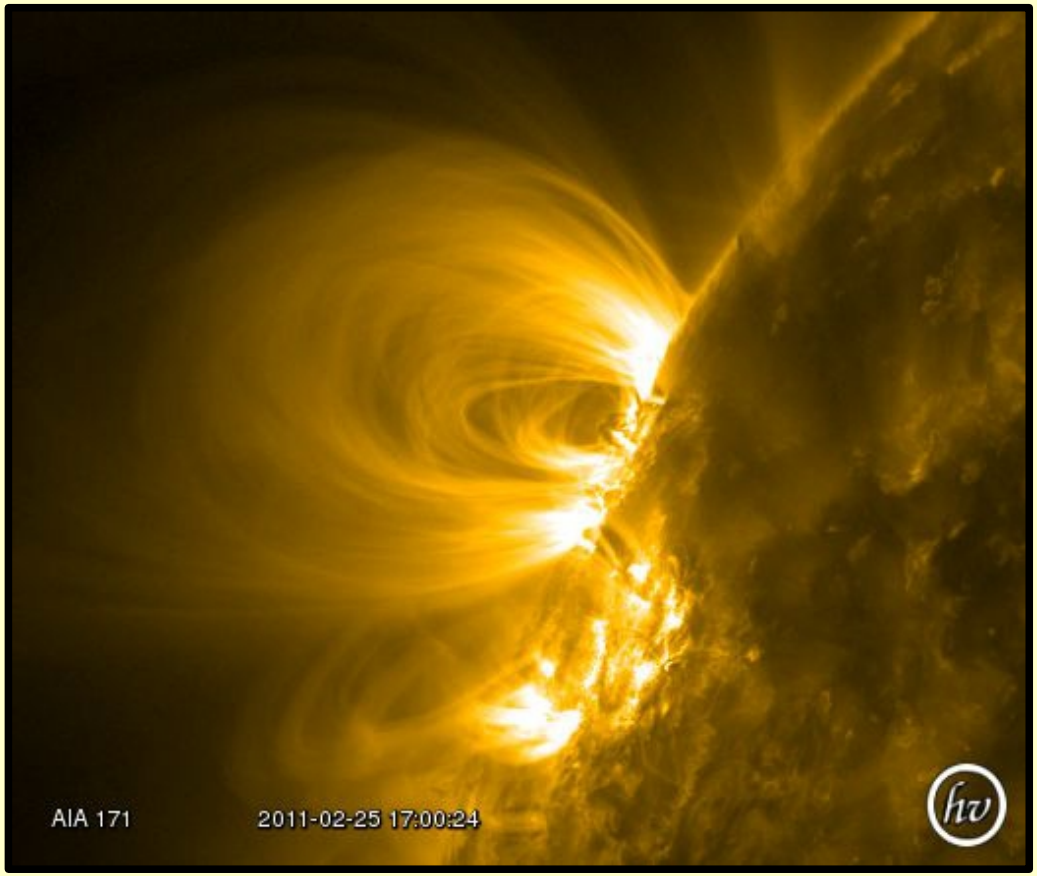
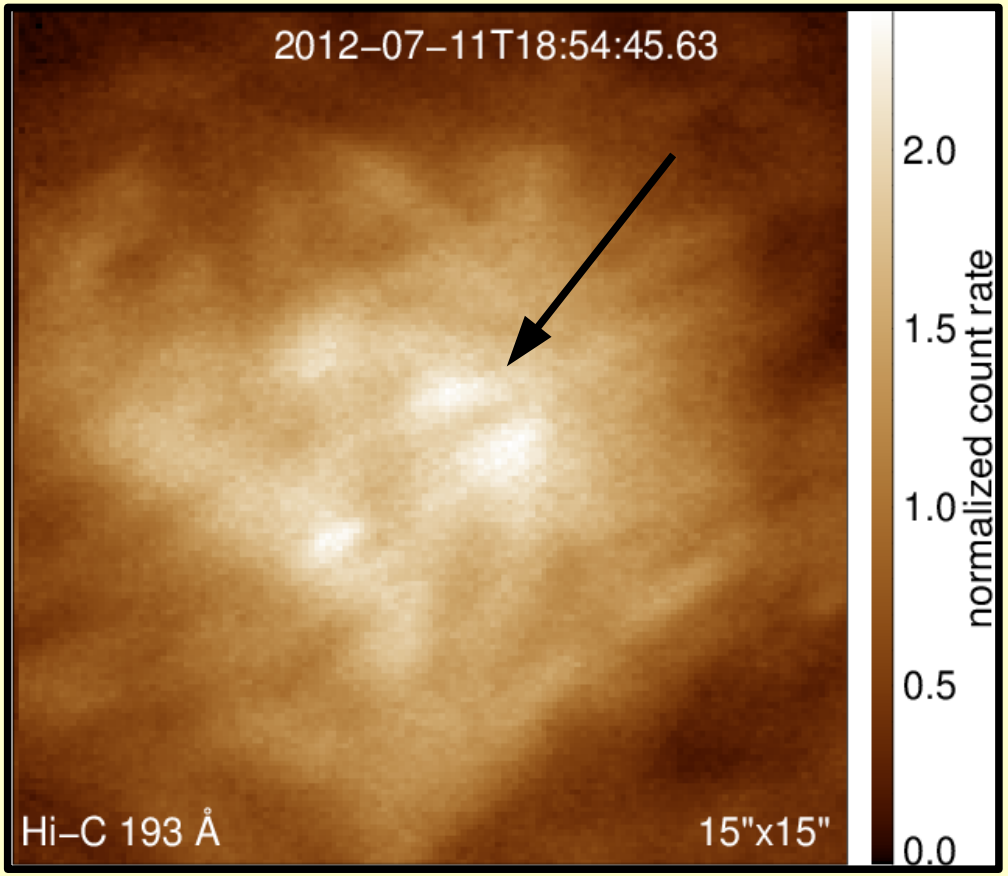
Small and large ~1 MK loops

