

# Chromospheric and Transition Region Dynamics as seen by IRIS

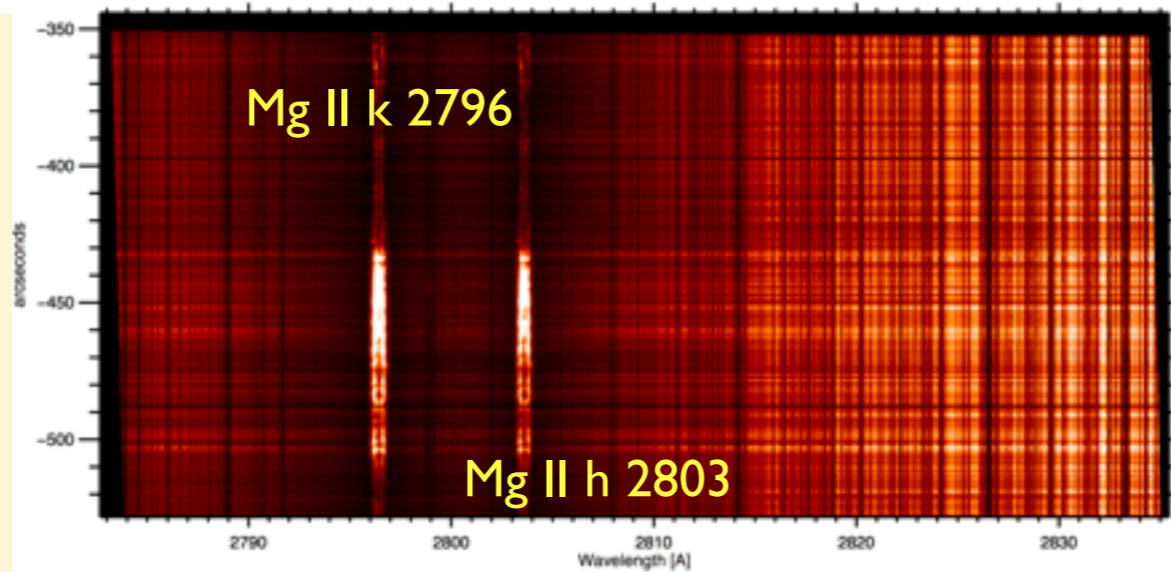
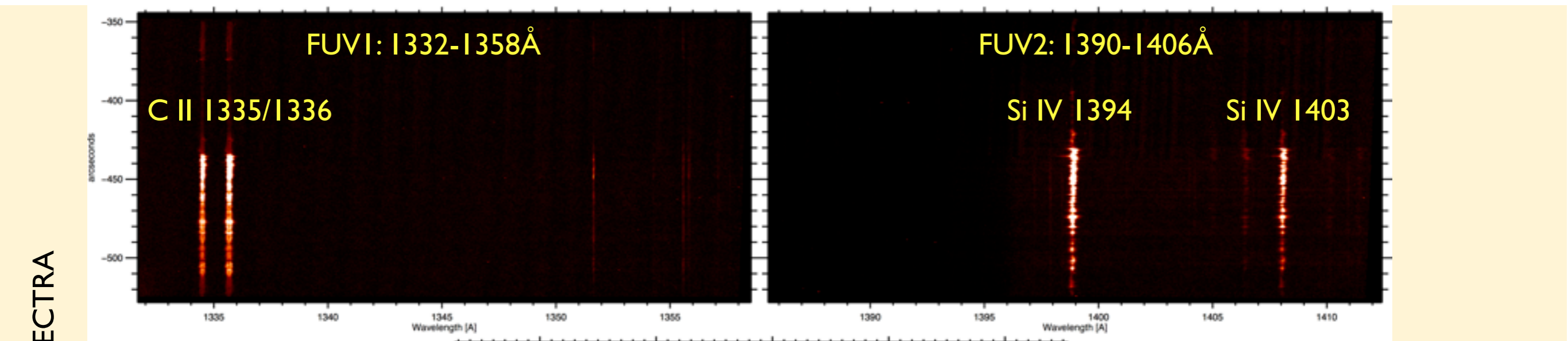
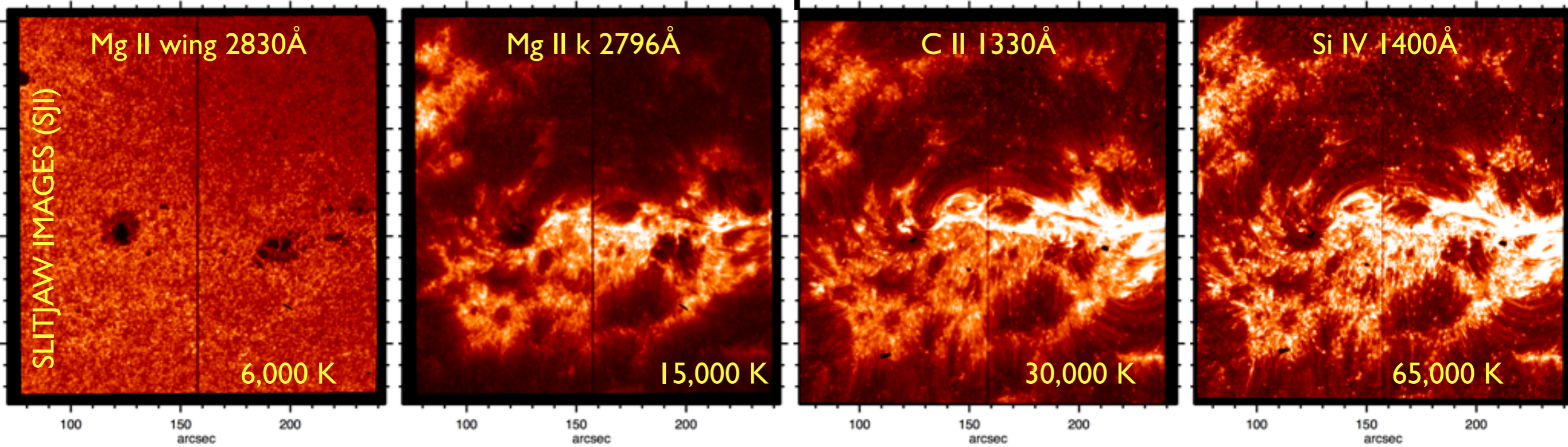


