Miniature coronal loops

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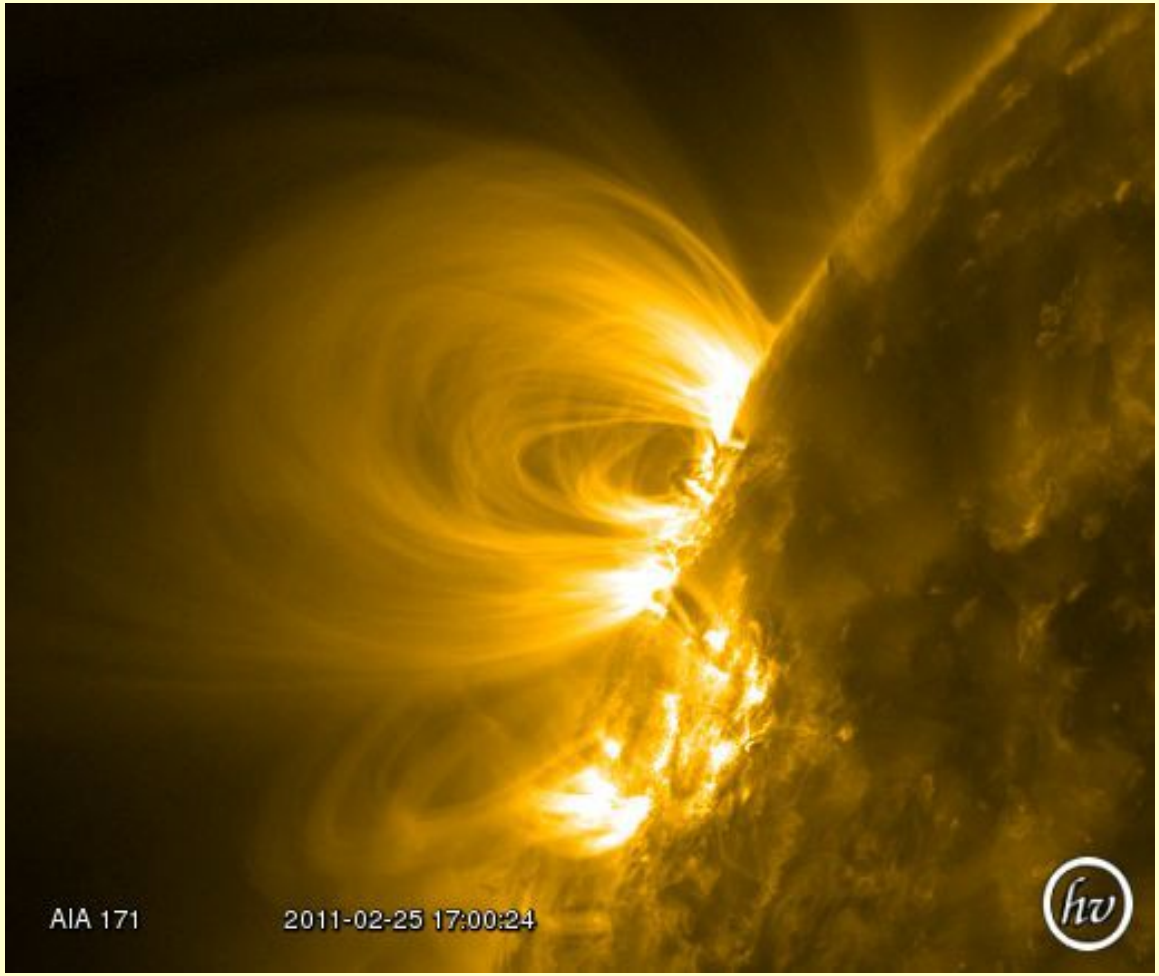
MAX-PLANCK-GESELLSCHAFT

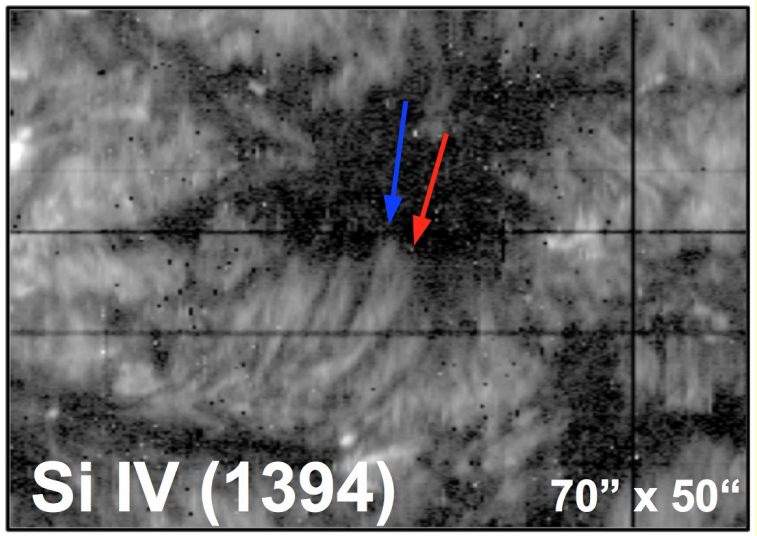
Hot and cool loops

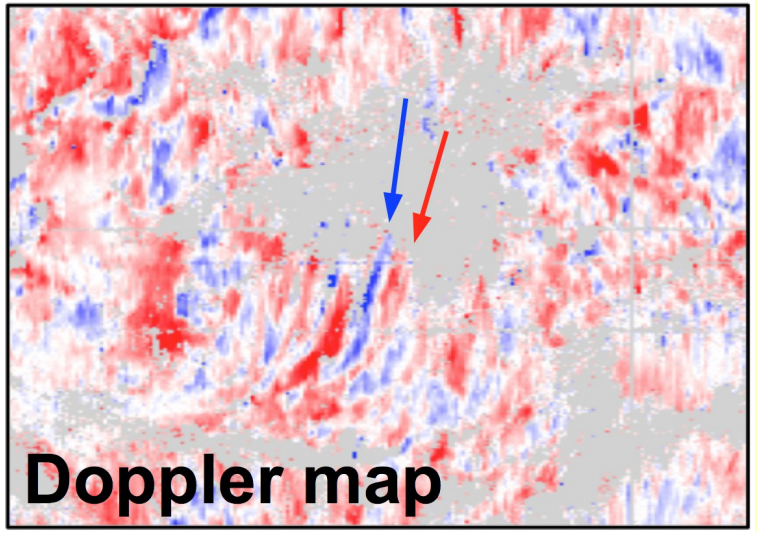
large hot loops building up the corona
$T>10^6$K, L≥30 Mm



AIA 171Å

small cool loops in the network
$T\sim10^5$K, L<10 Mm



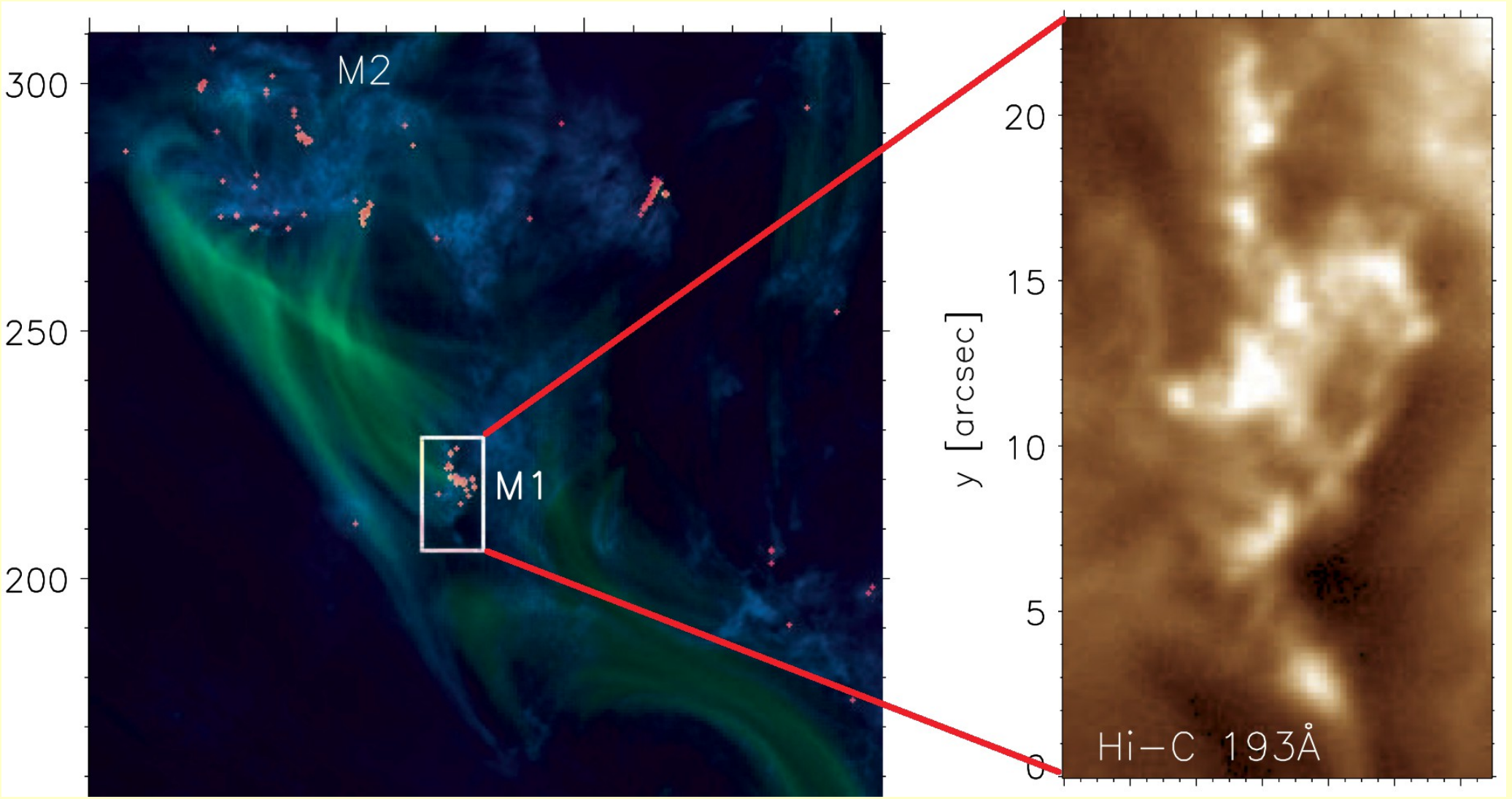


IRIS

also: hot coronal loops in 1 R_S

Small hot structures -”moss”