Large ~1 MK loops building up the corona
L~100 Mm, t~30 min



AIA 171Å

Small ~1 MK loops
L~1 Mm, t~2min

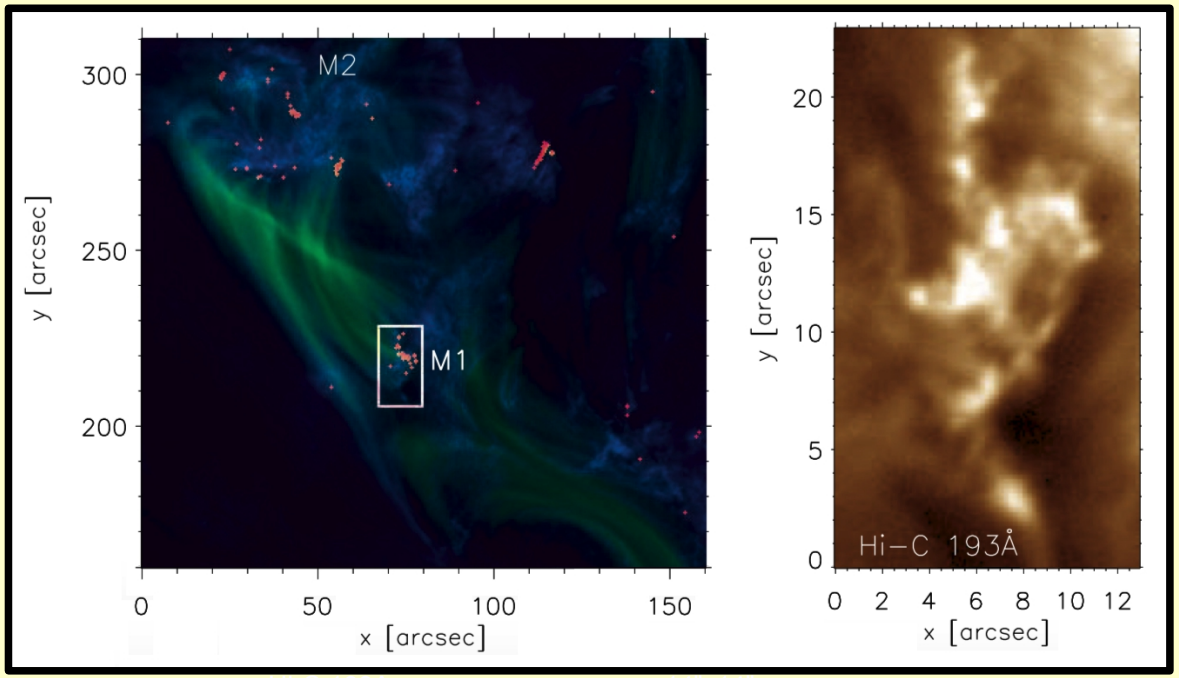


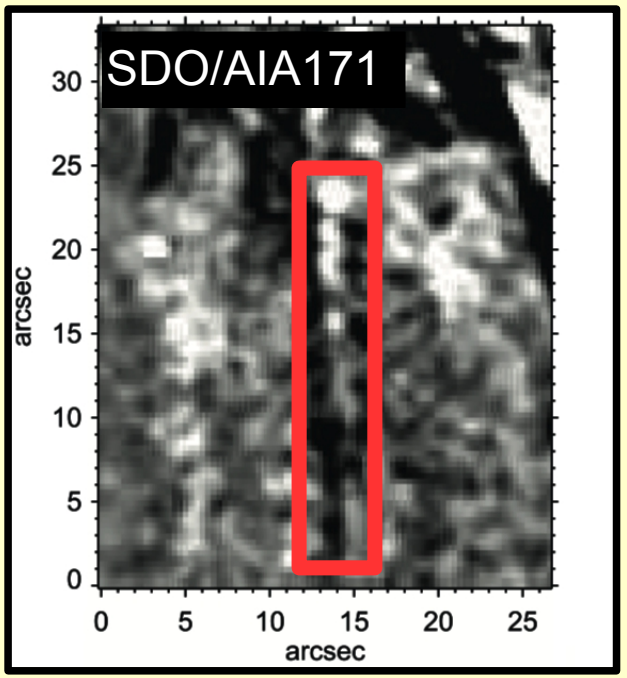
Peter et al (2013) A&A 556, 104
Barczynski et al (2017) A&A 599, A137

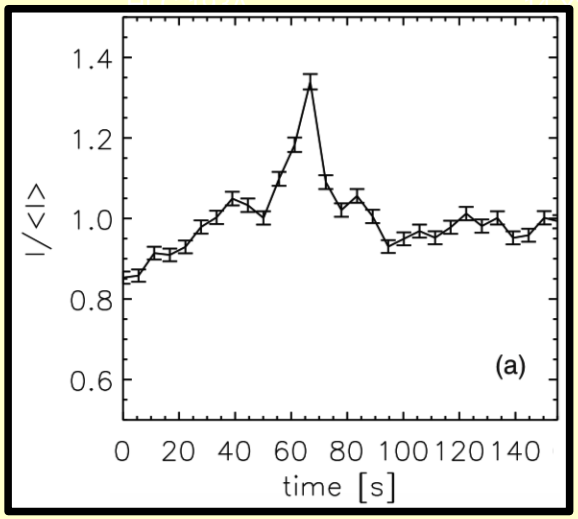
Coronal loops and their variability

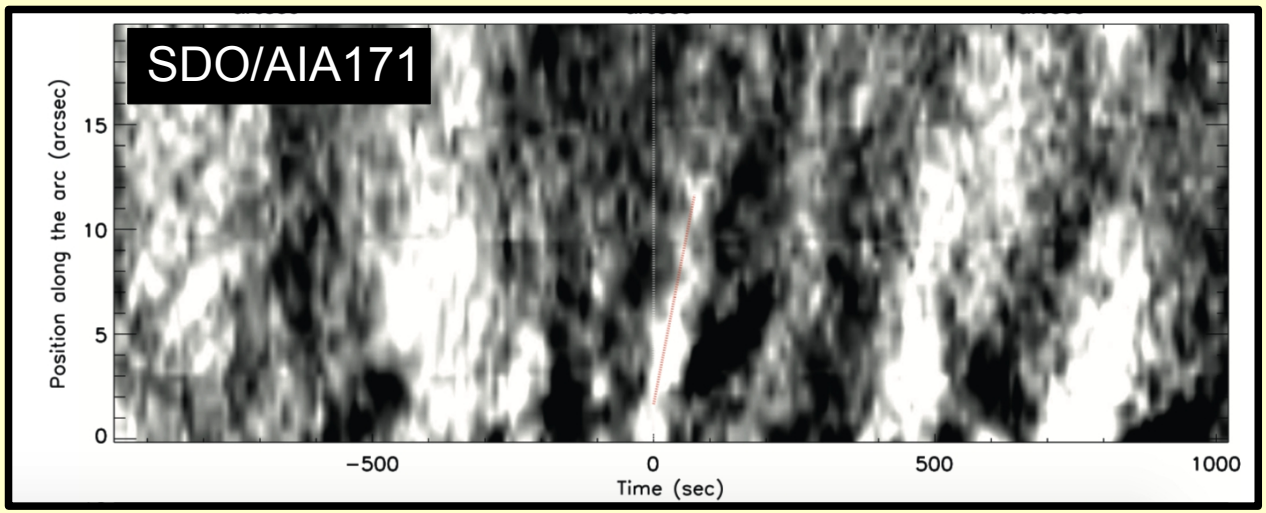
Moss
T>10^6K, L~2 Mm, t~15 sec

Propagating coronal disturbances
T~10^6K, t~3-10 min





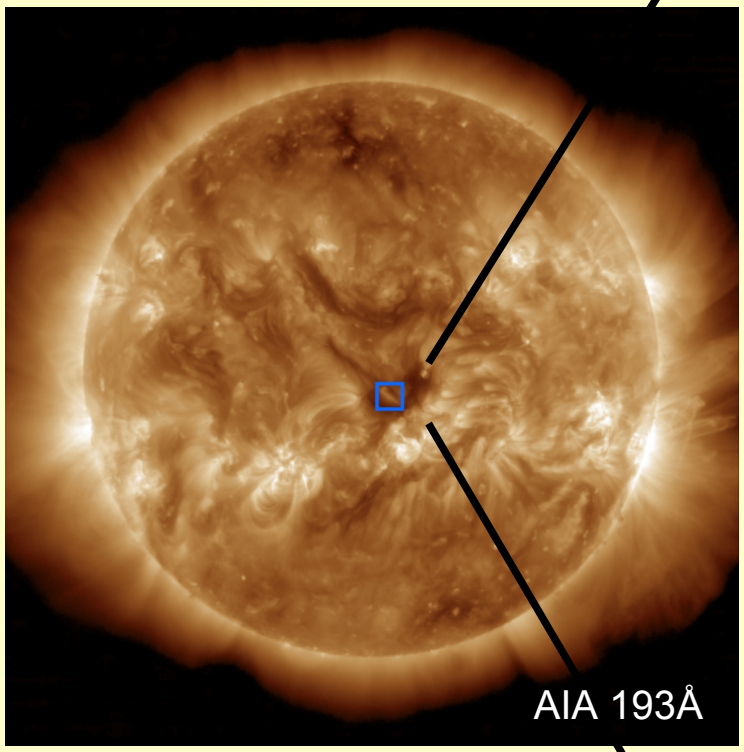




Testa et al (2013) ApJ 770, 1 (img. modified)