Bart De Pontieu and the IRIS team  
Lockheed Martin Solar & Astrophysics Laboratory

# IRIS events



# IRIS data products



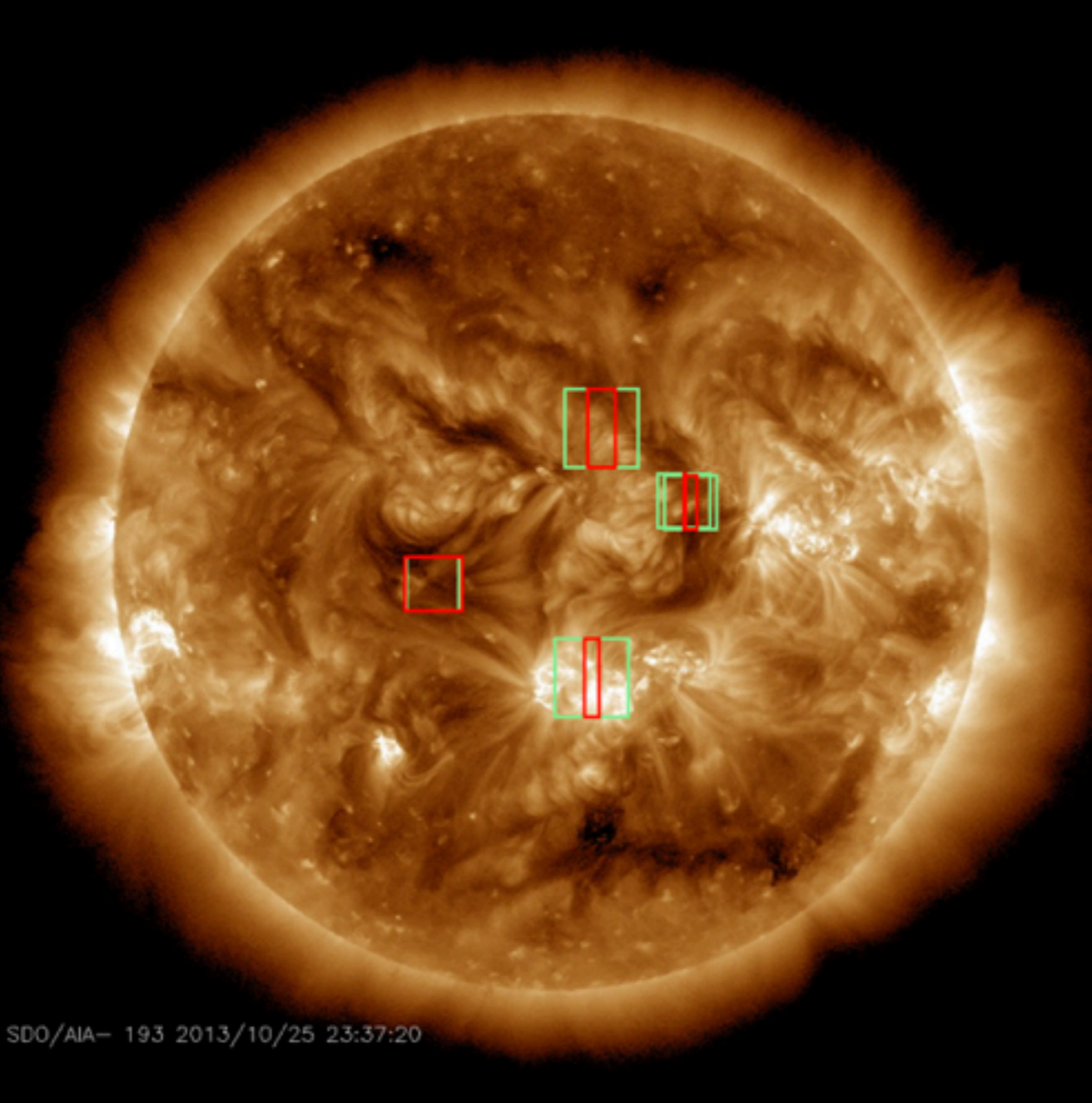
# IRIS recent observations

<http://iris.lmsal.com/iristoday>

x
INTERFACE REGION IMAGING SPECTROGRAPH  
IRIS TODAY

Start  End 

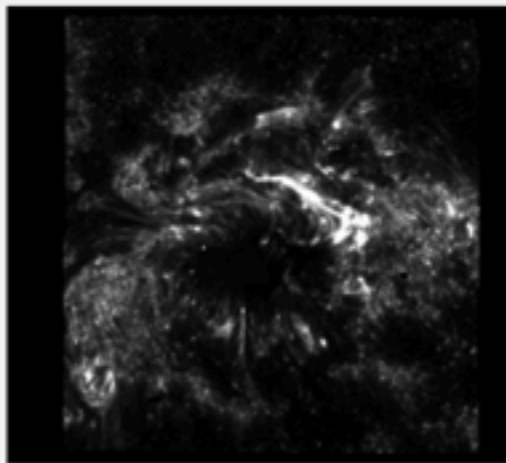
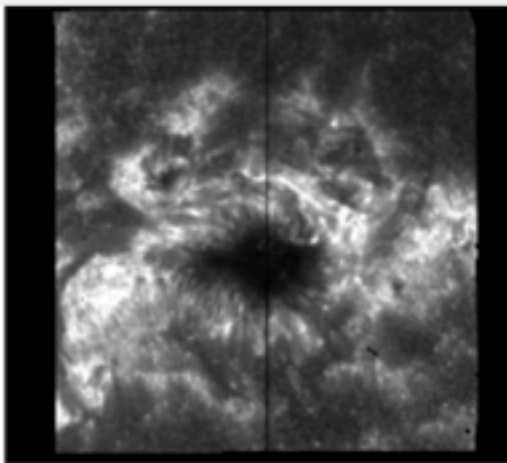
Boxes