- i.e. 10^6K emission at footspoints of really hot loops

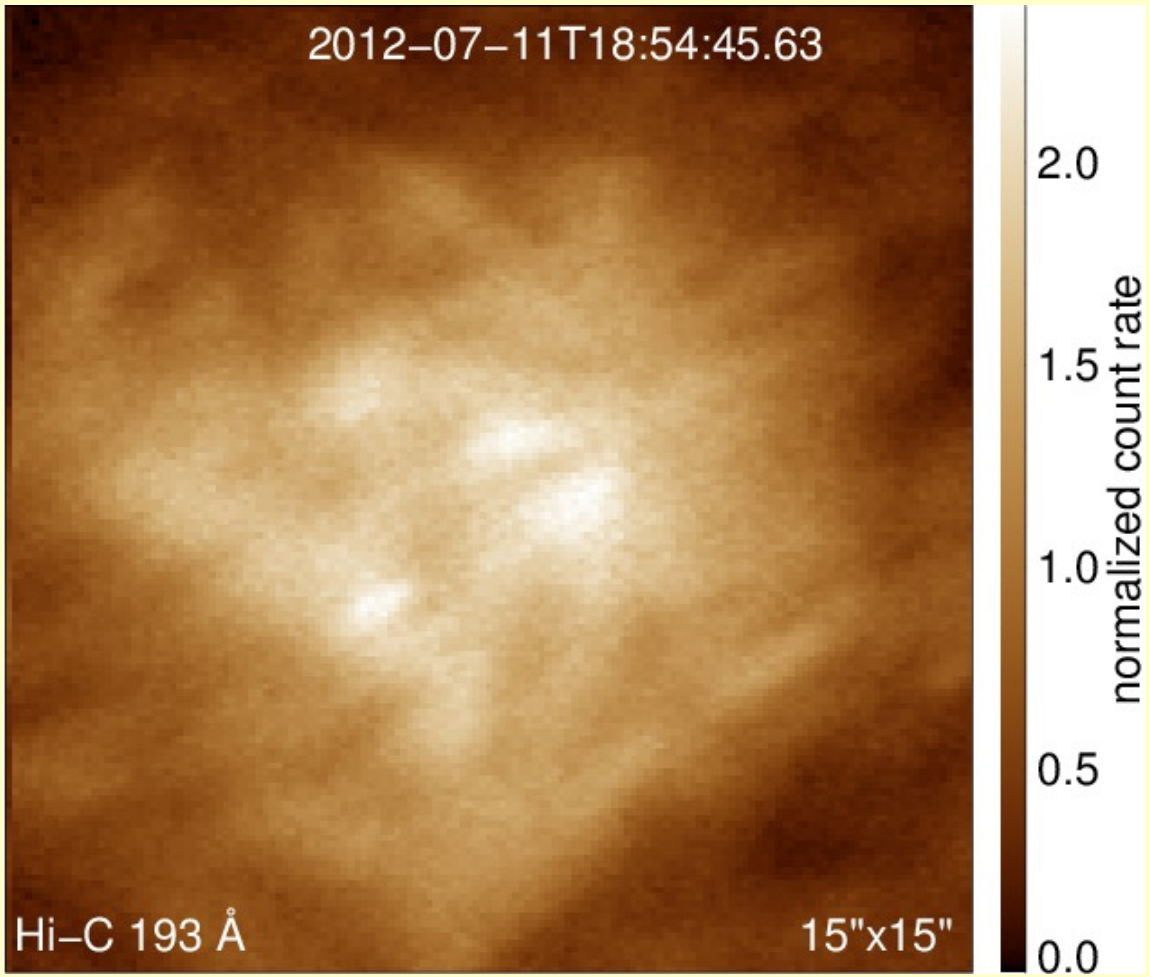


green AIA 94Å

blue Hi-C 193Å

dynamics evolution of moss by Testa et al (2013) ApJ 770, 1

Hi-C observation of miniature loops (?)

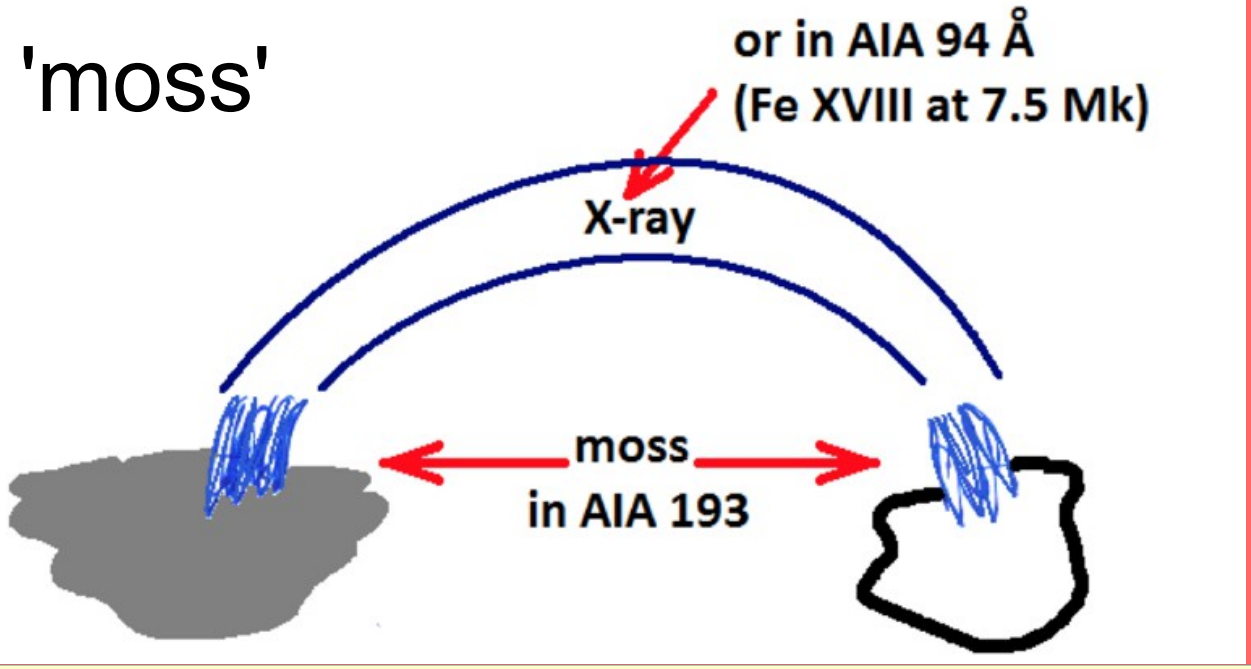


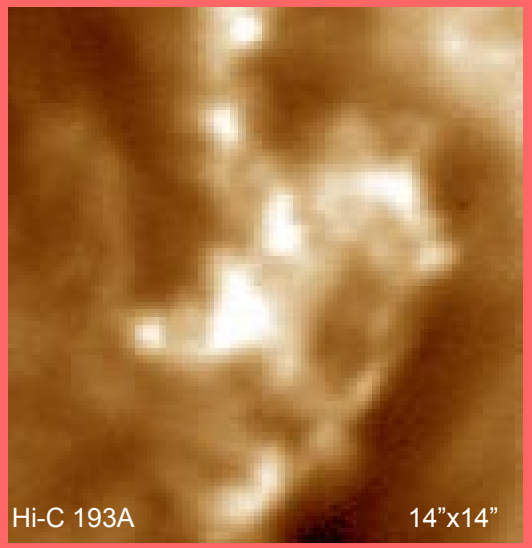
Peter et al (2013) A&A 556, 104

- small hot loop-like structures (<1 Mm)
- in plage area
- are these
  loops
  or
  Moss-type emission?

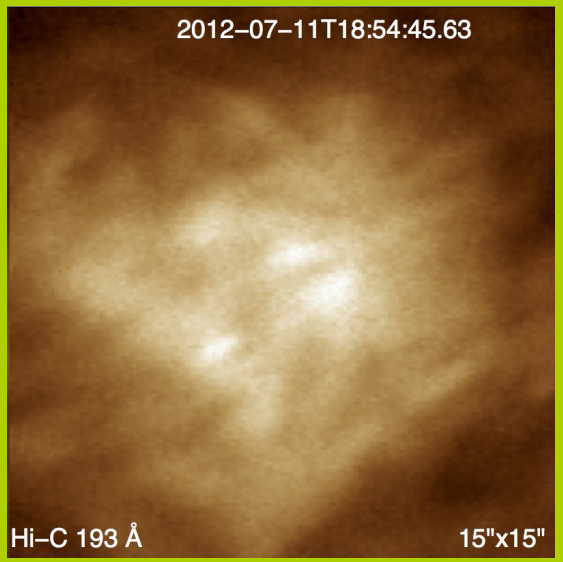
Scenario how small scale emission forms

'moss'