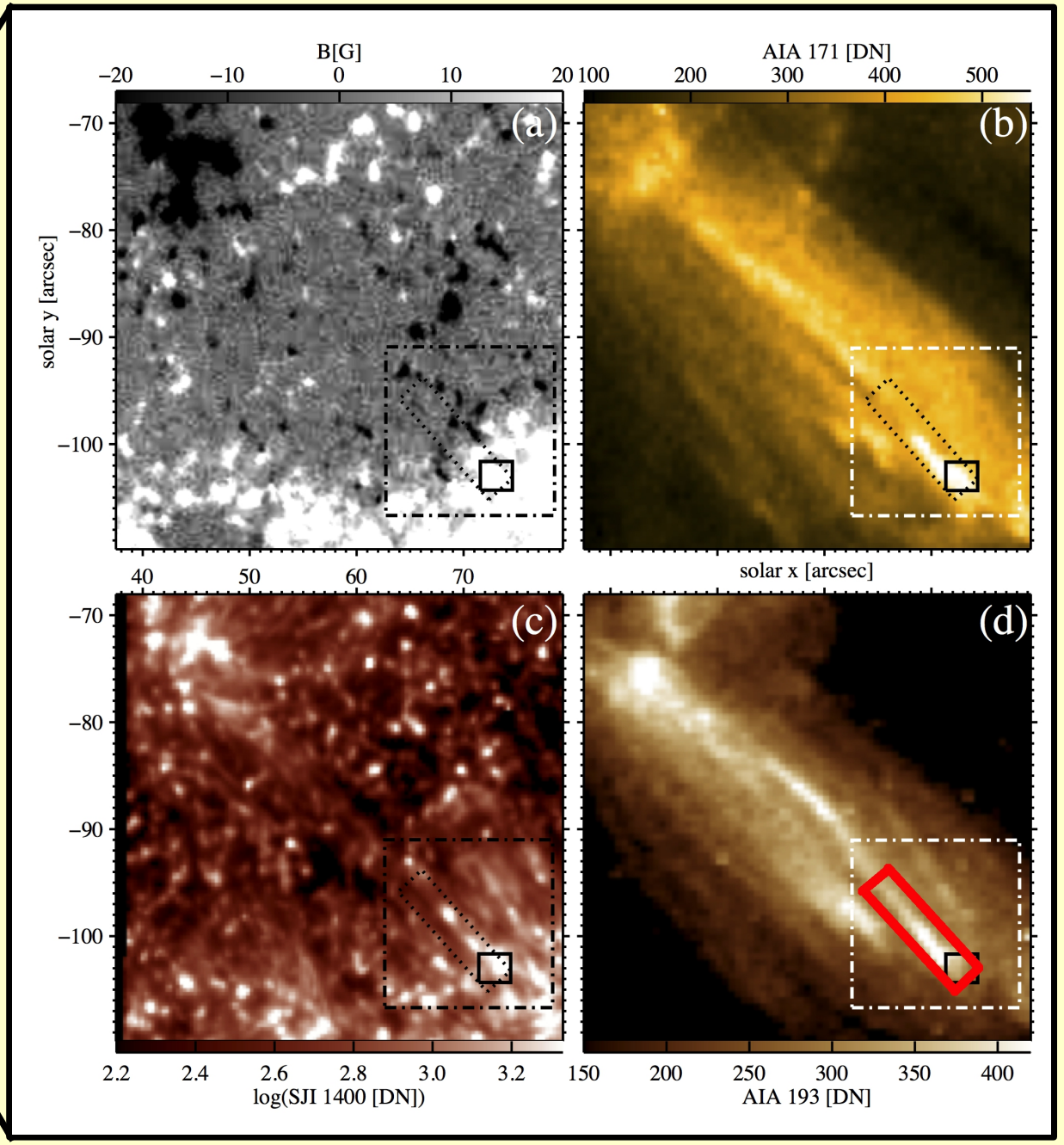
Bryans et al (2016) ApJL 829, 18

Propagating disturbance (PD)