SDO/AIA— 193 2013/10/25 23:37:20

Full-frame sunspot spectrum

OBS 3880013447: Dense synoptic raster  
2013-10-25 05:05:30-05:56:51

1400: 64s, 48 imgs	2796: 64s, 47 imgs
	

Where	Data Links
x,y: 95°,-280° Max FOV: 199"x174" Target: AR	Not yet available
Raster	SJI wave: cadence, # images
FOV: 33"x174" Steps: 96x0.35" Step Cad: 32.1s Raster Cad: 3,049s, 1 ras Linelist: v38_04	FOV: 166"x174"  1400: 64s, 48 imgs 2796: 64s, 47 imgs

# IRIS data search

<http://iris.lmsal.com/search>

INTERFACE REGION IMAGING SPECTROGRAPH  
IRIS DATA SEARCH [Help](#)

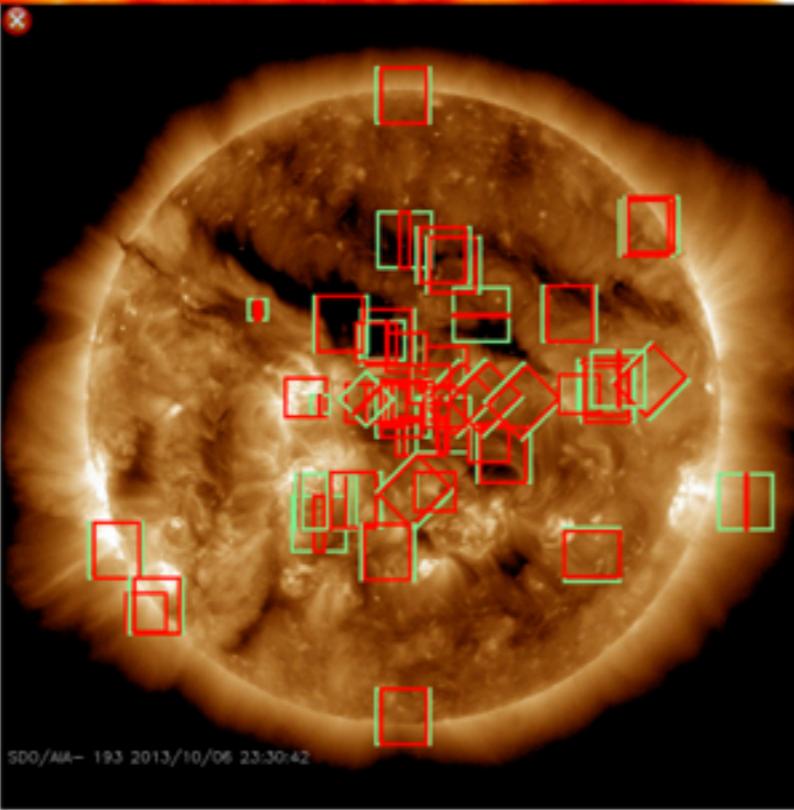
<< < Start > >>    << < End > >>  
2013-10-06T12:00    2013-10-21T12:00

min Raster max    min SJI max  
FOV X    FOV X  
FOV Y    FOV Y  
Count    Cadence  
Cdnce    1330  
Raster Step    1400  
Count    2796  
Size    2832  
Cdnce

Exposure Time    Target  
Min Exp    XCEN  
Exp Time    YCEN  
Radius  
OBSID:   
Target:

Spectral Lines

Count: 56    Search    Reset    193     Boxes  
 Only OBS with data



SDO/AIA - 193 2013/10/06 23:30:42

Time	Goal	OBS Desc.	X,Y	RX	RY	Raster Cad	Step Cad	Fast SJI	OBSID
2013-10-19 04:20-04:38	Throughput monitoring	Large coarse 64-step raster	43°,-91°	127°	119°	1082s	17s	1330: 68s	3882010144
2013-10-19 05:10-08:42	Prominence at E-limb	Very large dense raster	-875°,-442°	141°	174°	12674s	32s	1400: 64s	3820013446
2013-10-19 17:55-18:56	Context raster of AR11871	Very large dense raster	-45°,212°	141°	174°	3629s	9s	1400: 18s	3820009446
2013-10-19 22:40-23:31	Full-frame reference spectrum of AR	Dense synoptic raster	-256°,-359°	33°	174°	3049s	32s	1400: 64s	3880013447
2013-10-19 19:29-20:41	Moss of AR11871	Large sit-and-stare	-55°,206°	0°	119°	5s	5s	1400: 11s	3820007403
2013-10-17 04:20-04:38	Throughput monitoring	Large coarse 64-step raster	0°,-2°	127°	119°	1082s	17s	1330: 68s	3882010144
2013-10-17 18:40-19:31	Full-frame spectra of quiet Sun	Dense synoptic raster	127°,-54°	33°	174°	3049s	32s	1400: 64s	3880013447
2013-10-17 20:20-21:11	Full-frame spectra of coronal hole	Dense synoptic raster	4°,509°	33°	174°	2757s	32s	1400: 64s	3880013447
2013-10-18 04:20-04:38	Throughput monitoring	Large coarse 64-step raster	72°,-94°	127°	119°	1082s	17s	1330: 68s	3882010144
2013-10-17 07:15-10:47	Context raster of AR 11865	Very large dense raster	576°,-454°	141°	174°	12674s	32s	1400: 64s	3820013446

Overview	Where	Raster	SJI wavelength: cadence, no. of images	Data Links
<p>2013-10-19 19:29:30-20:41:17</p> 	<p><b>Moss of AR11871</b> OBS 3820007403: Large sit-and-stare</p> <p>x,y: -55°,206° Max FOV: 118°x119° Target: AR</p>	<p>FOV: 0°x119° Steps: 800x0° Step Cad: 5.4s Raster Cad: 5s, 1 ras Linelist: v38_01</p>	<p>FOV: 118°x119° 1400: 11s, 391 imgs 2796: 11s, 394 imgs</p>	<p><a href="#">Raster</a> 1430 MB <a href="#">1400</a> 258 MB <a href="#">2796</a> 252 MB</p>