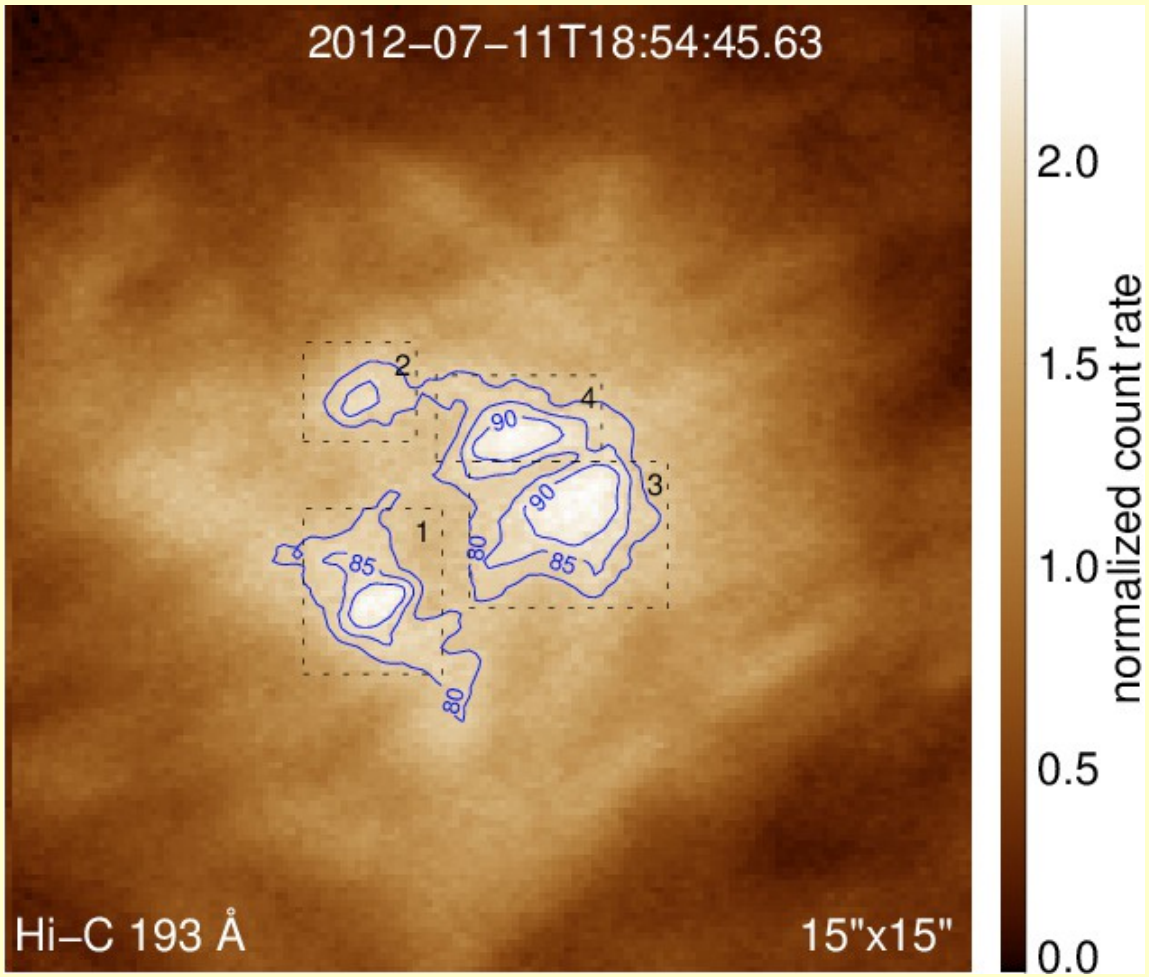




miniature loop



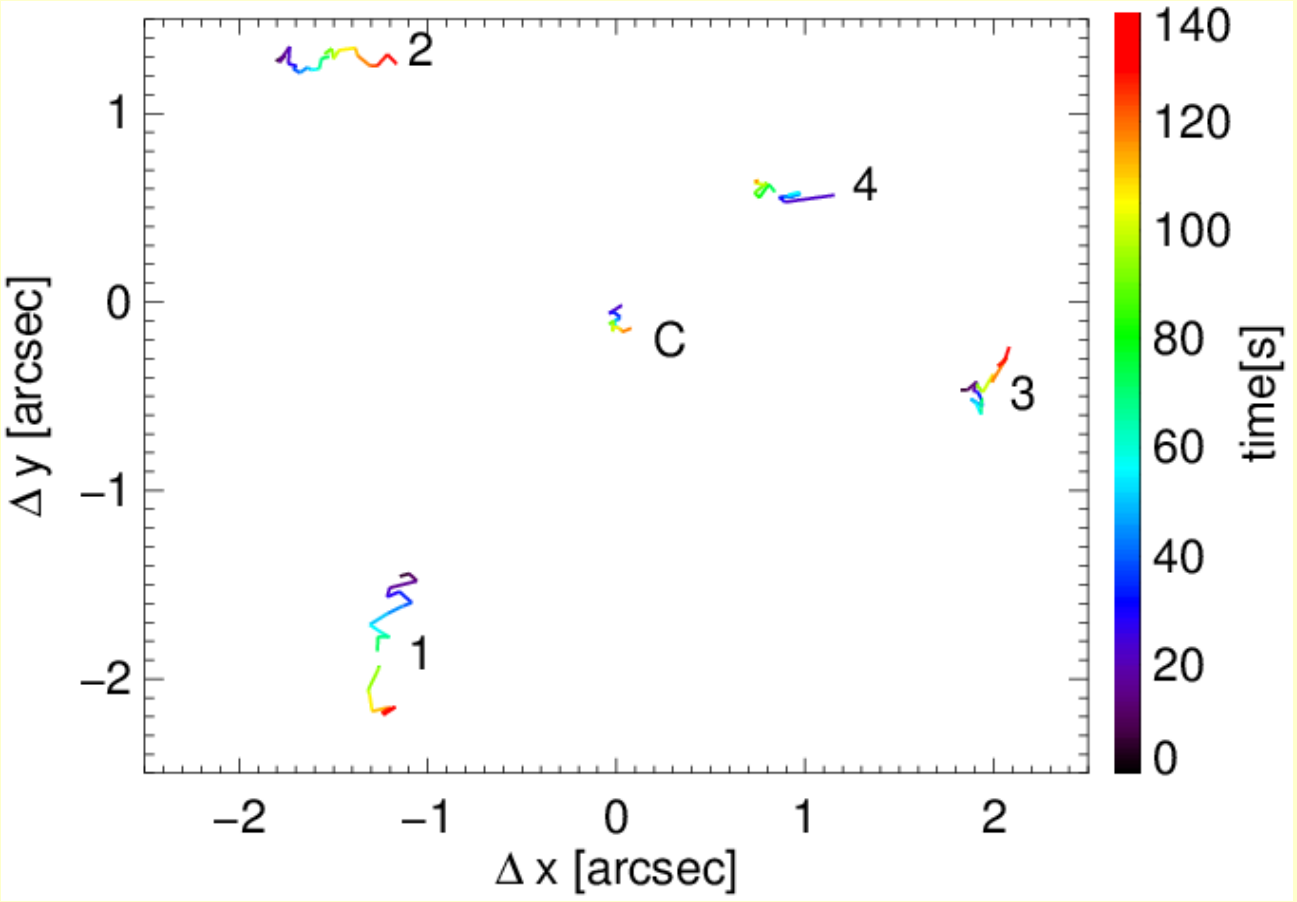
Questions about miniature structures



- is there a minimum size of the structures?
- what is the average lifetime?
- how do they evolve?

Properties of miniature structures

- *lifetime:* minutes
- *lenght:* 1-2 Mm
- *aspect ratio:* 1.5-2.5
- *speed:*
  - c.o.g: 3 km/s
  - rotation: 2 km/s



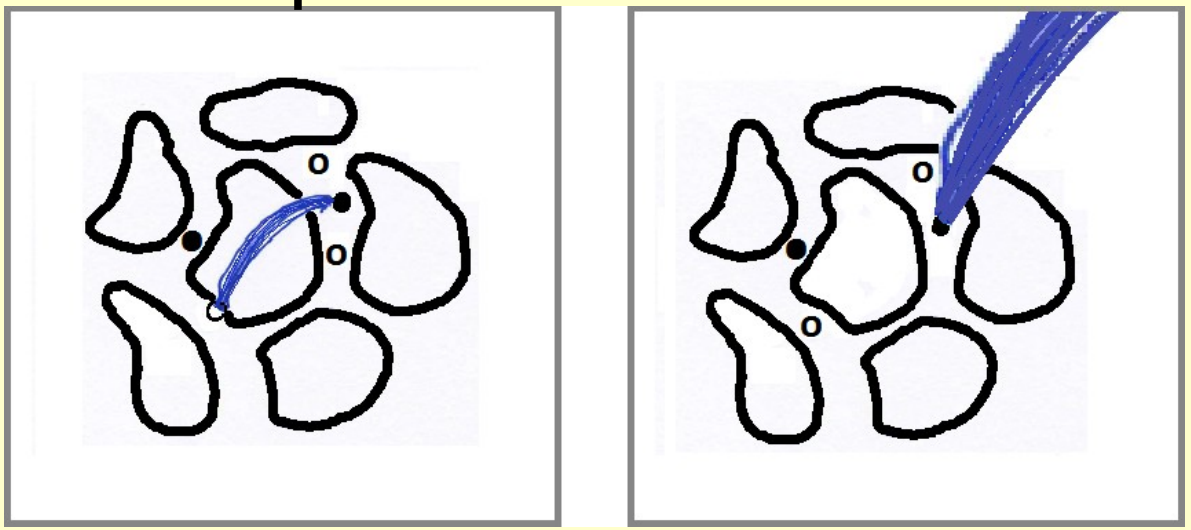
c.o.g montion of miniature structures

- consistent with photospheric granular montions

Relation to photospheric and coronal structures

- question:

loops or moss



- Hi-C emission next to or in between magnetic concentration
- Emission above magnetic concentration

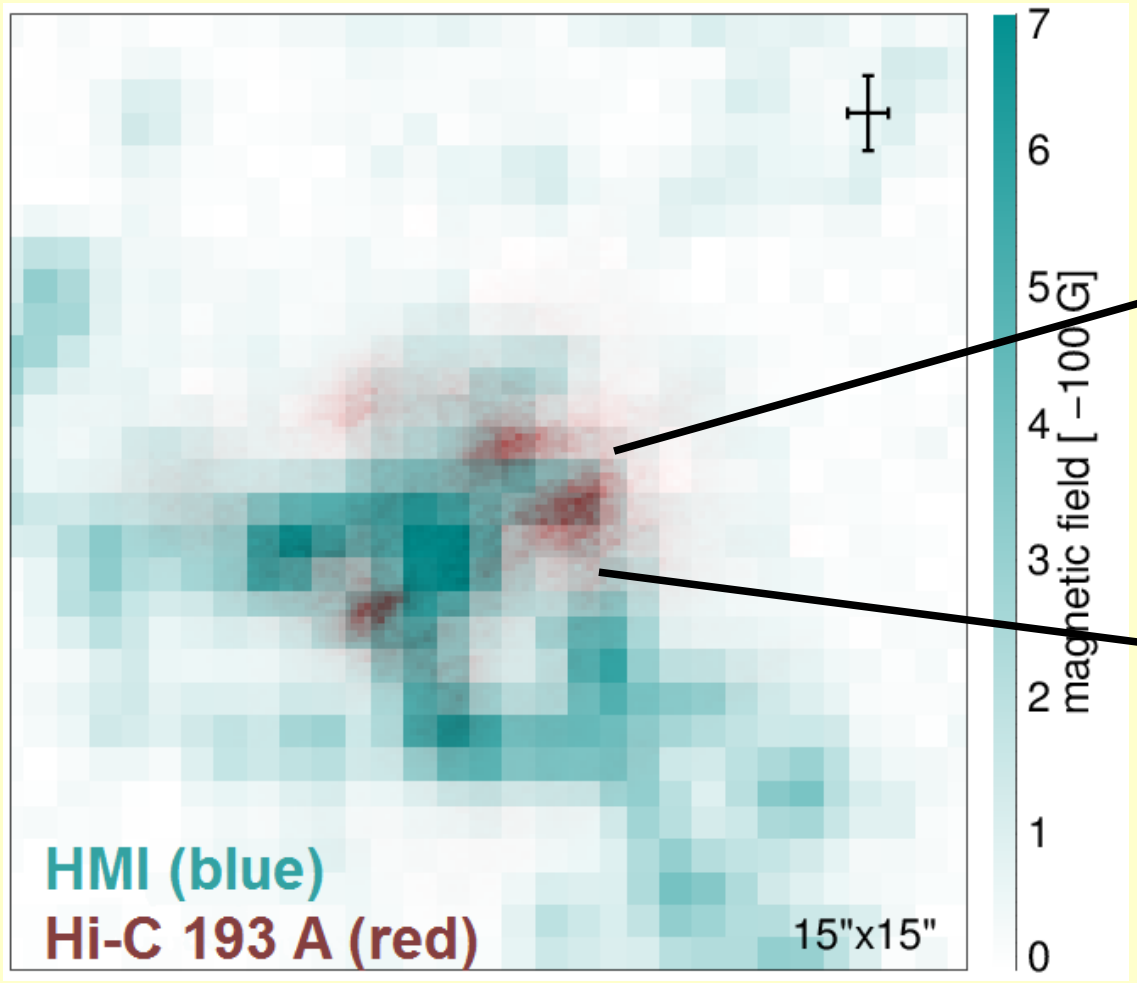
} check photospheric B

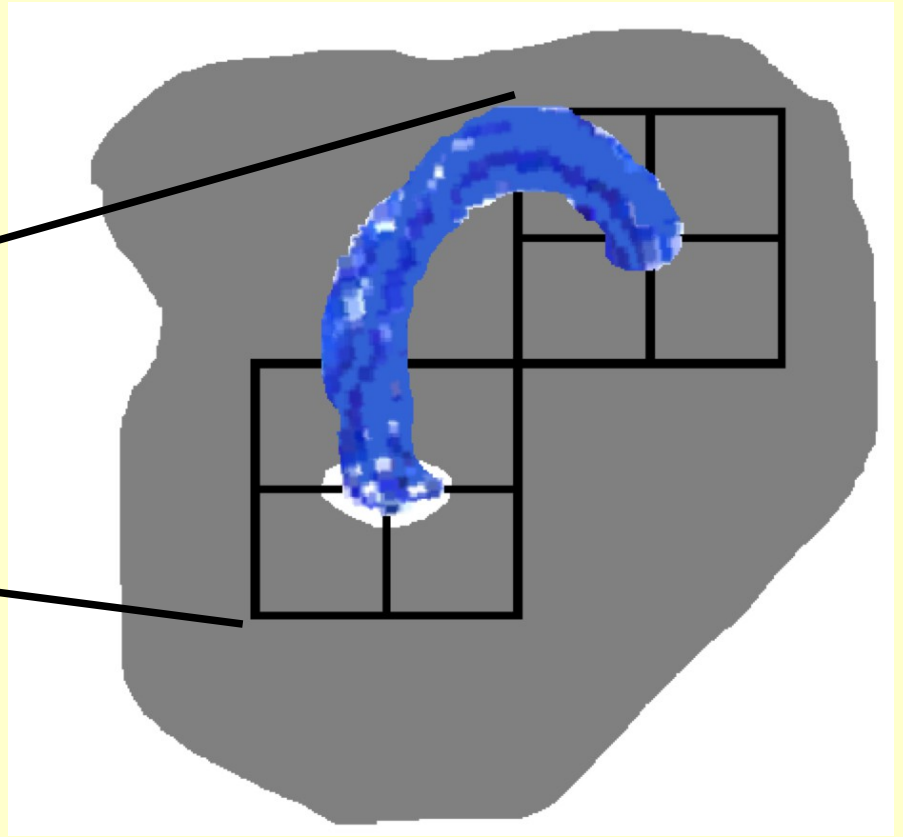
- Not necessary connceted to X-ray loops
- Hot coronal loop emerging from Hi-C structure