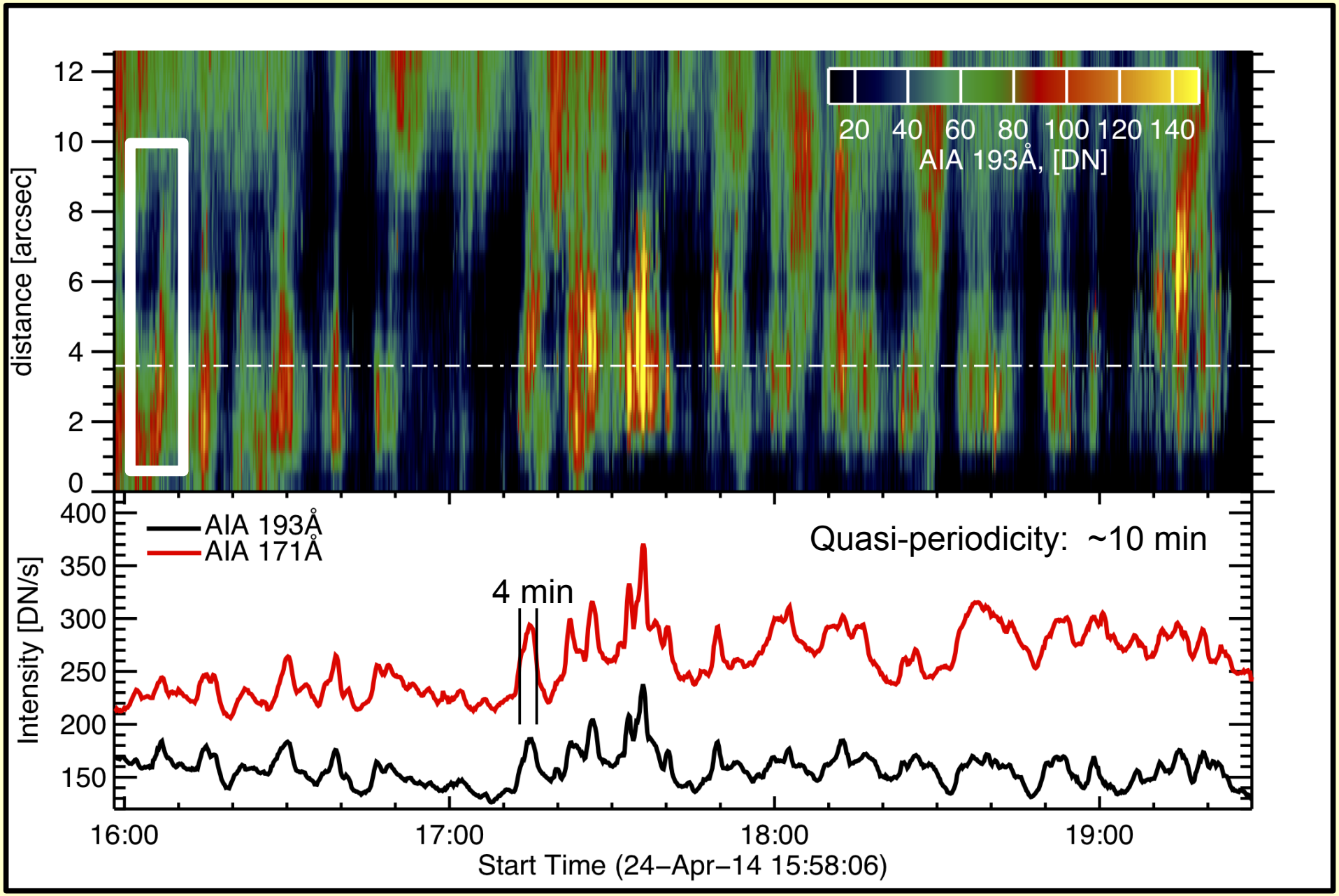
Closed loop system

Equatorial coronal hole

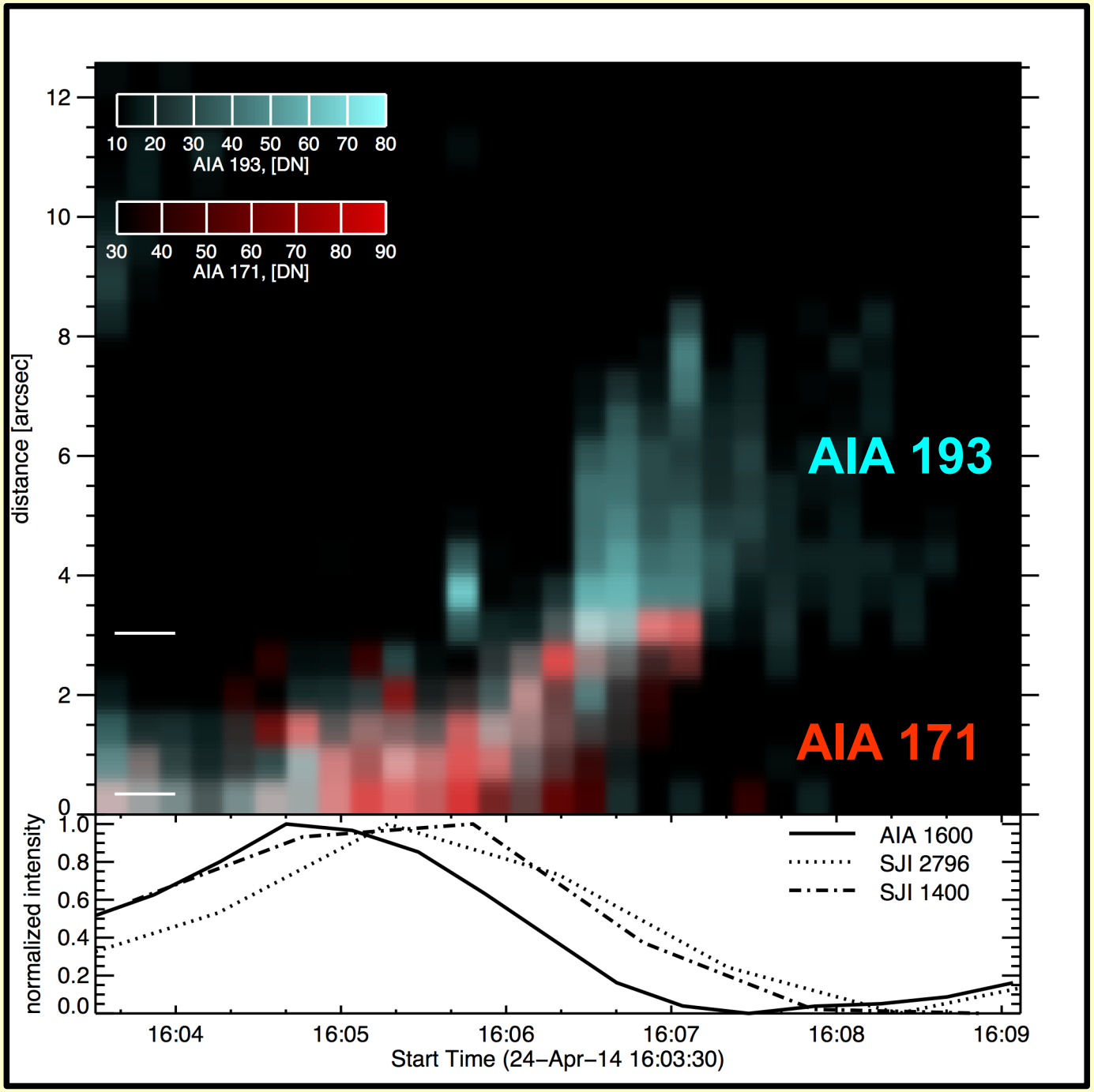


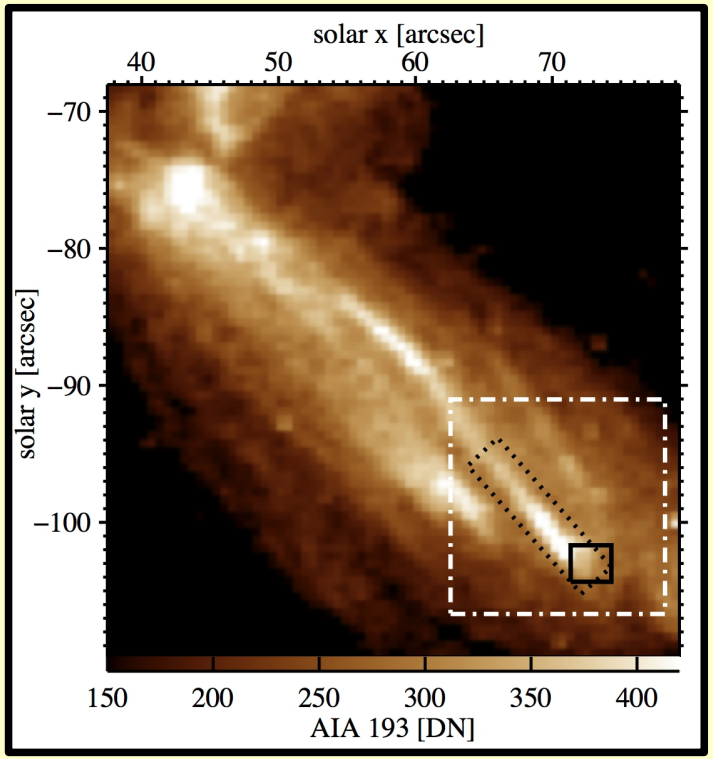
Time-space diagram

Background subtracted intensity variation of **quasi-periodic** propagating disturbance