# IRIS documentation

<http://iris.lmsal.com/documents.html>

**INTERFACE REGION IMAGING SPECTROGRAPH**

Home | Mission | Operations | Data | Analysis | Modeling | **Documents** | Software | Team | Press | Contact

**Operations/Planning**

- [ITN 1 - IRIS Operations Overview](#)
- [ITN 2 - Manual for Table Creator](#)
- [ITN 3 - Manual for Timeline Tool](#)
- [ITN 4 - Manual for Synthetic Observations Tool](#)
- [ITN 5 - Operations Under Roll Conditions](#)
- [ITN 6 - AEC Operations](#)
- [ITN 7 - Compression Approach](#)
- [ITN 8 - Checklist for IRIS planner](#)
- [ITN 9 - Periodic Calibration Activities](#)

**Data Flow**

- [ITN 10 - General Approach to Data Flow and Archiving](#)
- [ITN 11 - Definition of Data Levels](#)
- [ITN 12 - Definition of Keywords](#)
- [ITN 13 - VSO and IRIS](#)

**Calibration**

- [ITN 14 - Dark Current/Offset](#)
- [ITN 15 - Despiking](#)
- [ITN 16 - Flat-field](#)
- [ITN 19 - Geometric Calibration](#)
- [ITN 20 - Wavelength Calibration](#)
- [ITN 21 - Recasting into Level 2/3 Data](#)
- [ITN 22 - Co-alignment, Plate Scale Analysis](#)
- [ITN 23 - MTF/PSF Determination](#)
- [ITN 24 - Stellar Calibration](#)
- [ITN 25 - Gain Determination](#)

**Data Analysis**

- [ITN 26 - User Guide To Data Analysis](#)
- [ITN 27 - Quicklook Tools Manual](#)
- [ITN 28 - IRIS IDL Data Structure](#)
- [ITN 29 - Deconvolution Approach](#)
- [ITN 30 - 60 Day Observing Plan](#)
- [ITN 31 - IRIS science planning: tables, linelists, targets SolarSoft Tree and UVSP Database](#)

**Numerical Modeling**

- [ITN 33 - General Overview of Numerical Simulations](#)
- [ITN 34 - Numerical Simulations Quicklook Tools](#)
- [ITN 35 - Numerical Simulations Synthetic Observables](#)
- [ITN 36 - RH 1.5 D Manual](#)
- [ITN 37 - How to Derive Physical Information from Mg II h/k](#)

**IRIS Technical Notes List (ITN)**

**Talks & Posters**

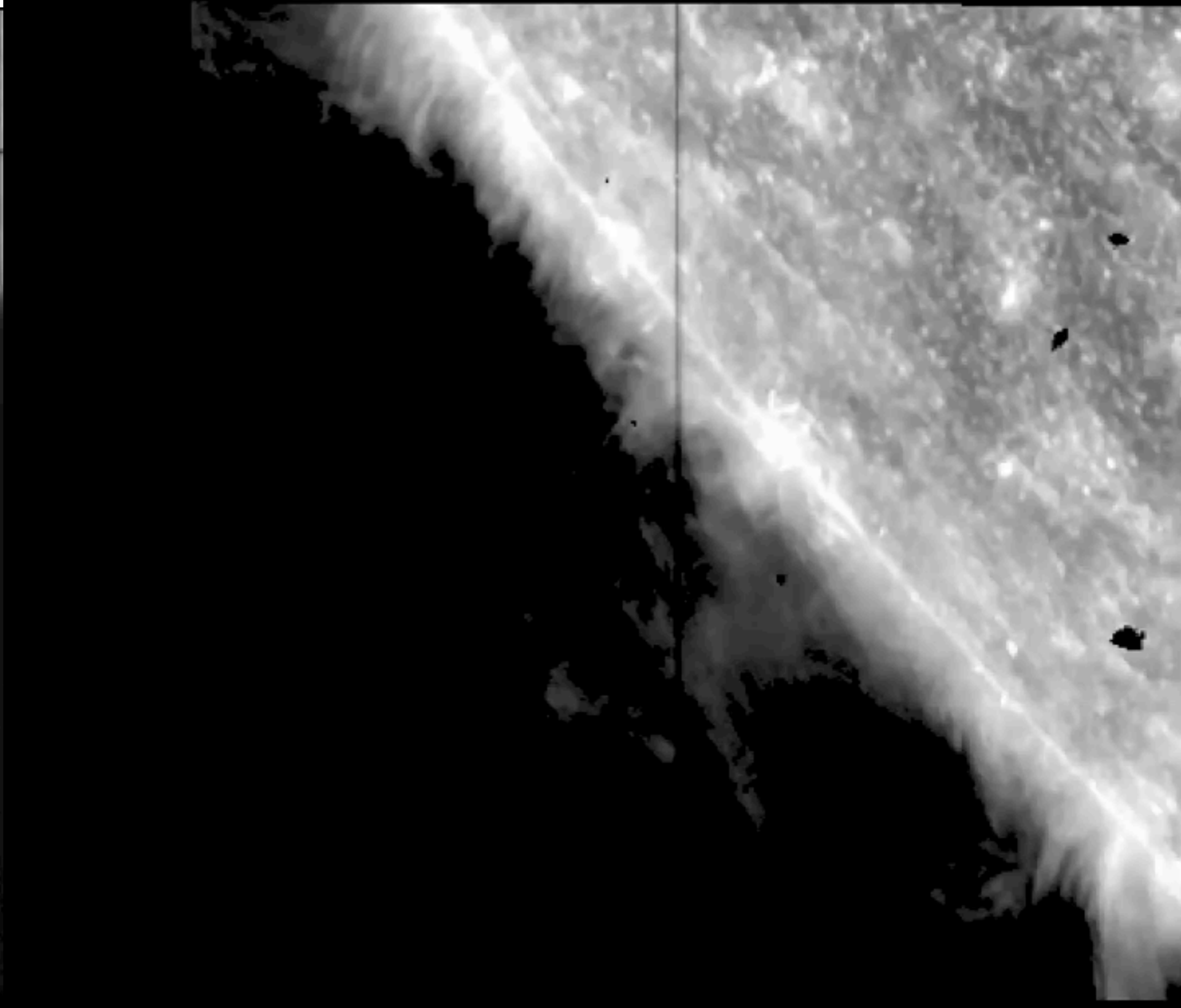
- [Invited Talks at the SDO-4/IRIS/Hinode Workshop - March 2012](#)
- [IRIS Talk Hinode 5 Meeting Keynote \(430 MB\) PDF \(36 MB\)](#)
- [IRIS Poster](#)
- [FUV Camera View](#)
- [NUV Camera View](#)