} check emission

Relation to photospheric magnetic field

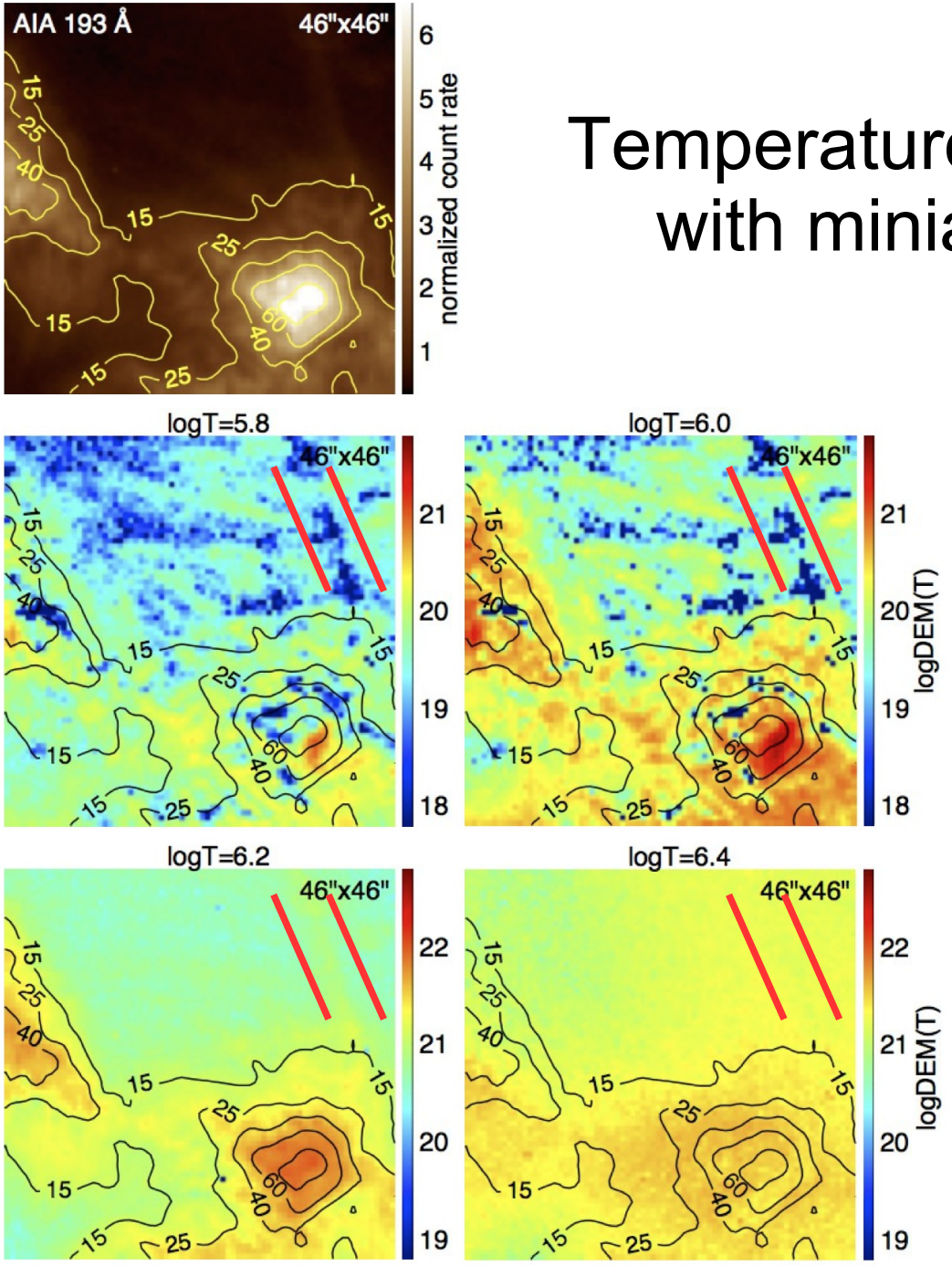
after extensive alignment
(better than approx. 0.5")





- strong Hi-C emission avoids magnetic concentration
- consistent with "hidden" opposite polarities at HMI resolution

Differential emission measure DEM(T)

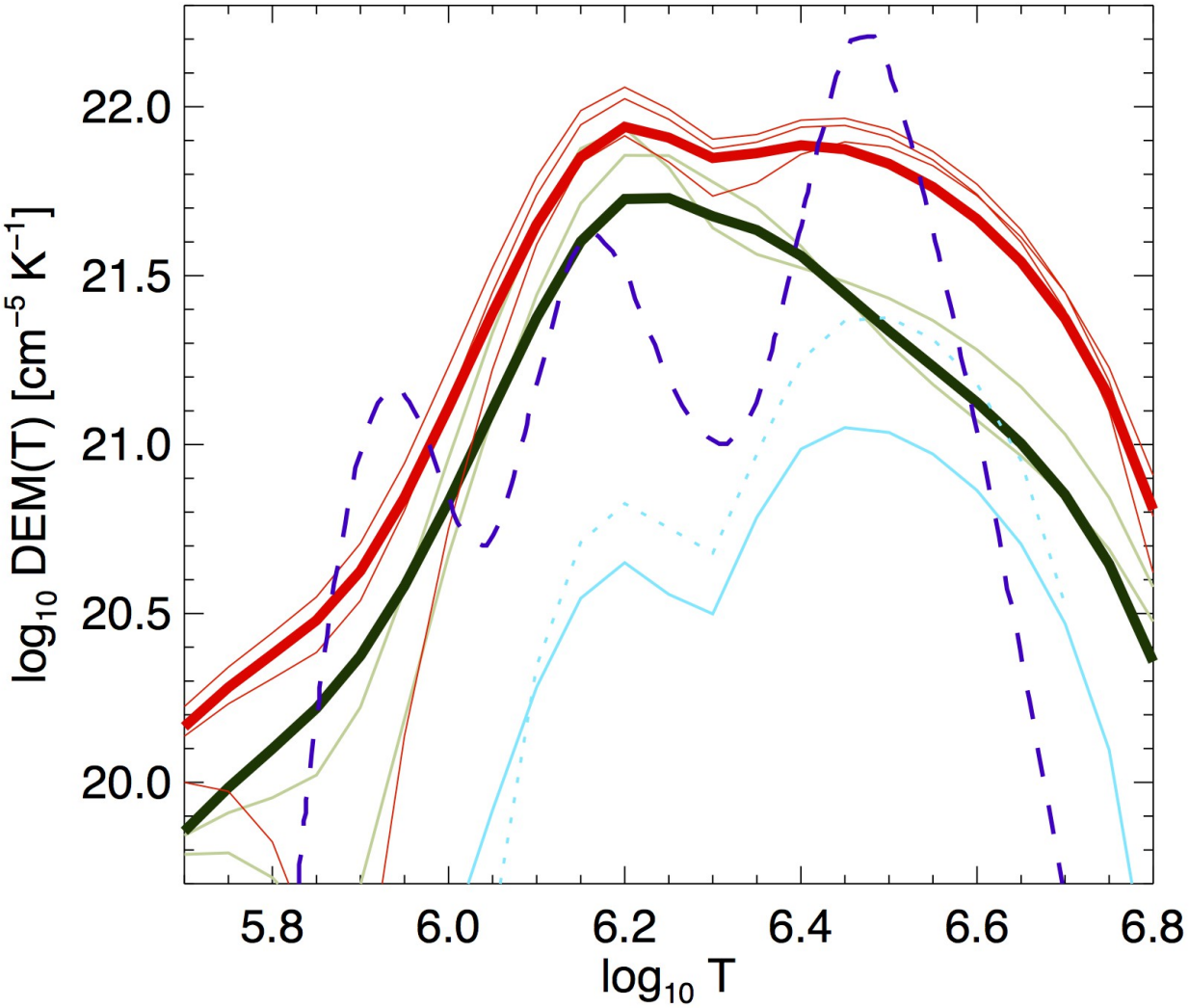


Temperature maps of the plage region with miniature-loop like structures

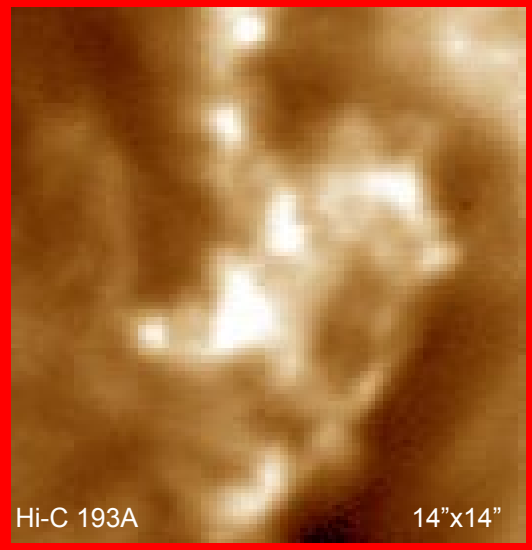
No signature of hot loop
(as in a moss-type scenario)
at the place where
a faint X-ray structure is visible

DEM calculated according
to Hannah & Kontar A&A 539, A146 2012

Differential emission measure DEM(T)

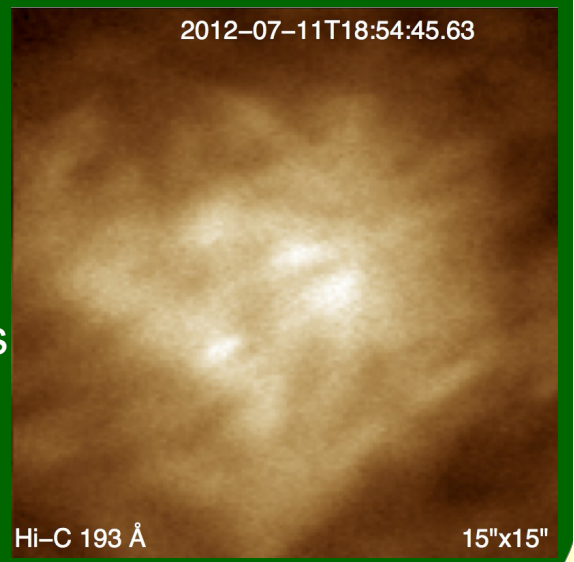


'moss'



Testa et al (2013) ApJ 770, 1

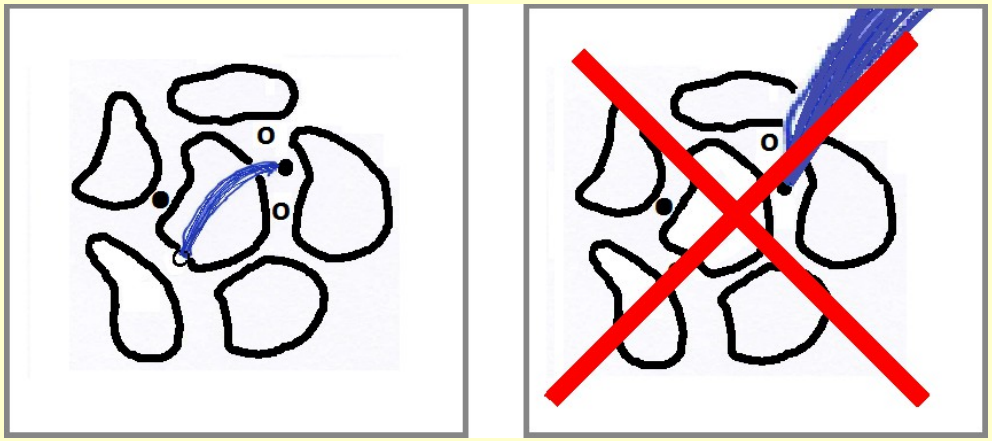
Miniature loop-like structures



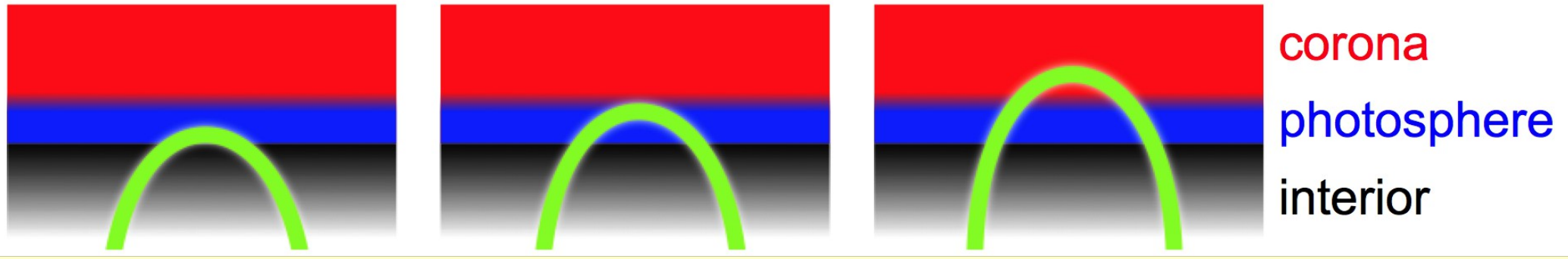
„quite area”

three DEMs components
(CH, QS, AR)
Landi et al ApJ, 672, 674

Conclusions



- miniature loop structures in plage areas are *not* moss emission (no hot loops)
- miniature loops might be related to flux tubes emerging through photosphere
- 3D models will have to show if small-scale flux emergence can produce such transient small hot loops



follow by Ishikawa et al. 2010

Thank you for your attention!