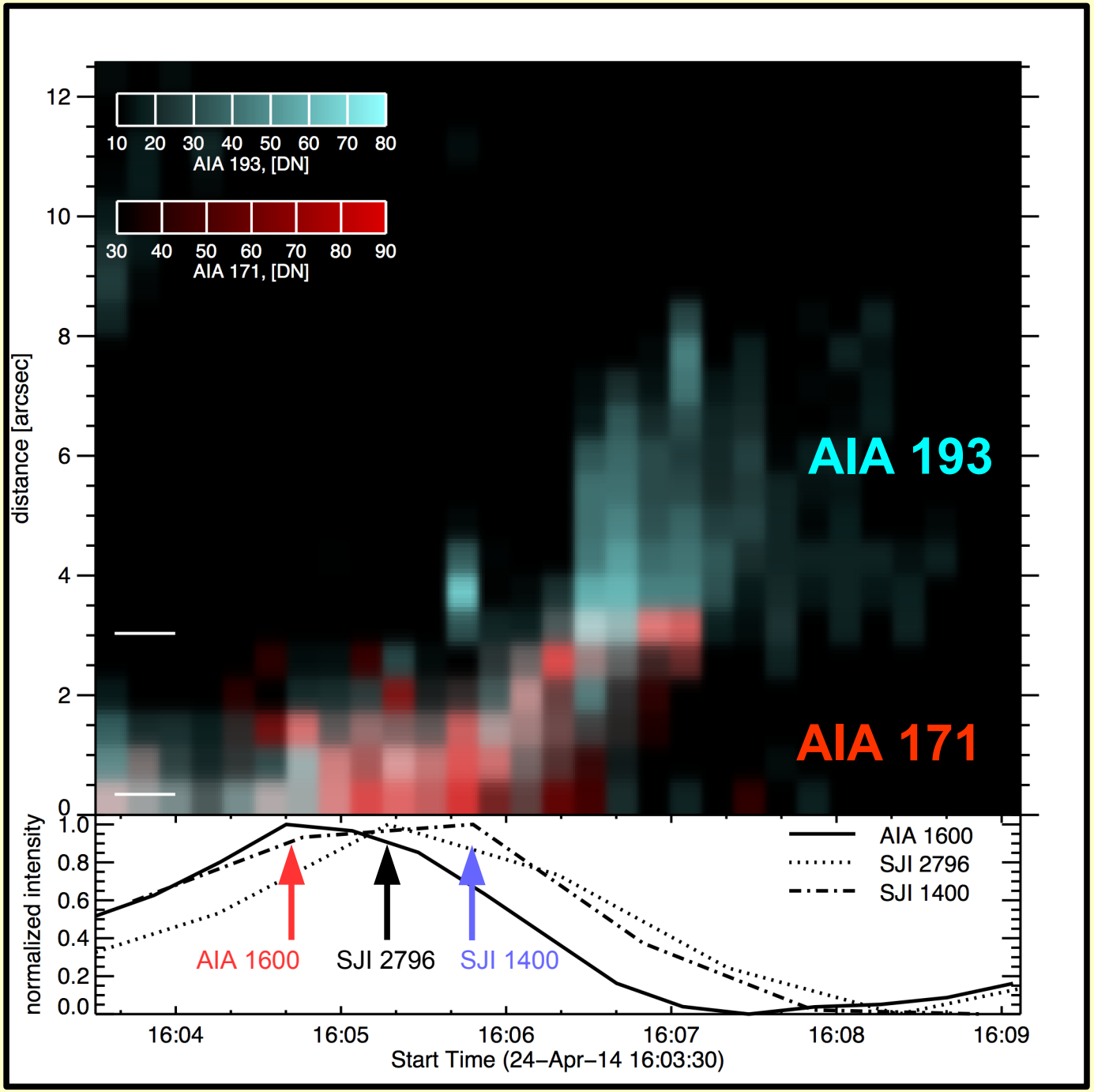


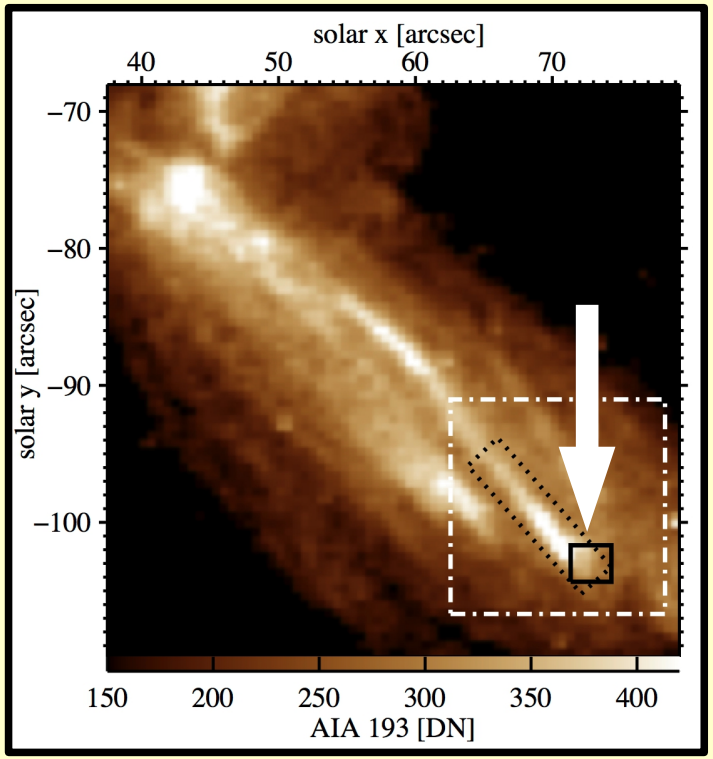
Time-space diagram zoom





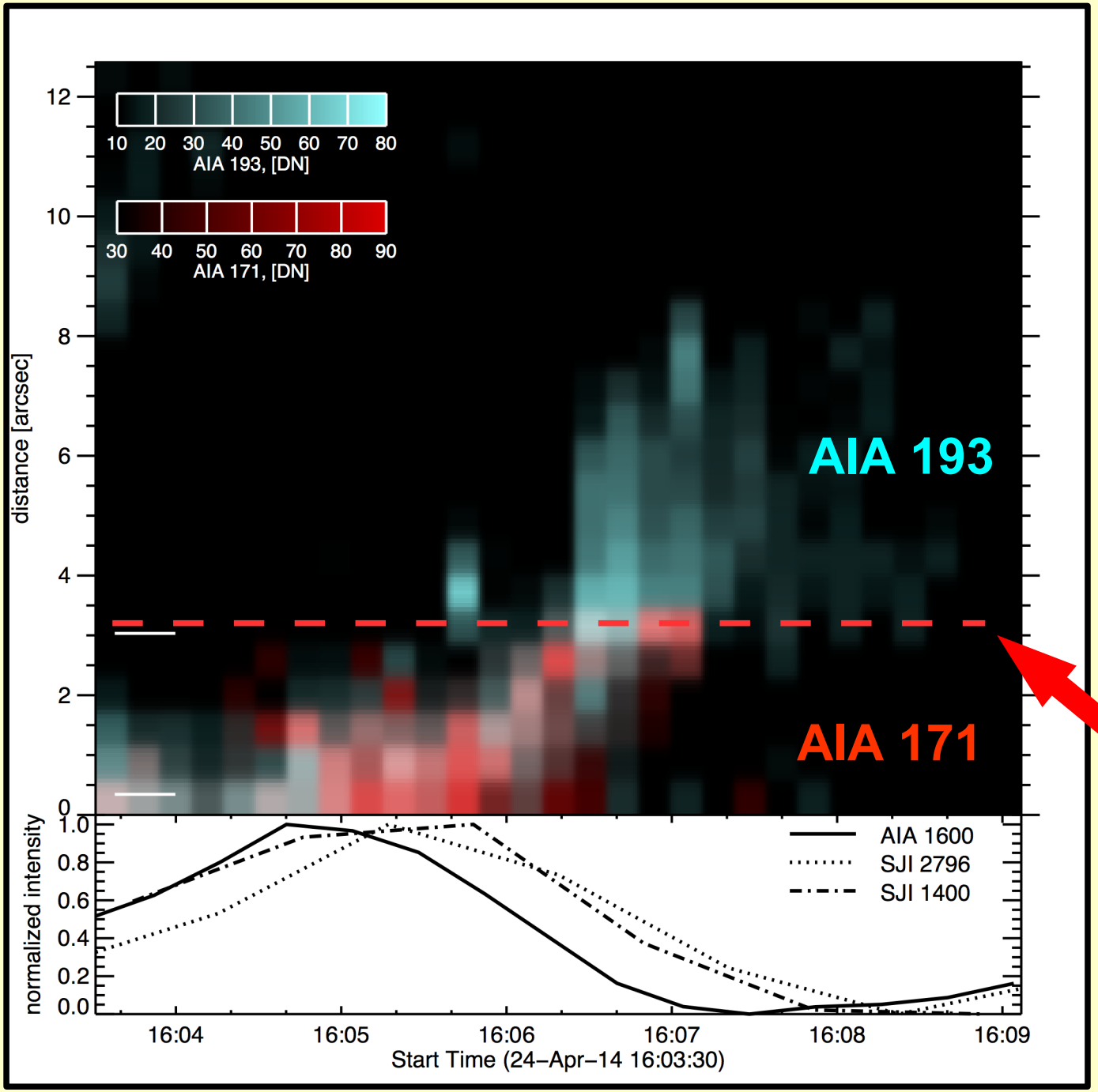
Time-space diagram zoom

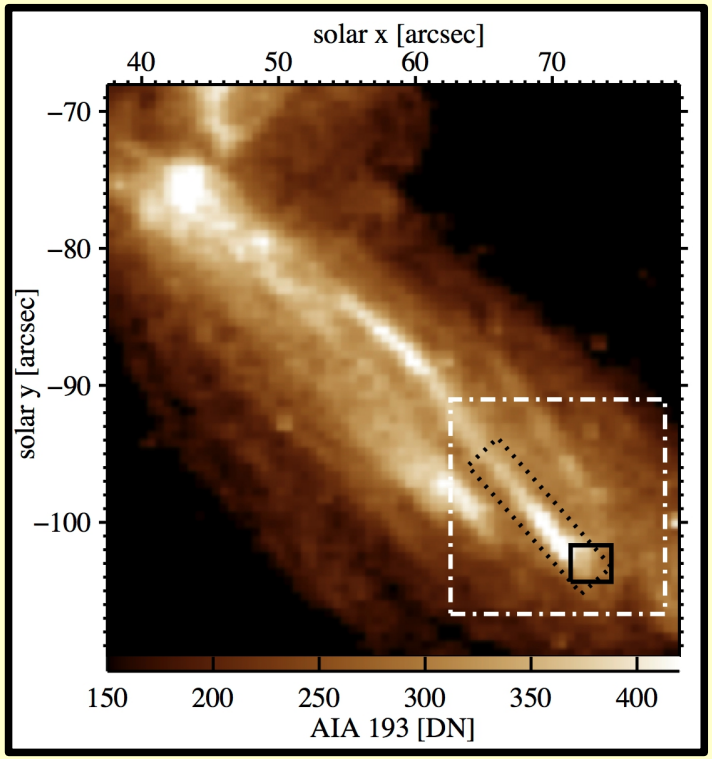




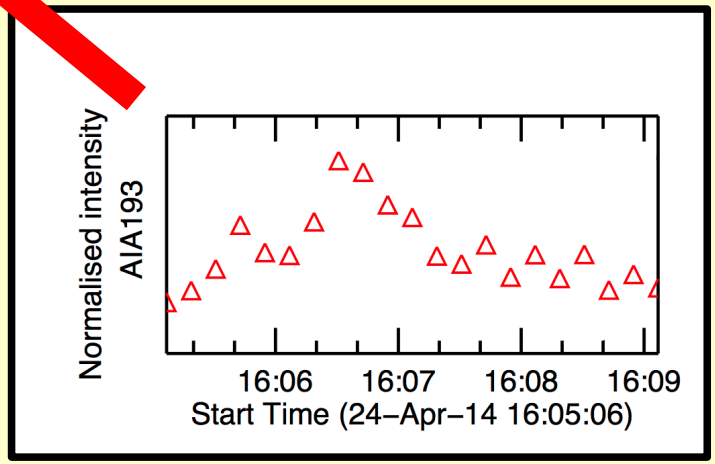
- Propagation of disturbance from lower to the upper atmosphere