**Concept Study Report**

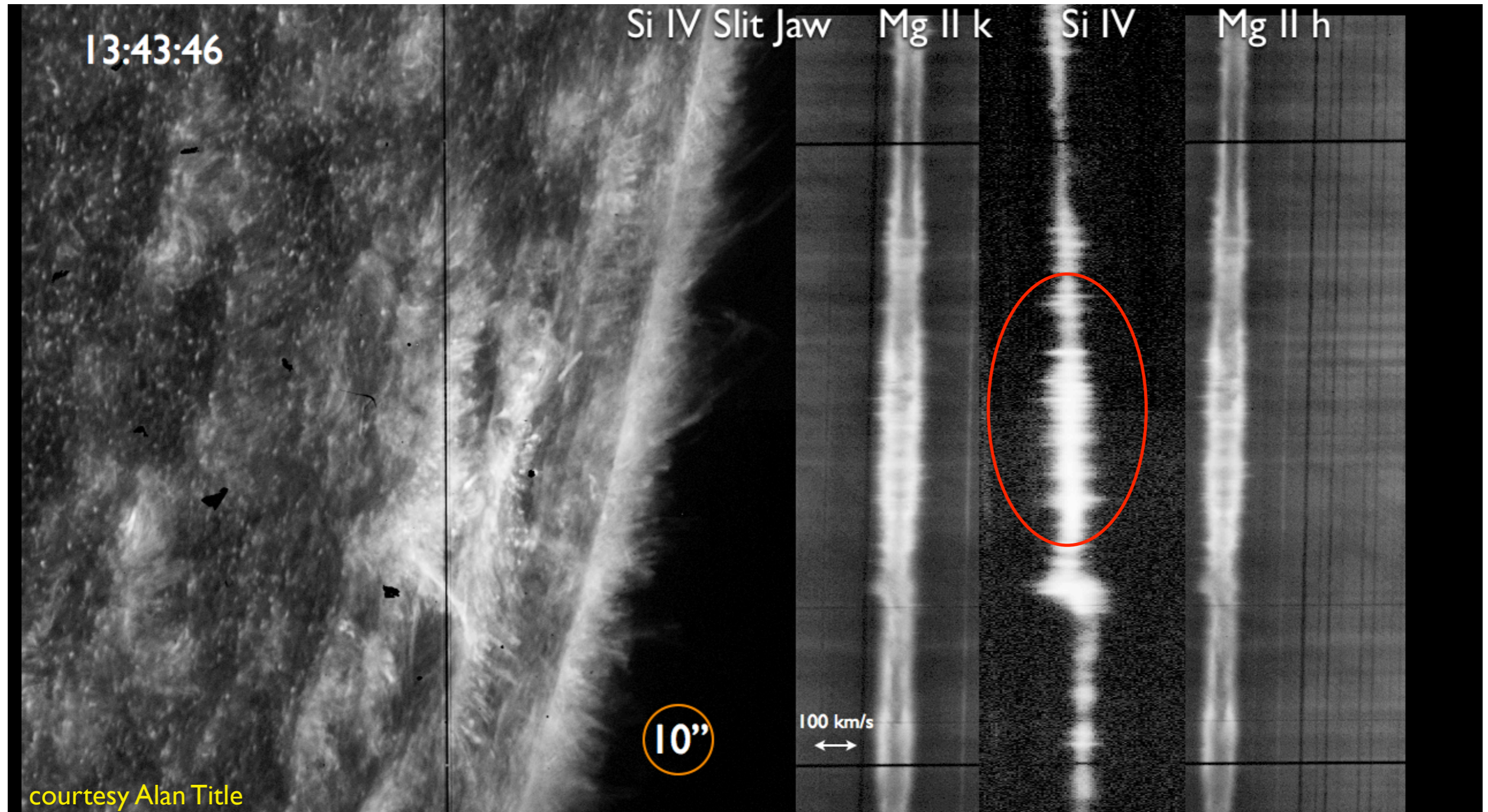
- [Executive Summary](#)
- [Science Goals](#)
- [Instrument Description](#)

Lockheed Martin Solar and Astrophysics Laboratory | NASA IRIS Home Page | NASA Explorer | IRIS on Facebook