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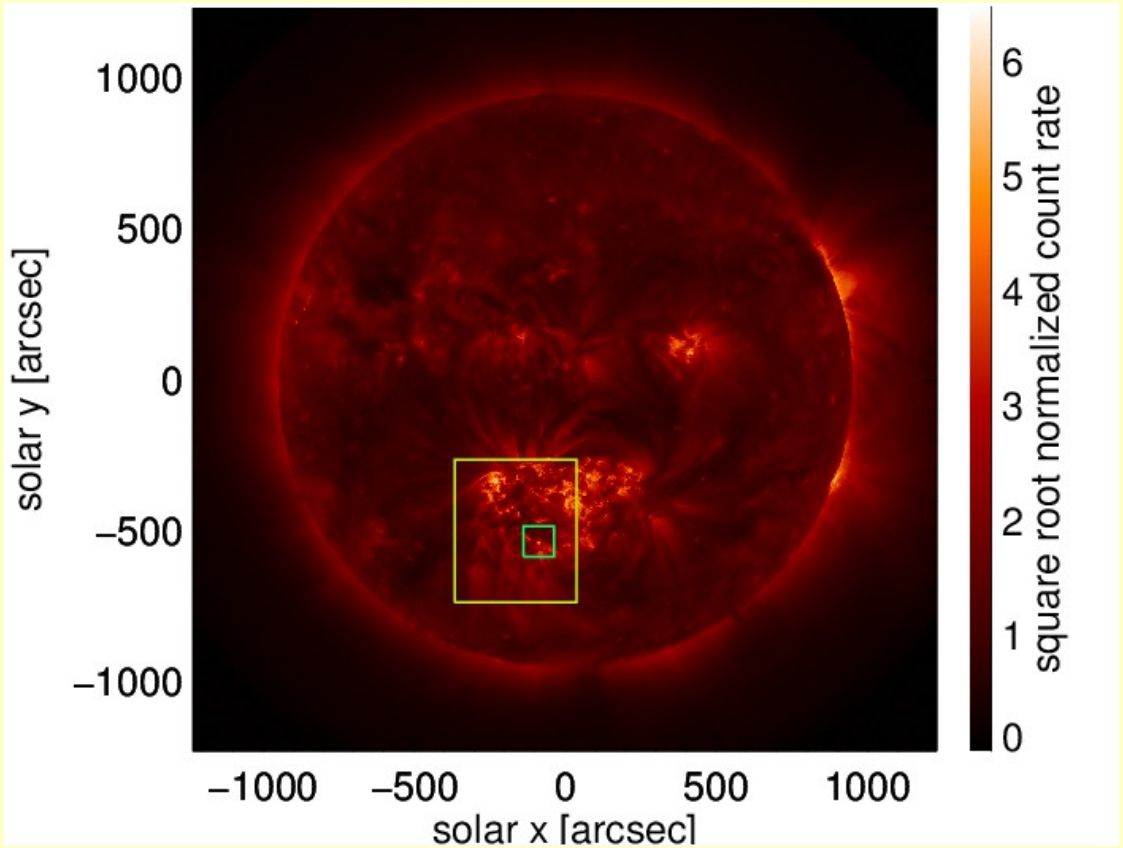
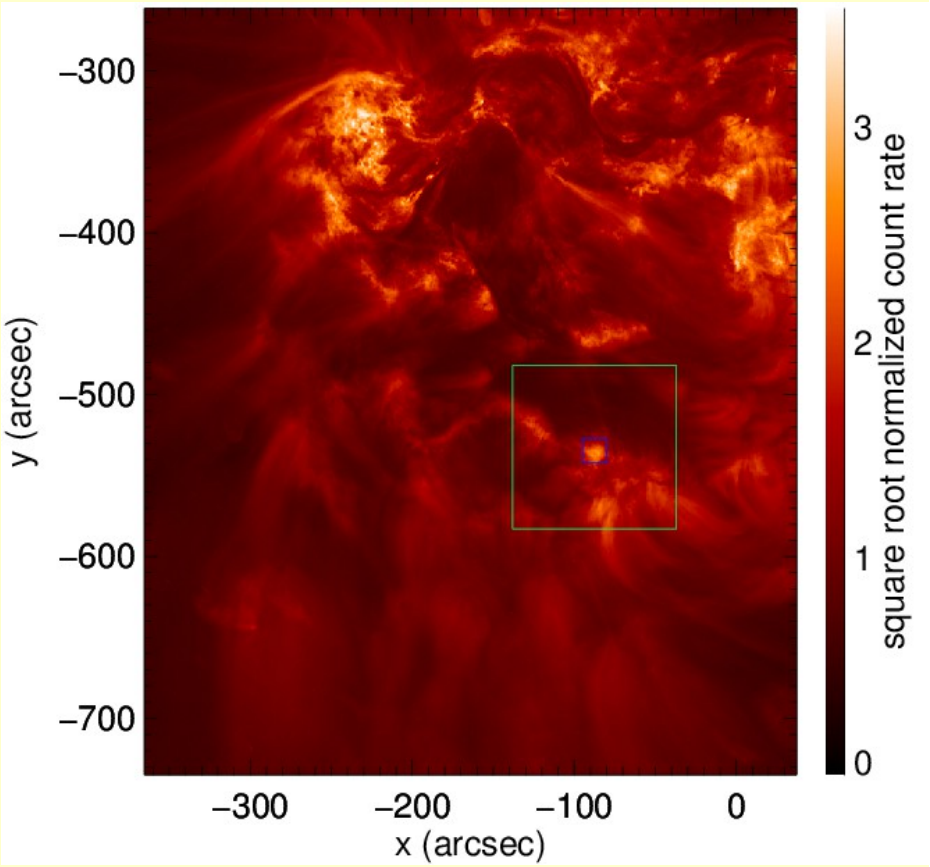
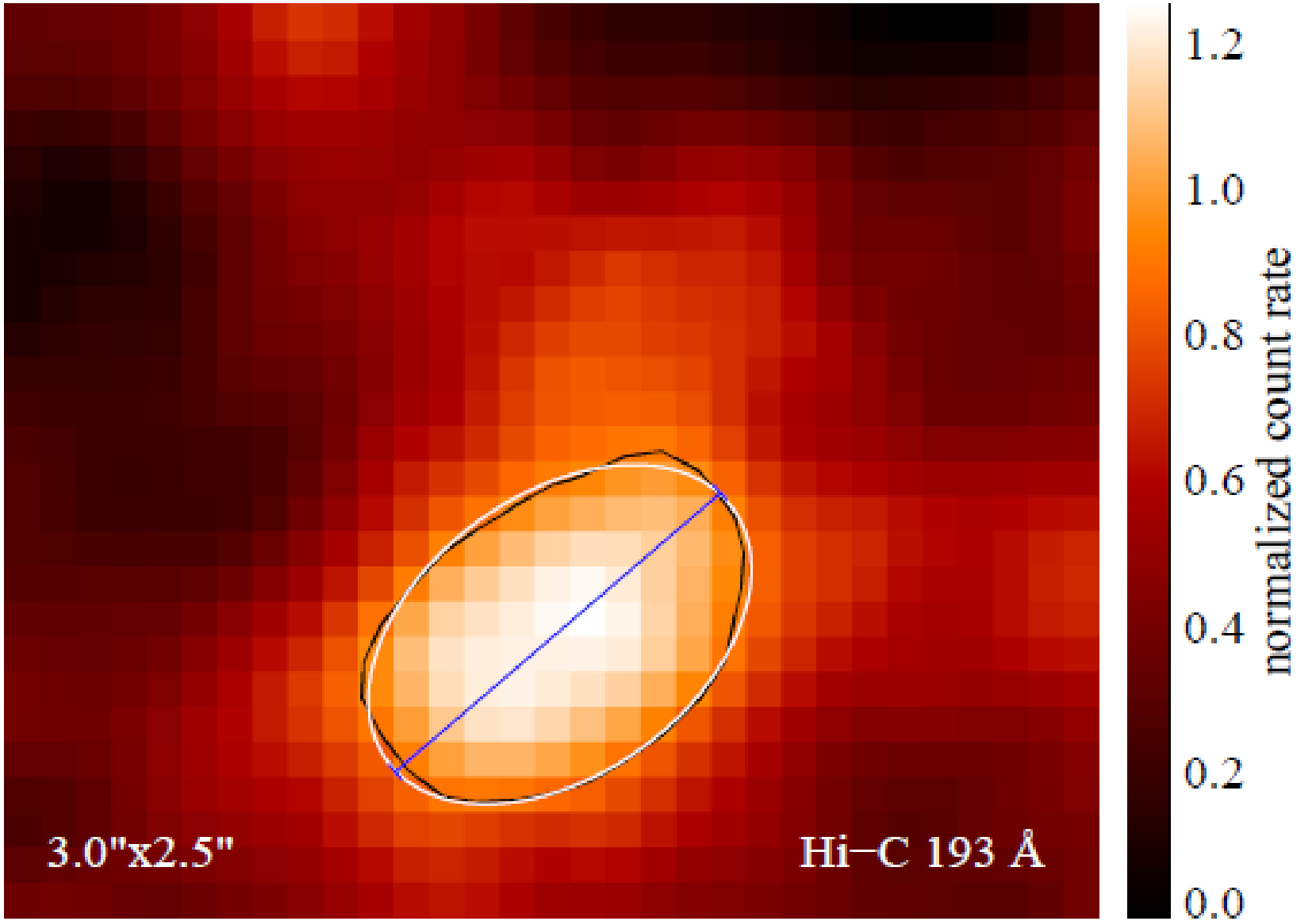
Appendix

ROI

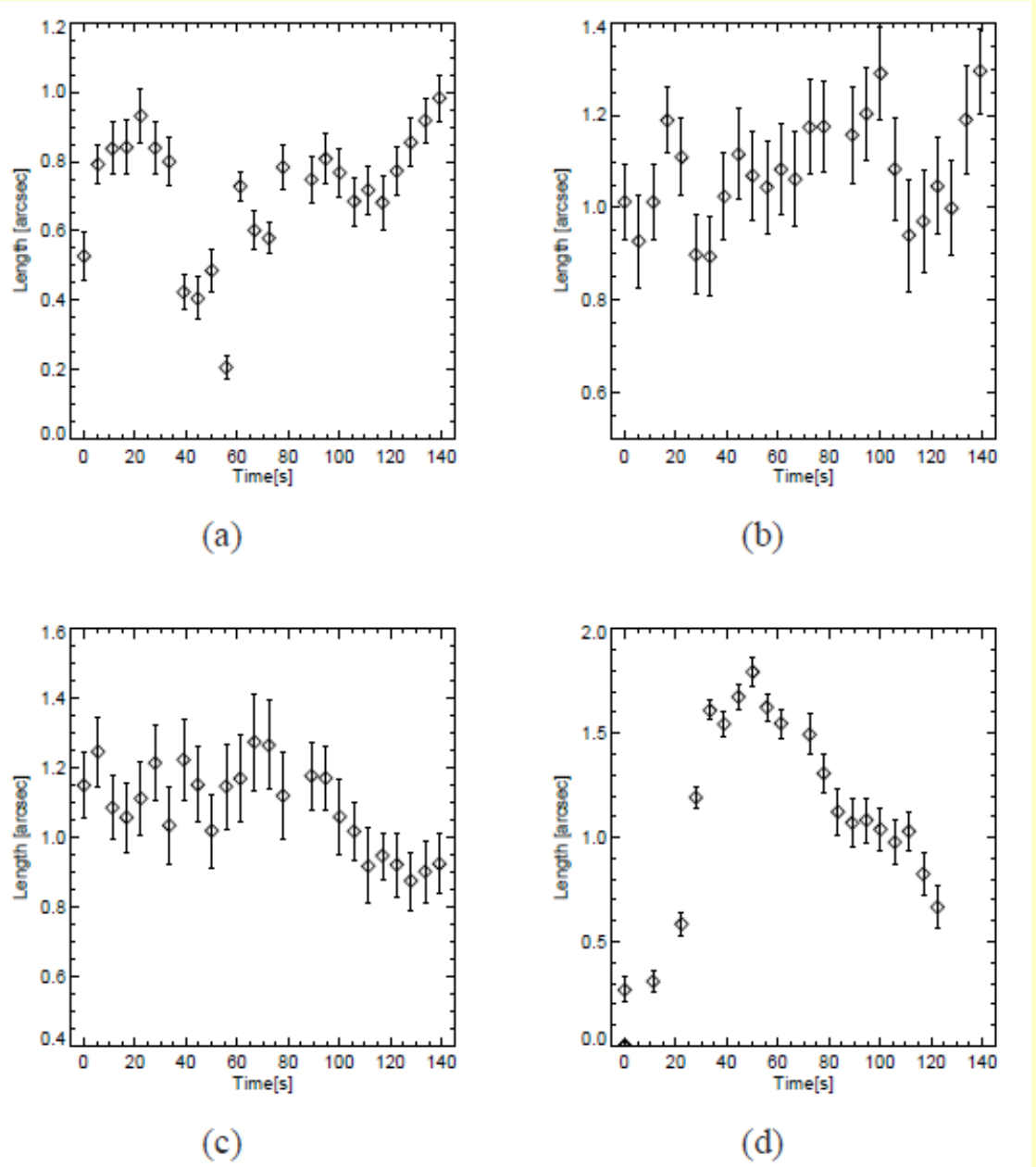

1000
500
0
−500
−1000
solar y [arcsec]
−1000
−500
0
500
1000
solar x [arcsec]
6
5
4
3
2
1
0
square root normalized count rate