Time-space diagram zoom

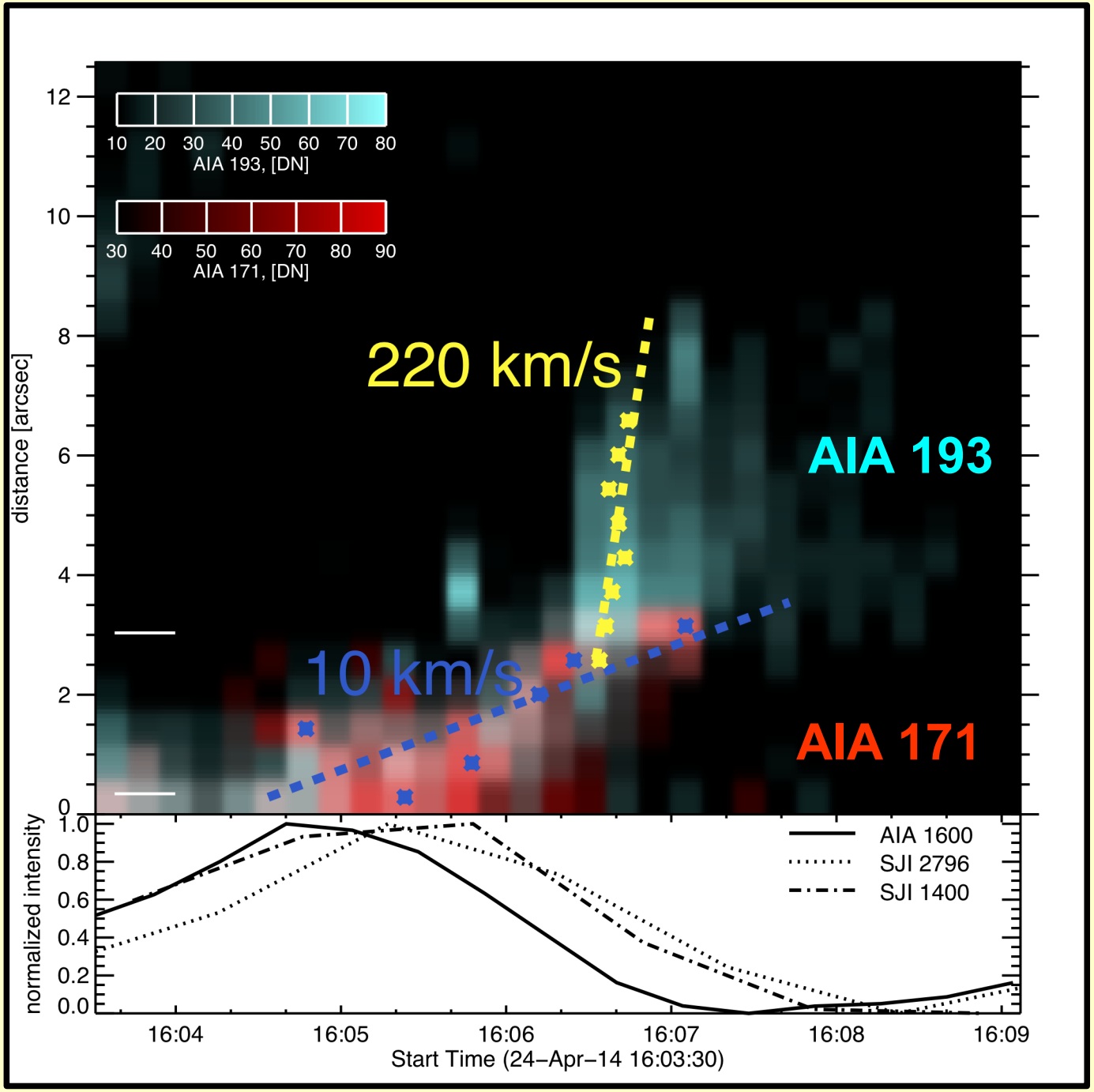


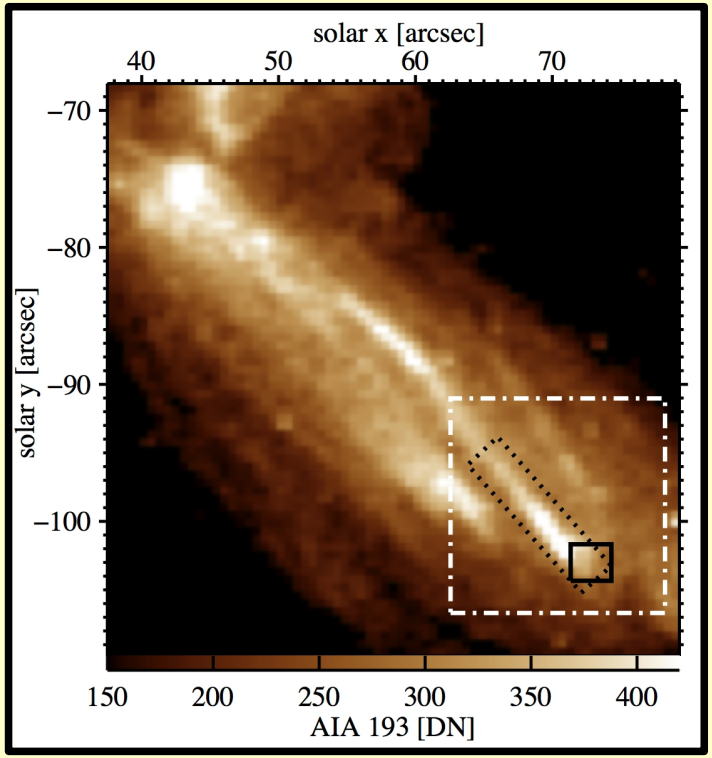


Example of intensity distribution

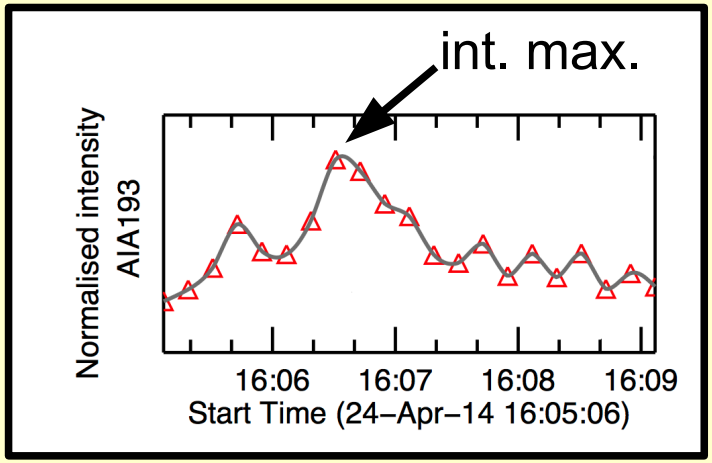


Apparent speed of heat front

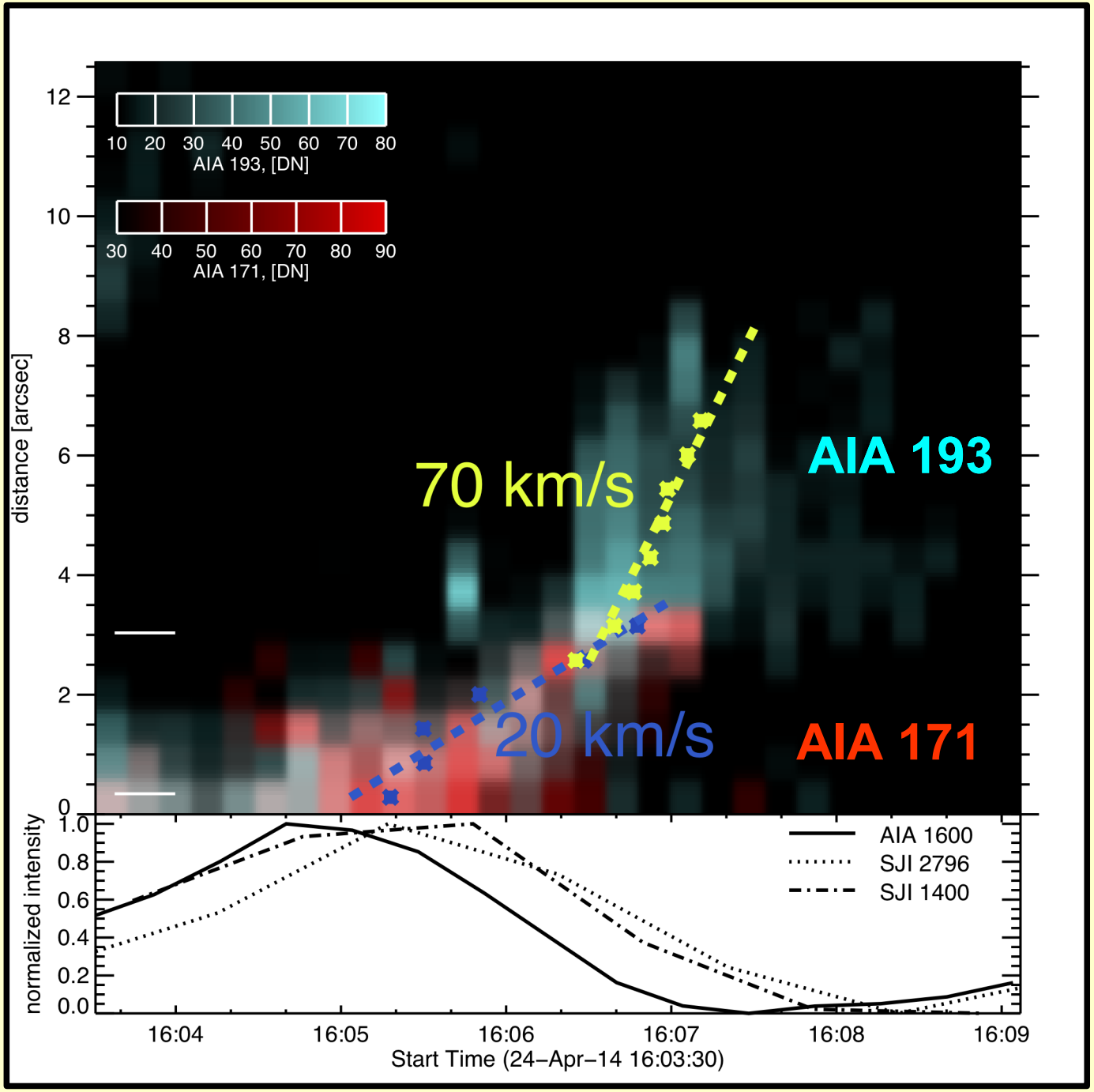


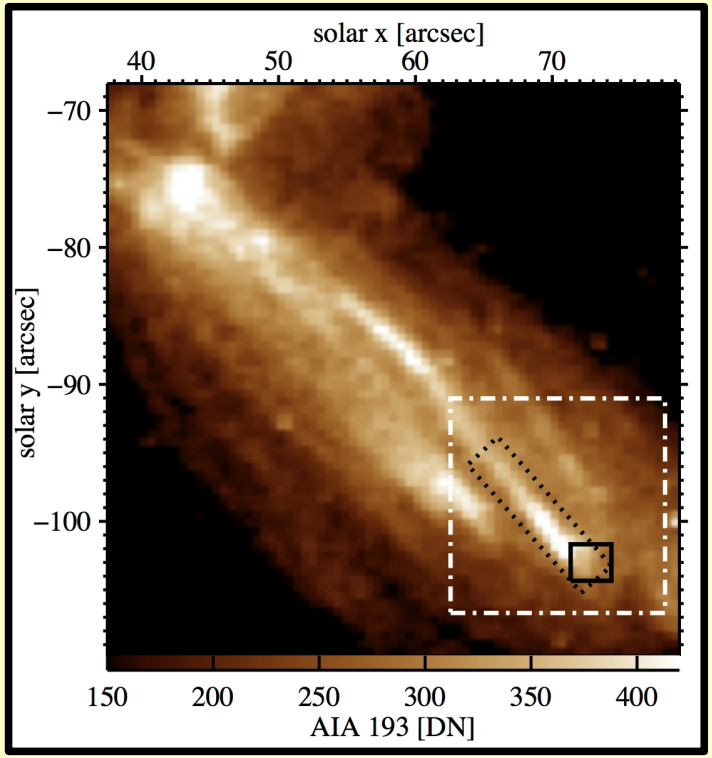


Example of intensity distribution