# IRIS data and calibration



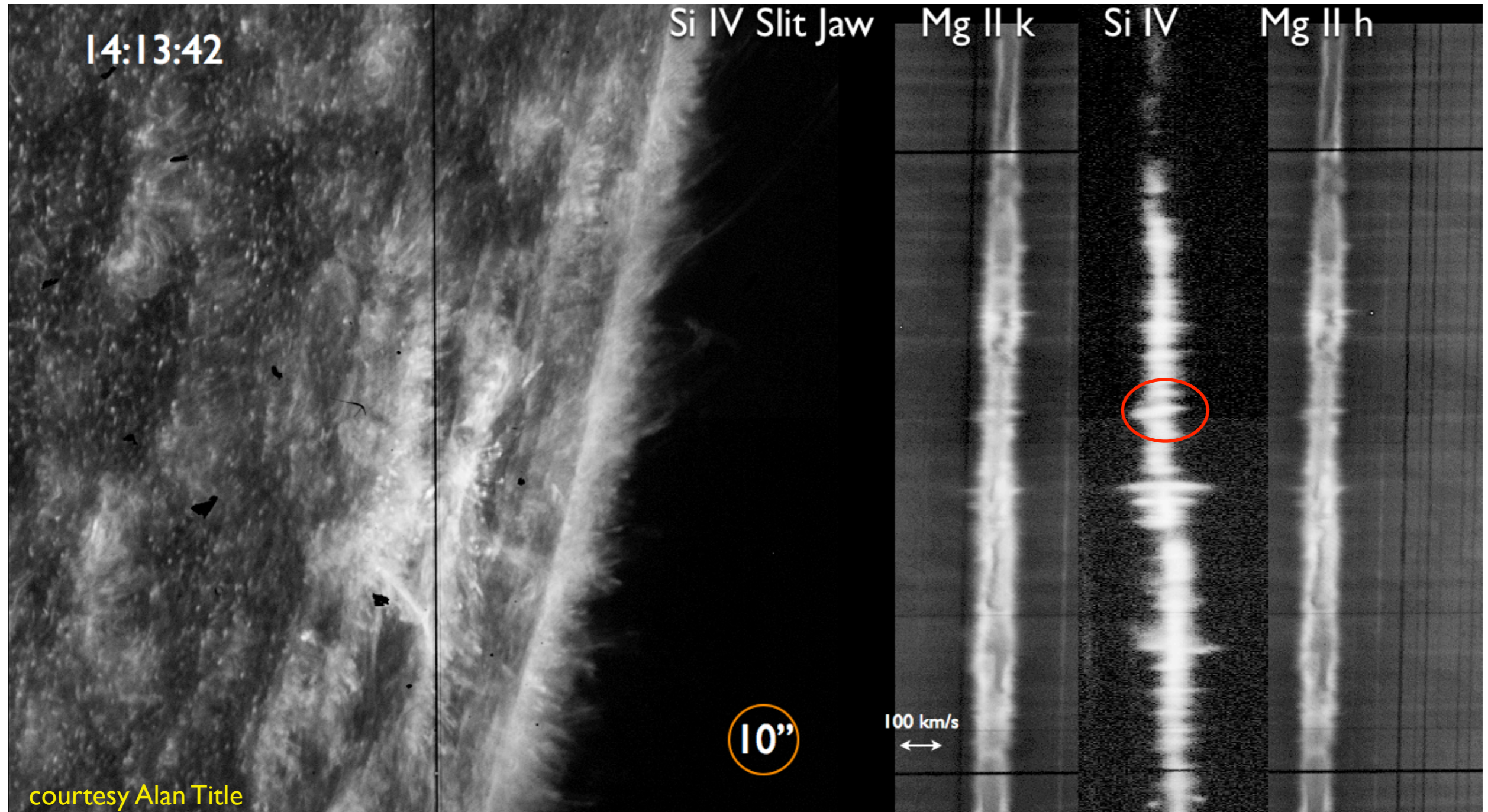
# IRIS slitjaw and spectra reveal multitude of high velocity events



IRIS spectra show a multitude of high velocity events associated with non-thermal broadening, both for a wide range of temperatures