−300
−400
−500
−600
−700
y (arcsec)
−300
−200
−100
0
x (arcsec)
3
2
1
0
square root normalized count rate

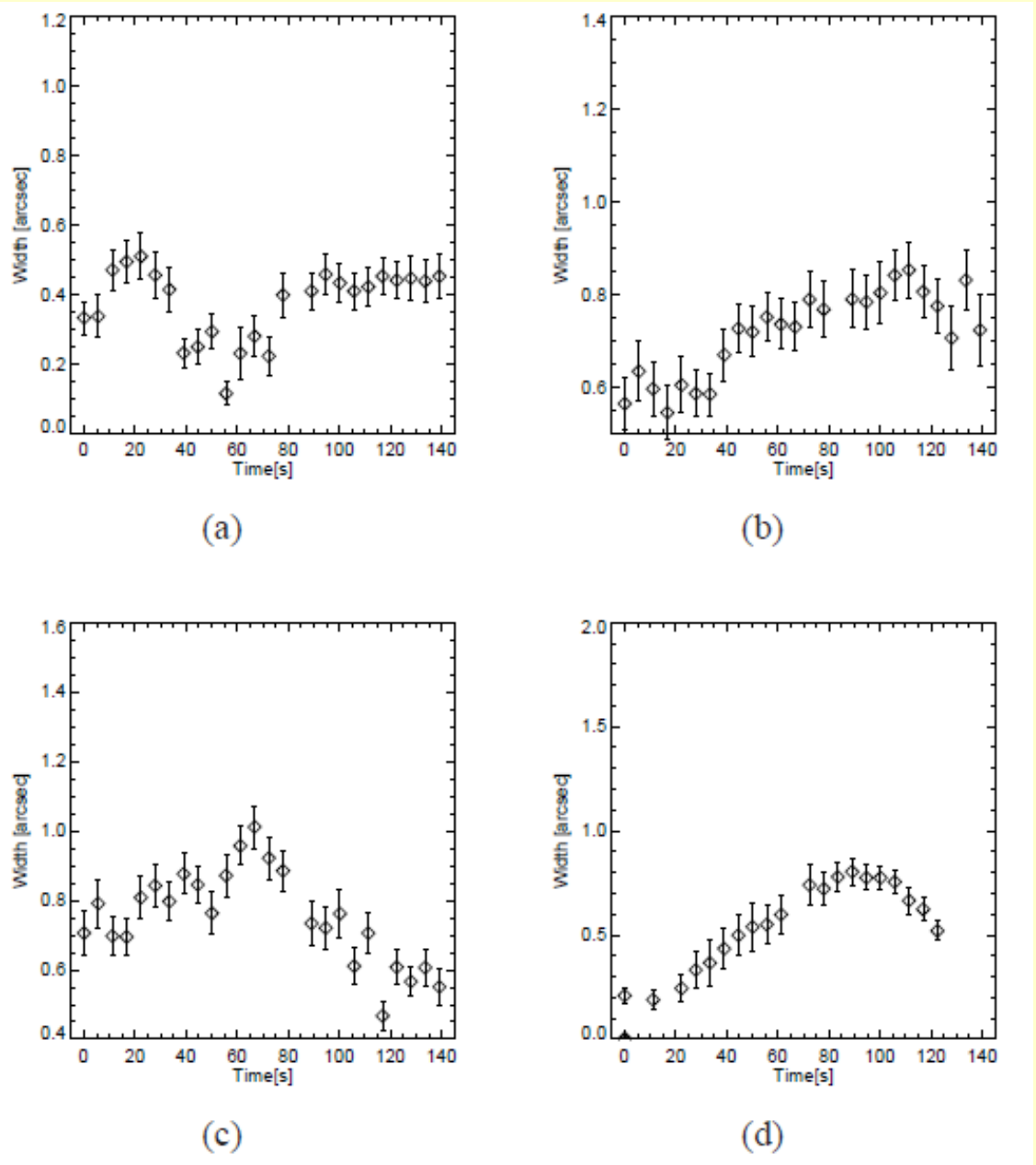
Ellipse fitting



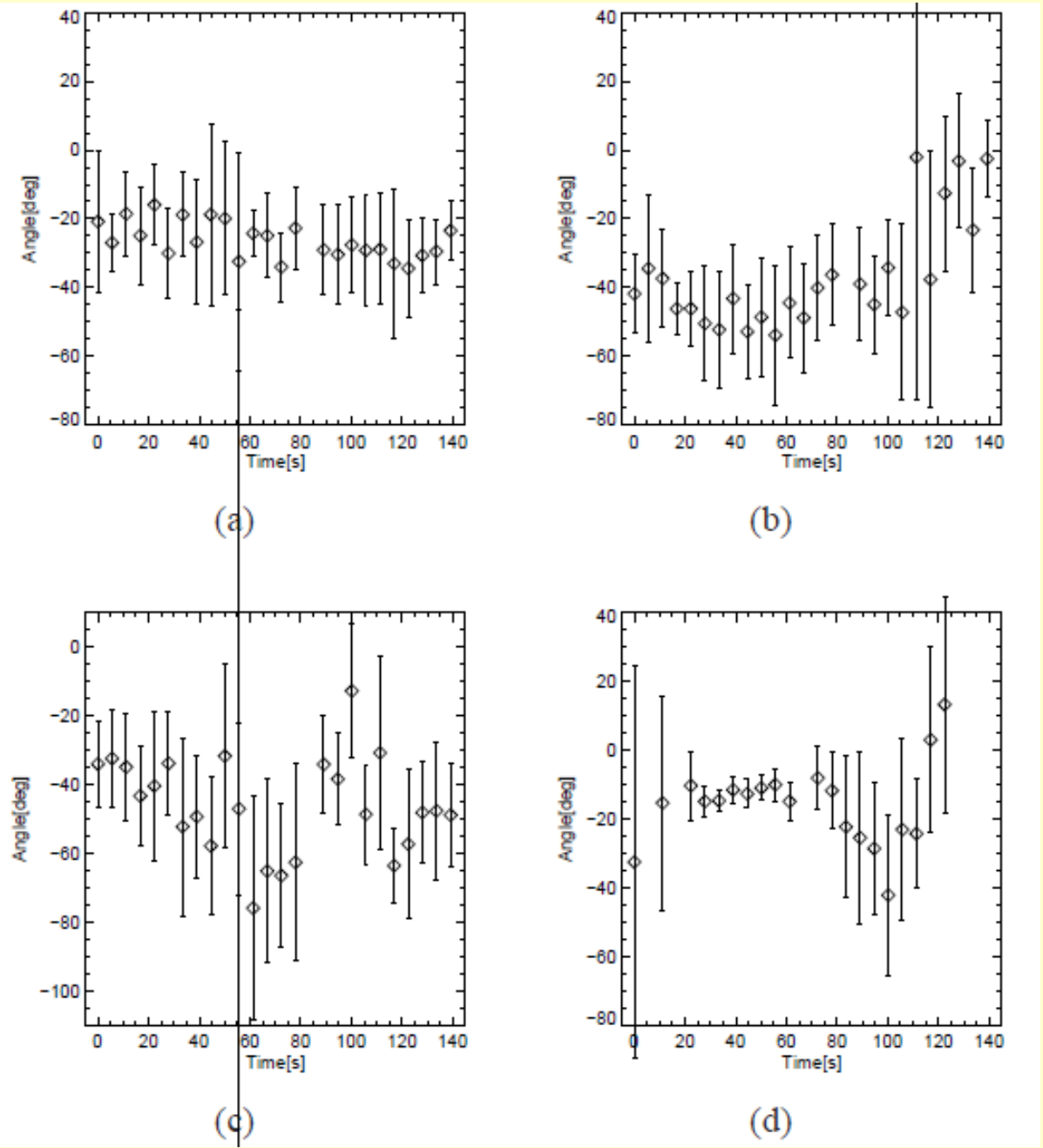
Length



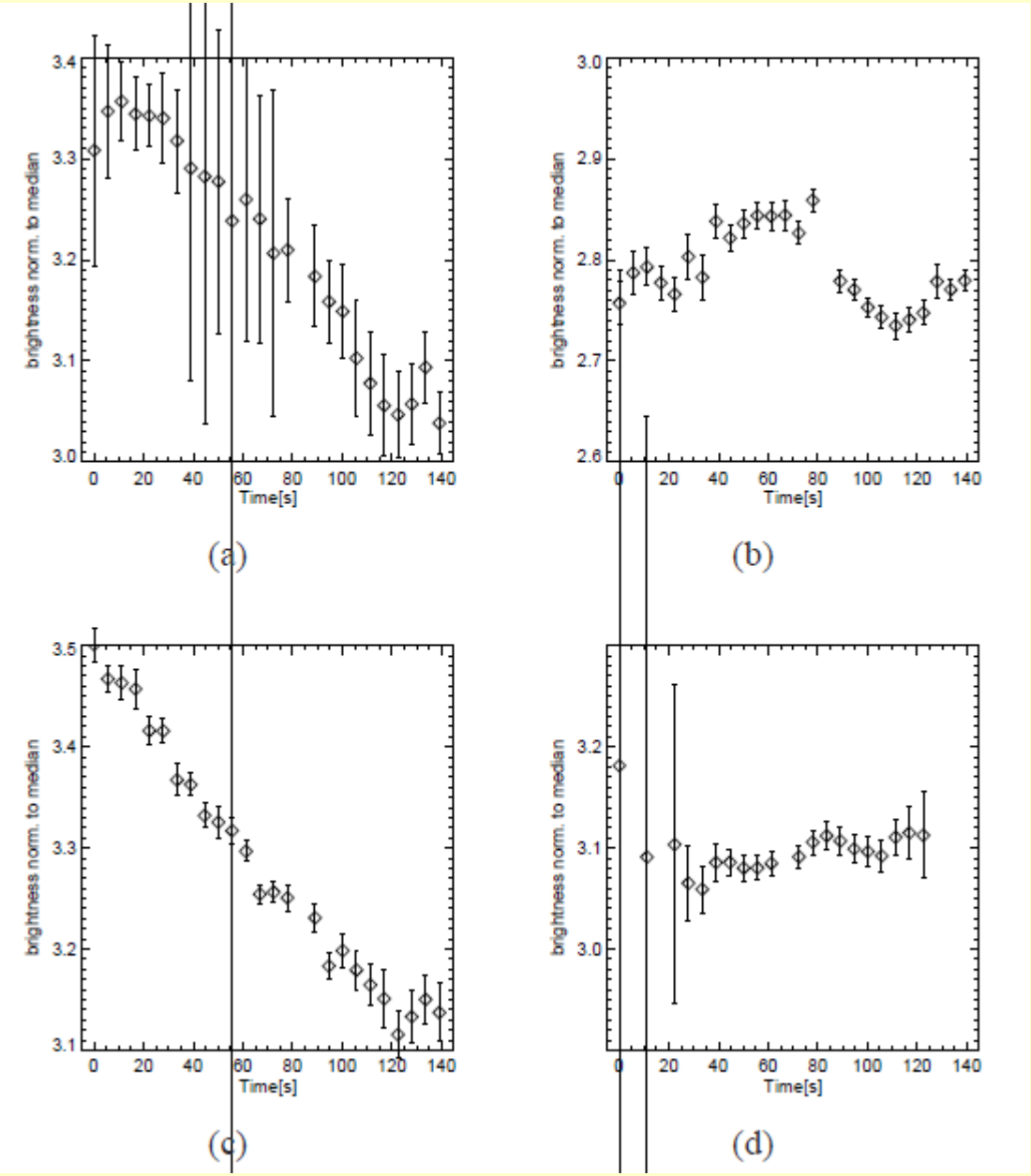
Width

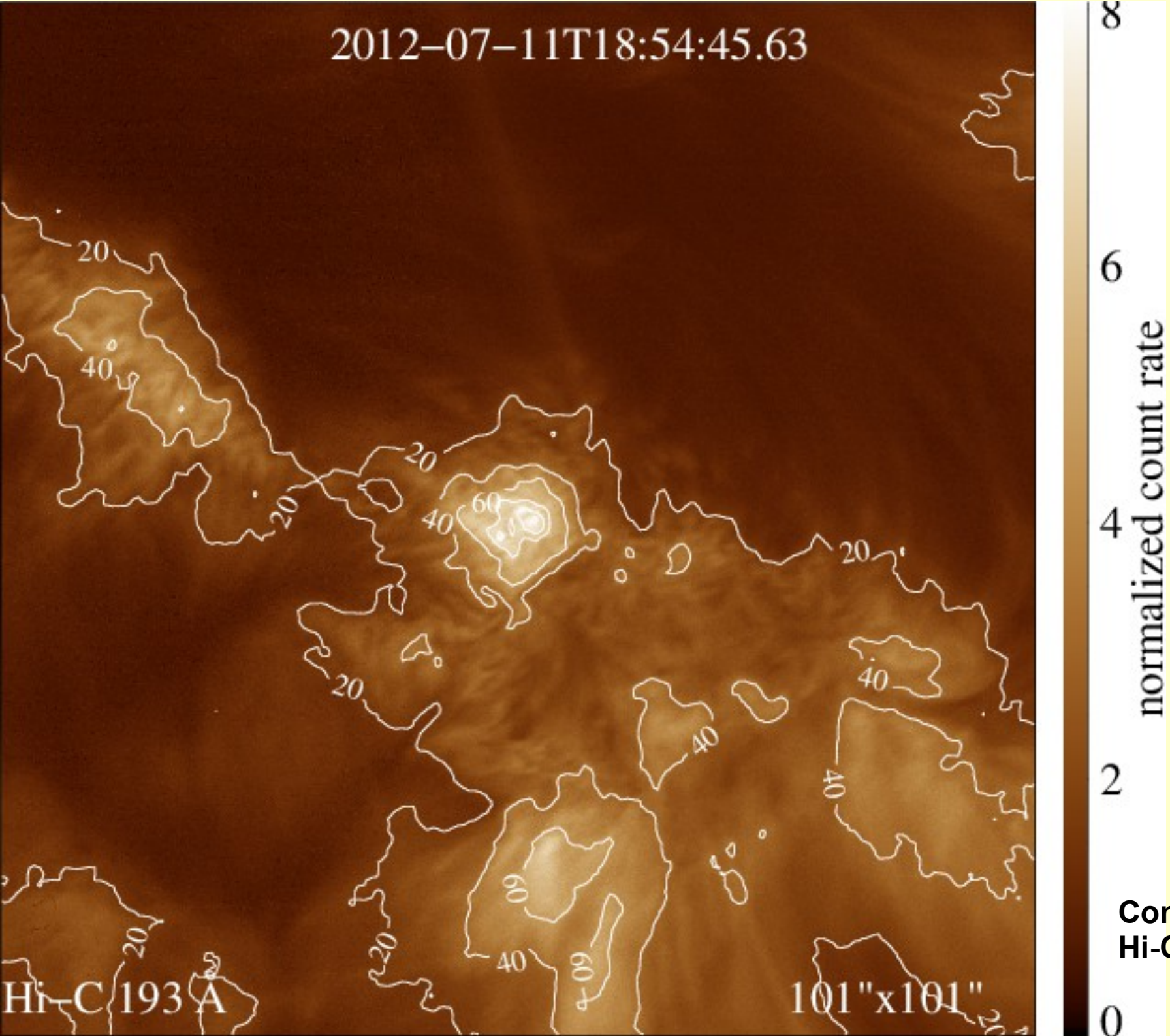


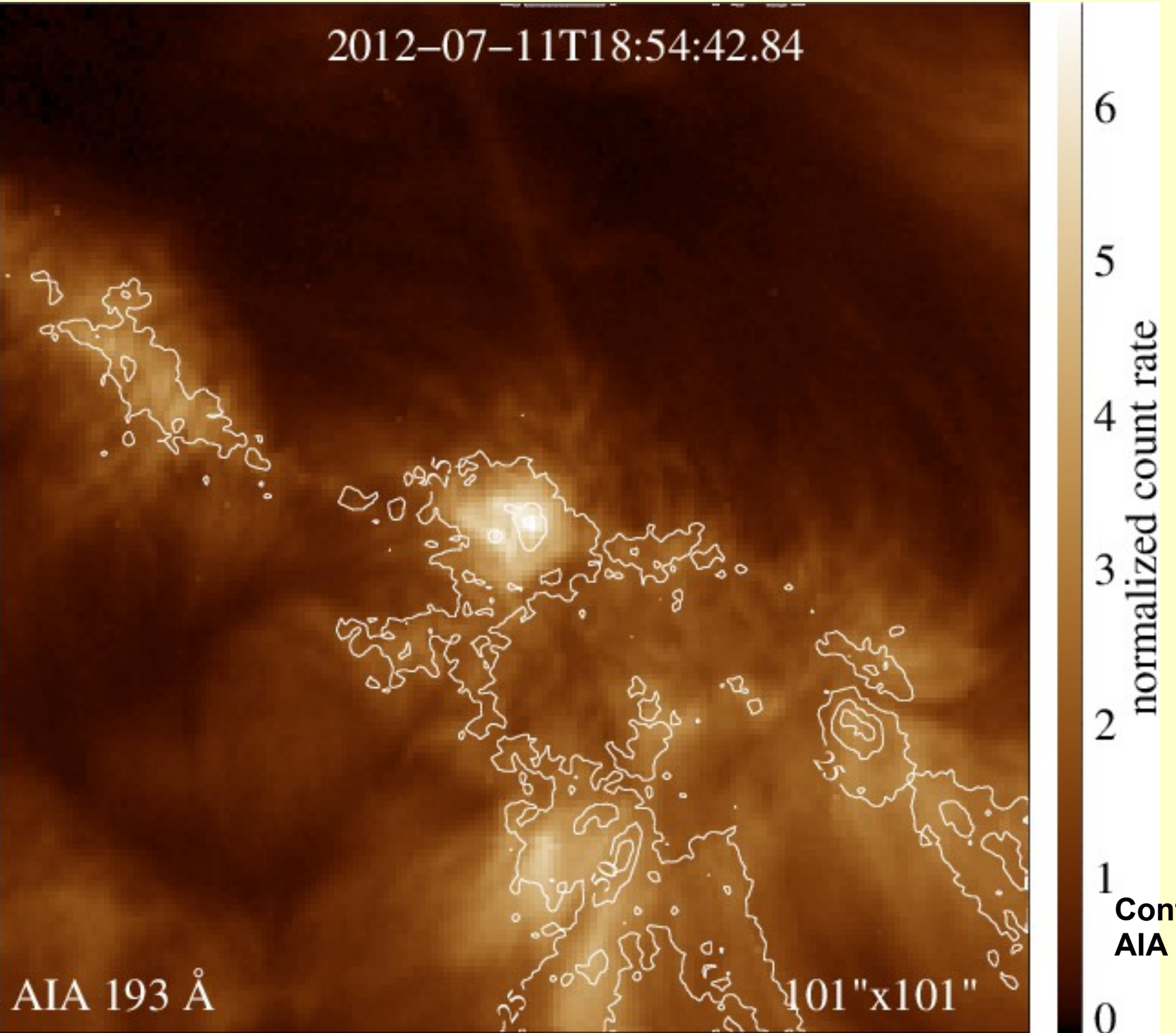
Angle



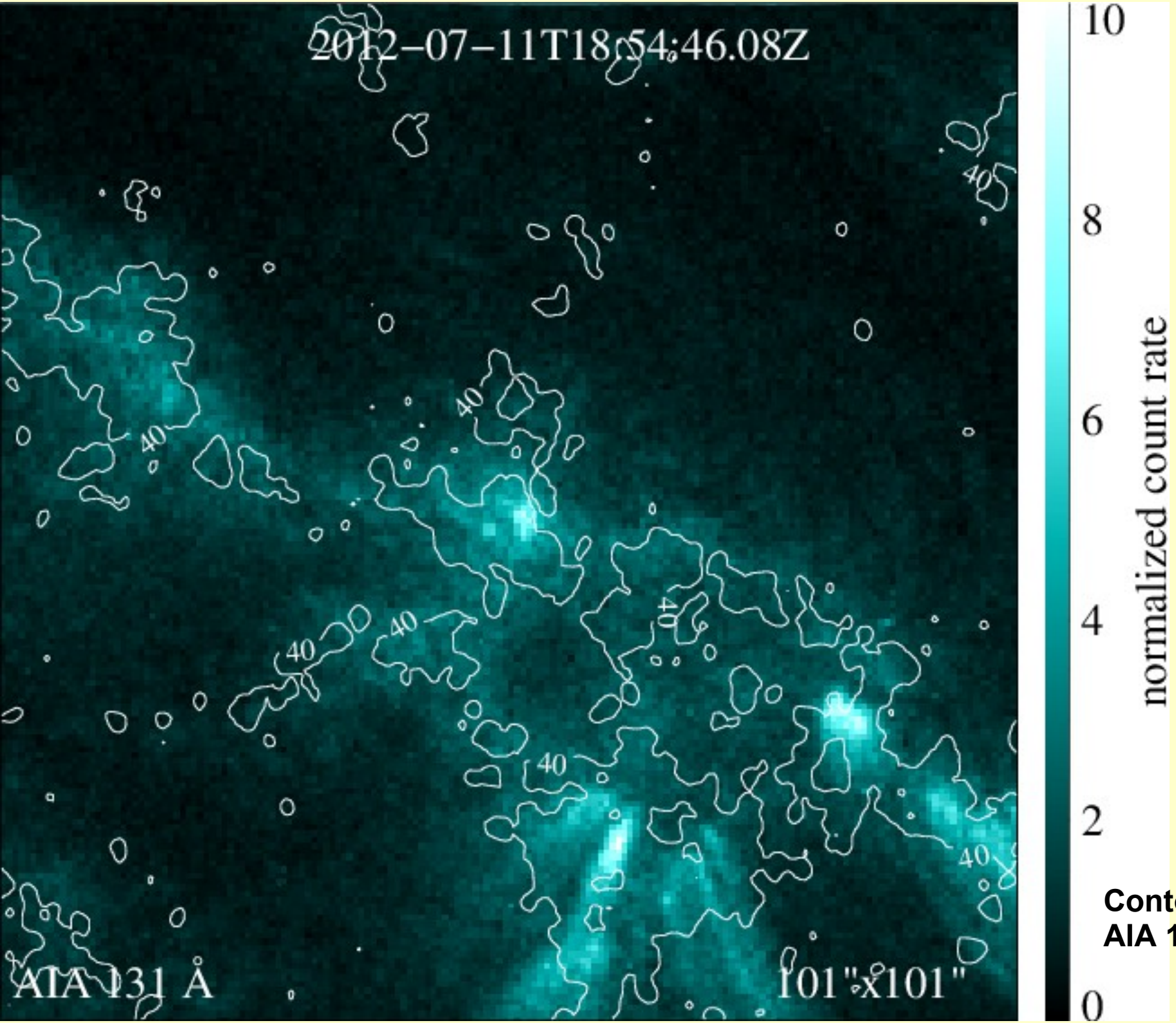
Brightness