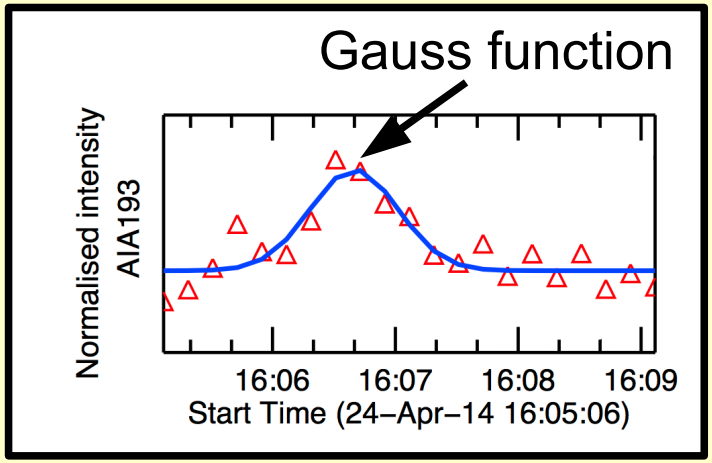


Apparent speed of bulk part





Example of intensity distribution



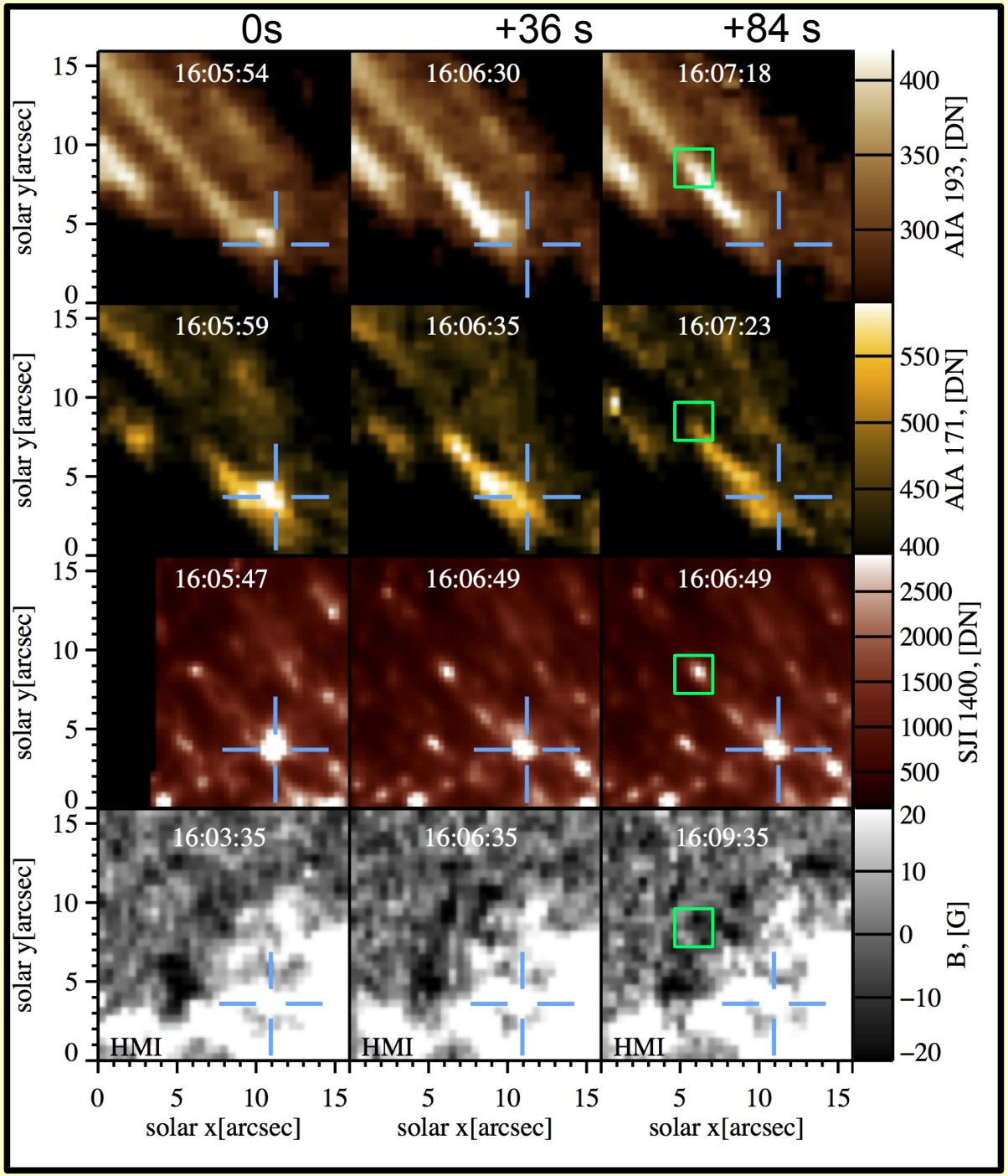
Unresolved magnetic field activity?

AIA 193

AIA 171

SJI 1400

SDO/HMI



- unipolar magnetic patch
- bright dots with opposite polarities (see green box)