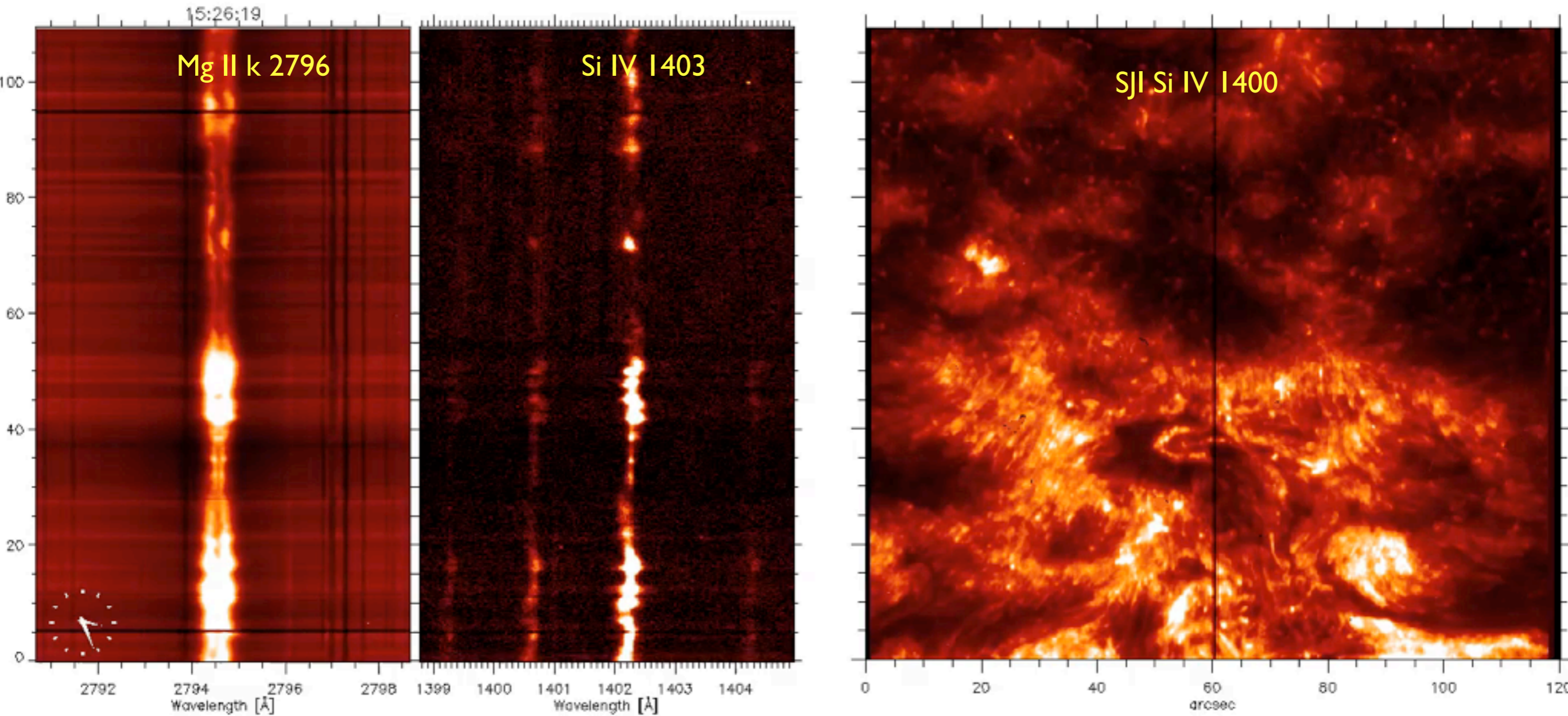


# IRIS slitjaw and spectra reveal multitude of high velocity events

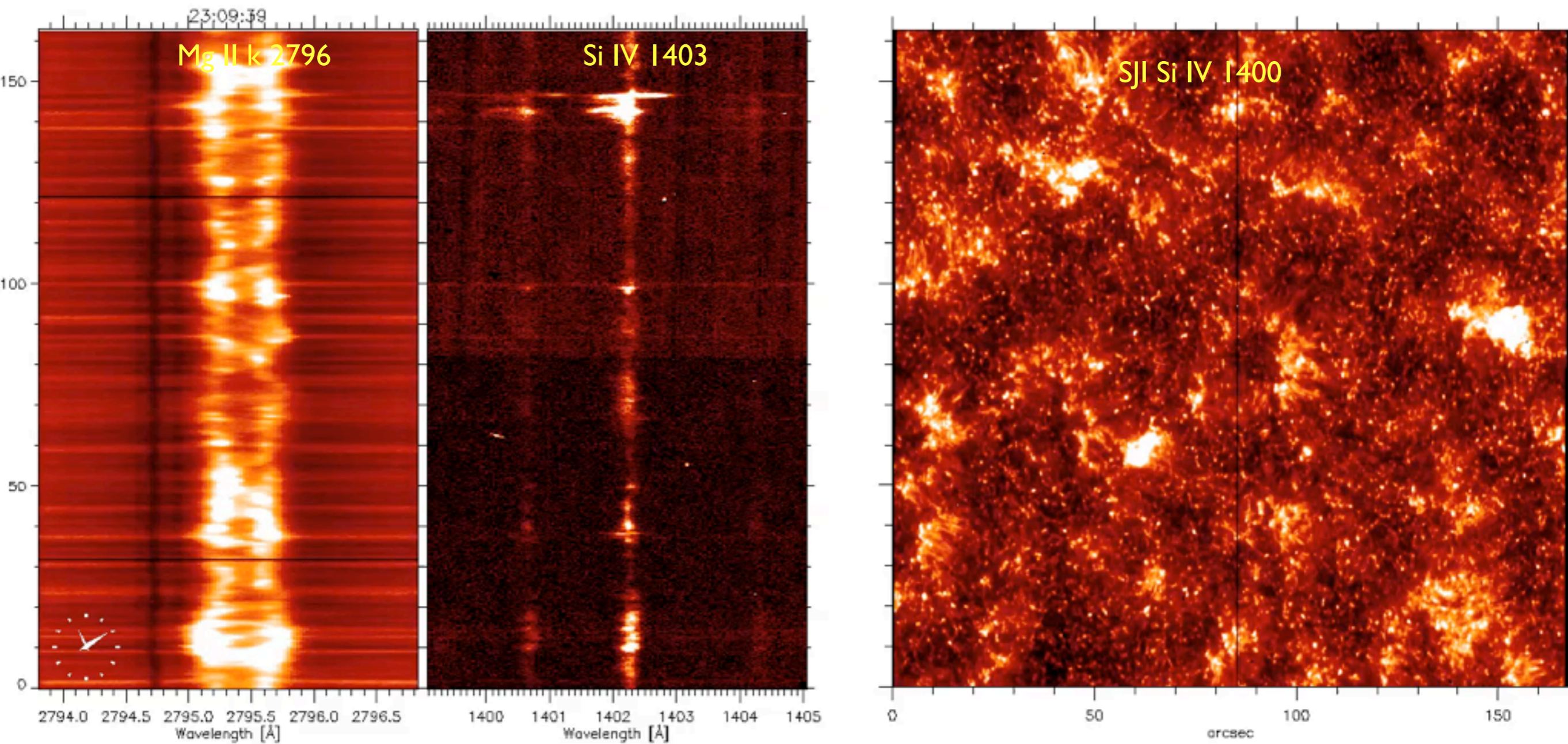


IRIS spectra show a multitude of high velocity events associated with non-thermal broadening, both for a wide range of temperatures