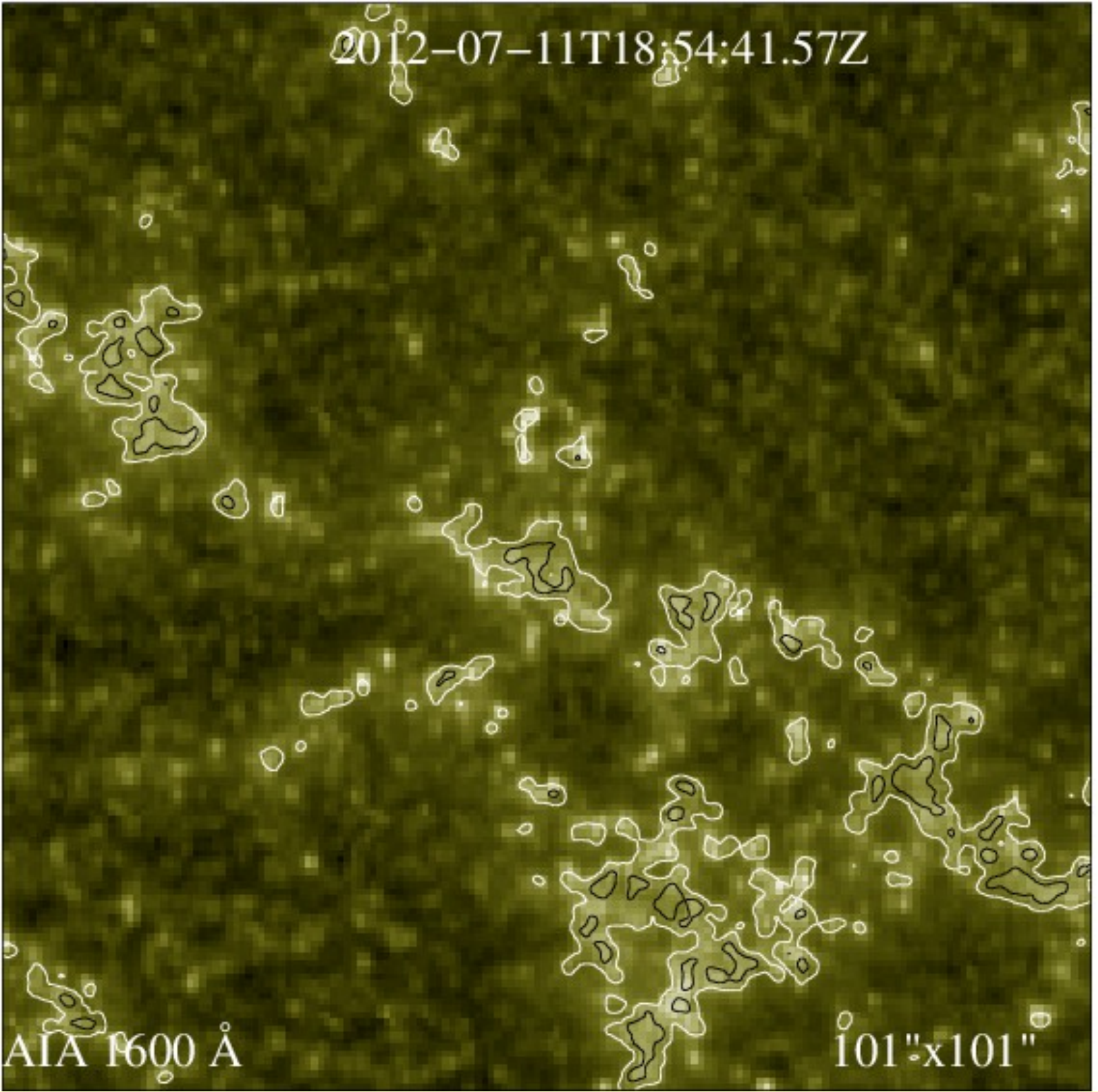



2012–07–11T18:54:45.63
20
40
20
20
60
40
20
20
40
40
40
60
20
40
60
20
Hi–C 193 Å
101"x101"
8
6
4
2
0
normalized count rate
Contour:
Hi-C



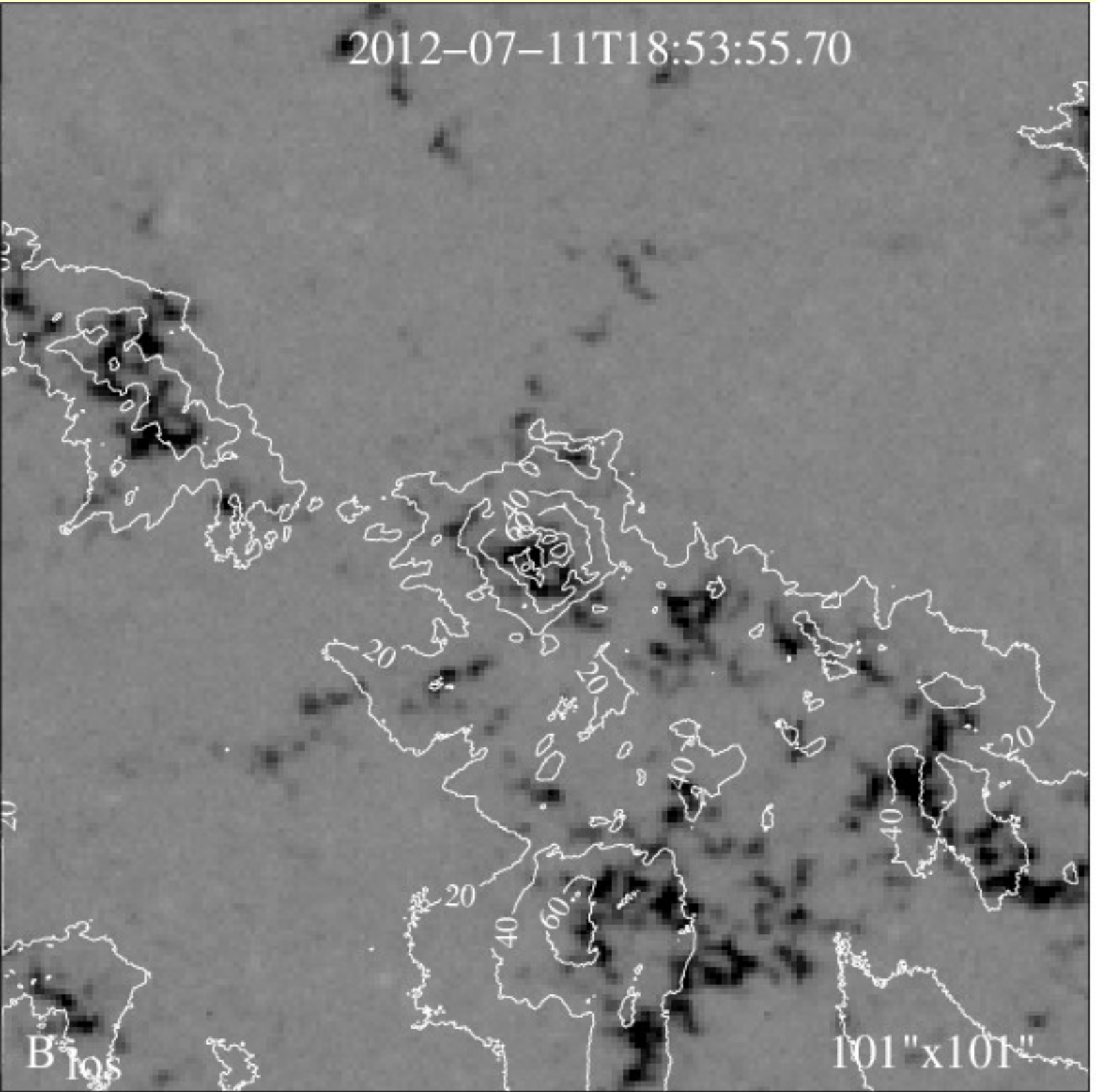
Contour: AIA 131


2012-07-11T18:54:46.08Z
40
AIA 131 Å
101"x101"
10
8
6
4
2
0
normalized count rate
Contour:
AIA 1600



Contour:
HMI

- **white: B=-300G**
- **black: B=-100G**