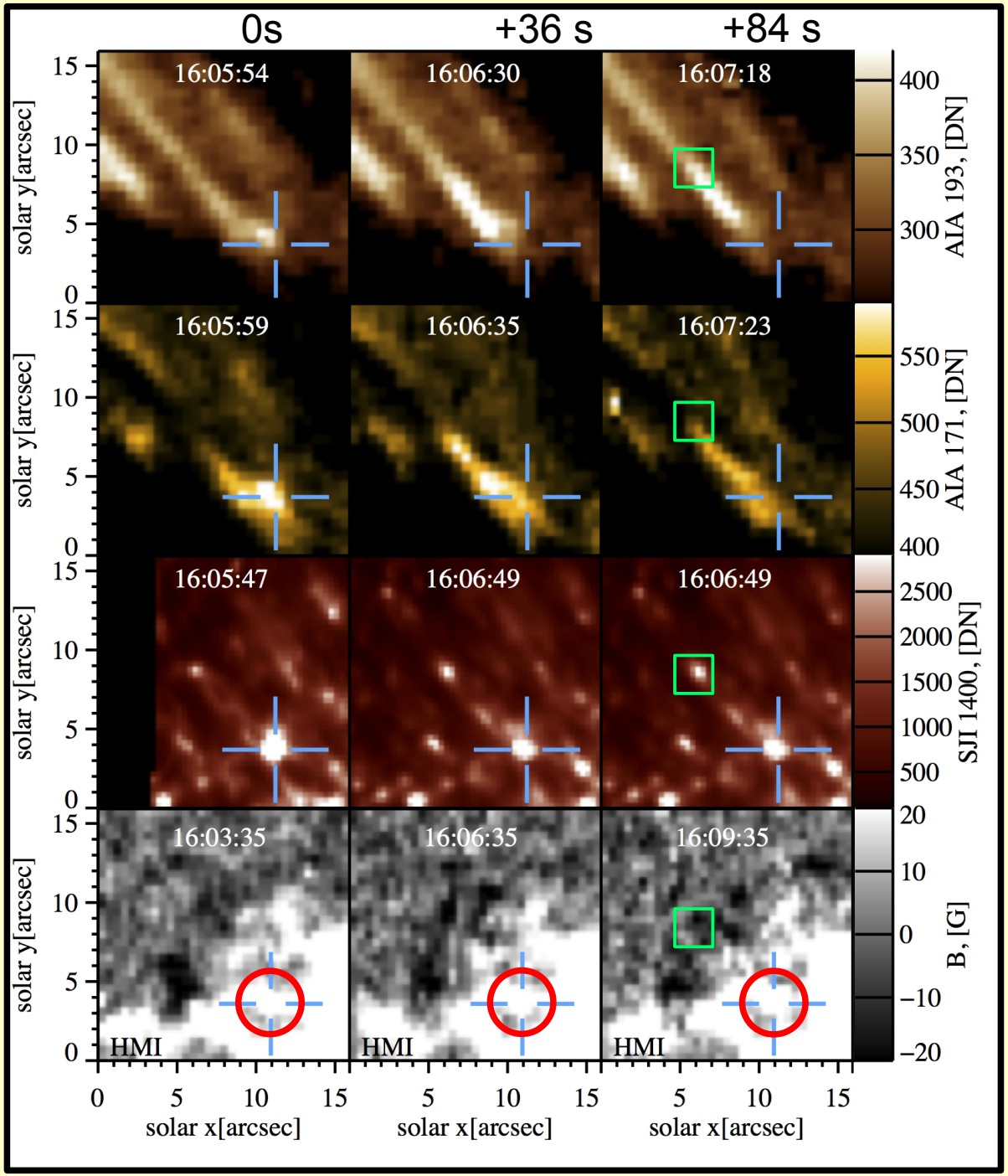
Unresolved magnetic field activity?

AIA 193

AIA 171

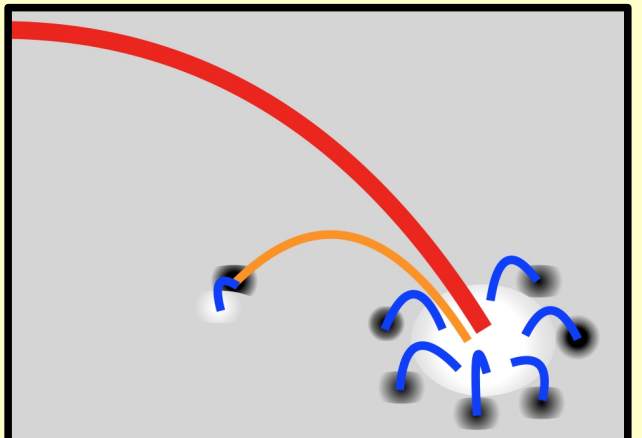
SJI 1400

SDO/HMI



- unipolar magnetic patch
- bright dots with opposite polarities (see green box)
- ring
  → unresolved polarity

Magnetic field configuration



Unresolved magnetic field activity?

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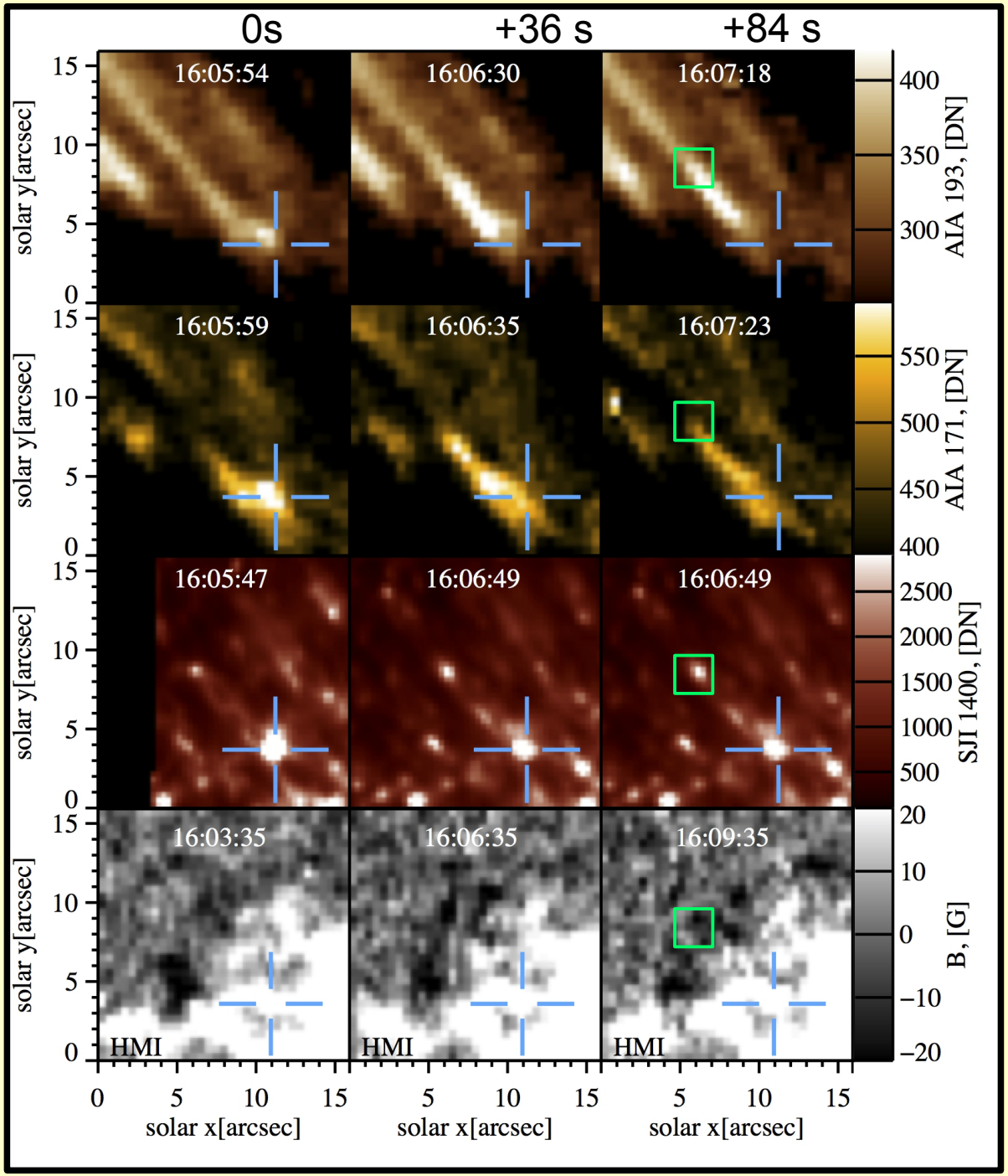

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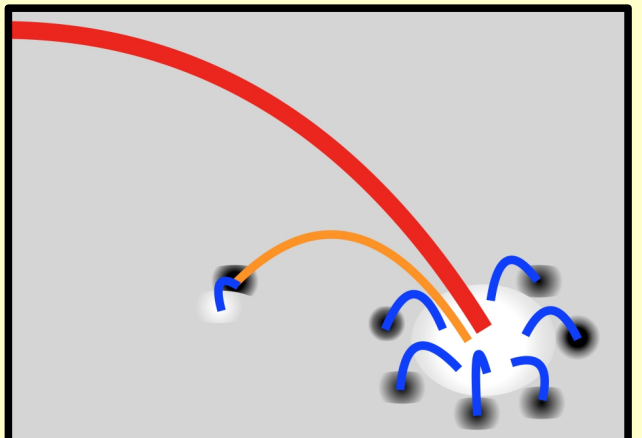
Magnetic field configuration



Concluding remarks and open questions?

- Propagation of disturbance from the lower to the upper atmosphere

- Dynamics of propagating disturbance
  -quasi-periodicity
  -moving heat front
  (speed ~220 km/s, faster than local sound speed)
  -bulk of propagating disturbance (subsonic speed ~ 70 km/s)

- Propagating disturbance is faster than sound-speed
  - signature of propagating heat front
  - propagating Alfvenic disturbance

- Visibility and relation to underlying magnetic field
  -this is only single event
  -their relation with underlying magnetic field need a further investigation

Thank you for your attention!

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http://www2.mps.mpg.de/data/outgoing/barczynski/

Appendix

Method of speed calculation