2012–07–11T18:53:55.70
20
20
20
40
40
60
B los
101"x101"


0
2
4
6
magnetic field [–100 G]

Contour: Hi-C

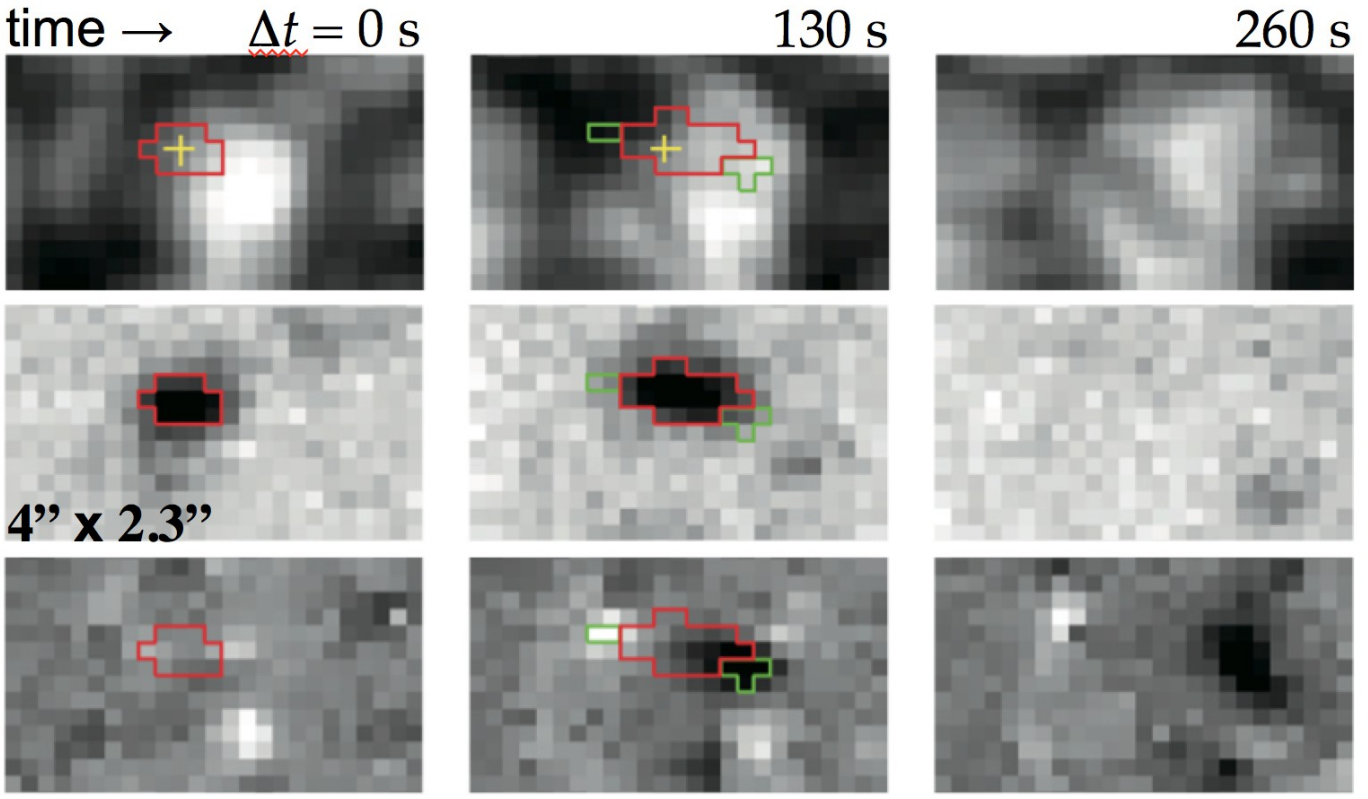
Observation of small "photospheric loops"

emerging flux in / around a granule

1- signal in lin. pol.

2- circ. pol. at sides

3- lin.pol. vanishes



Hinode/SOT
Ishikawa et al (2010) ApJ 713, 1310

consistent with flux tube breaking through photosphere