# IRIS slitjaw and spectra reveal multitude of high velocity events, both at the limb and on disk

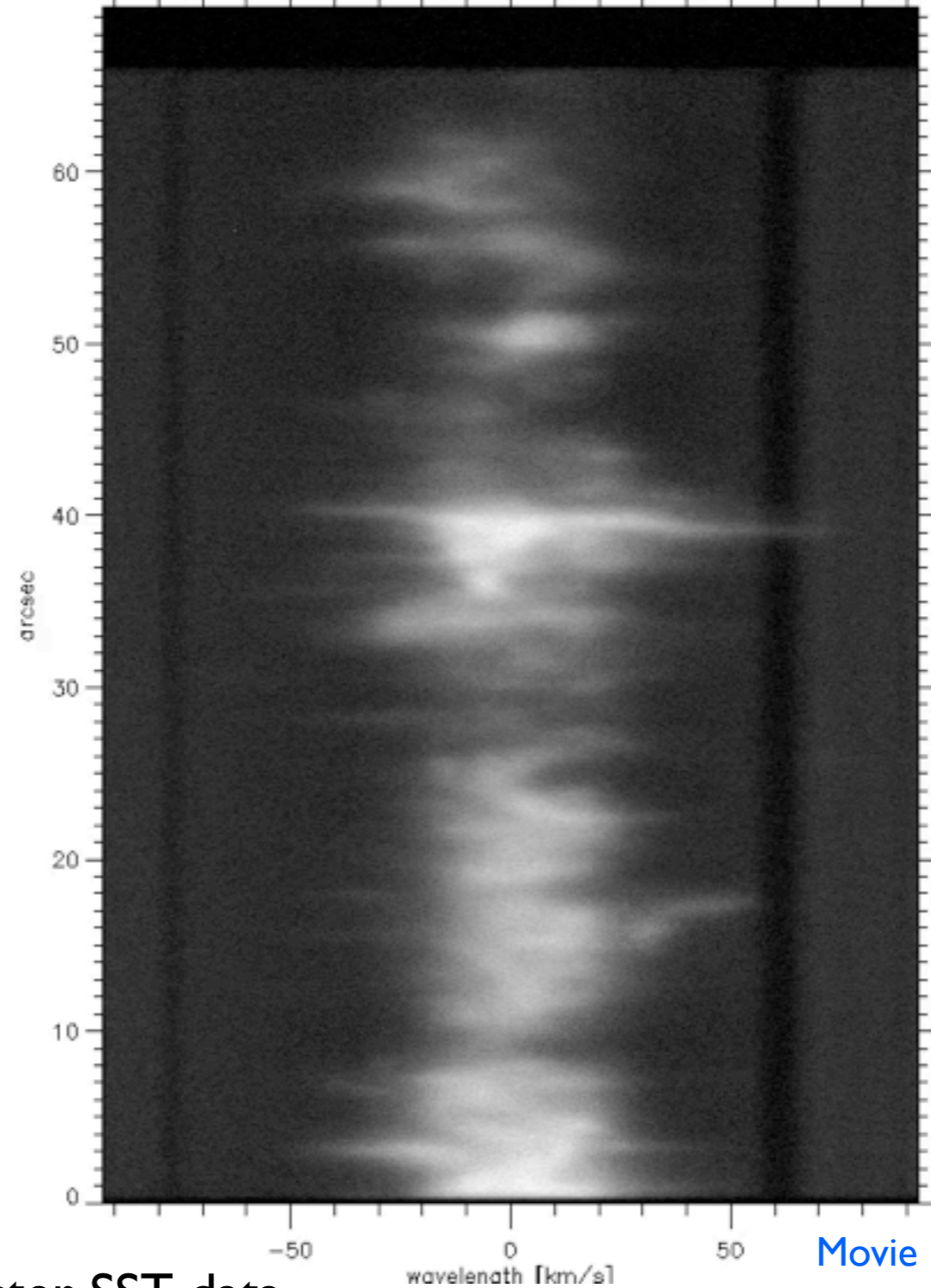
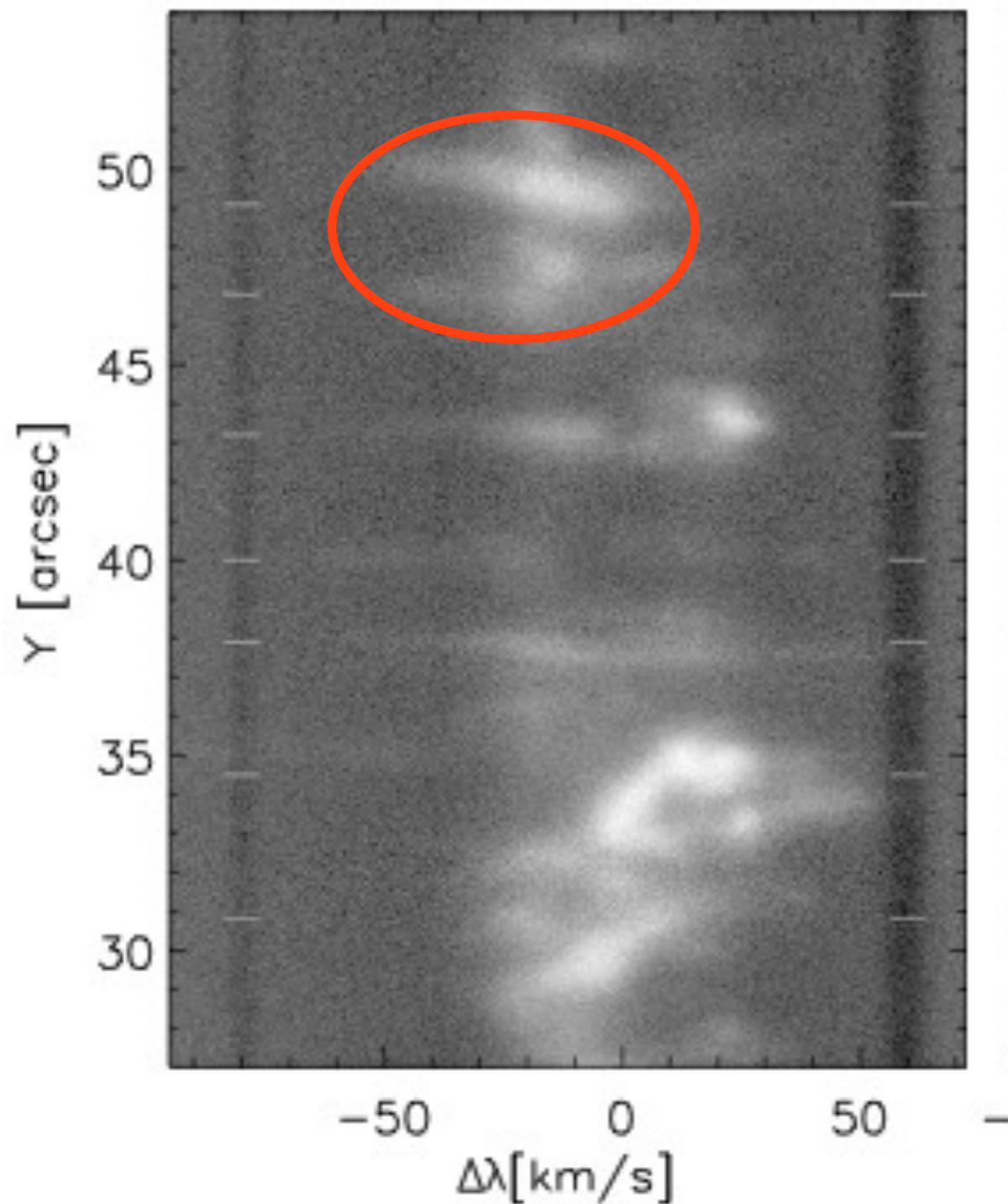


# Quiet Sun and coronal hole dynamics also dominated by shocks and high velocity events



(mix of bi-directional flows and torsional motions?)

# Spicules dominated by three types of motions field-aligned upflows, swaying motions and torsional motions

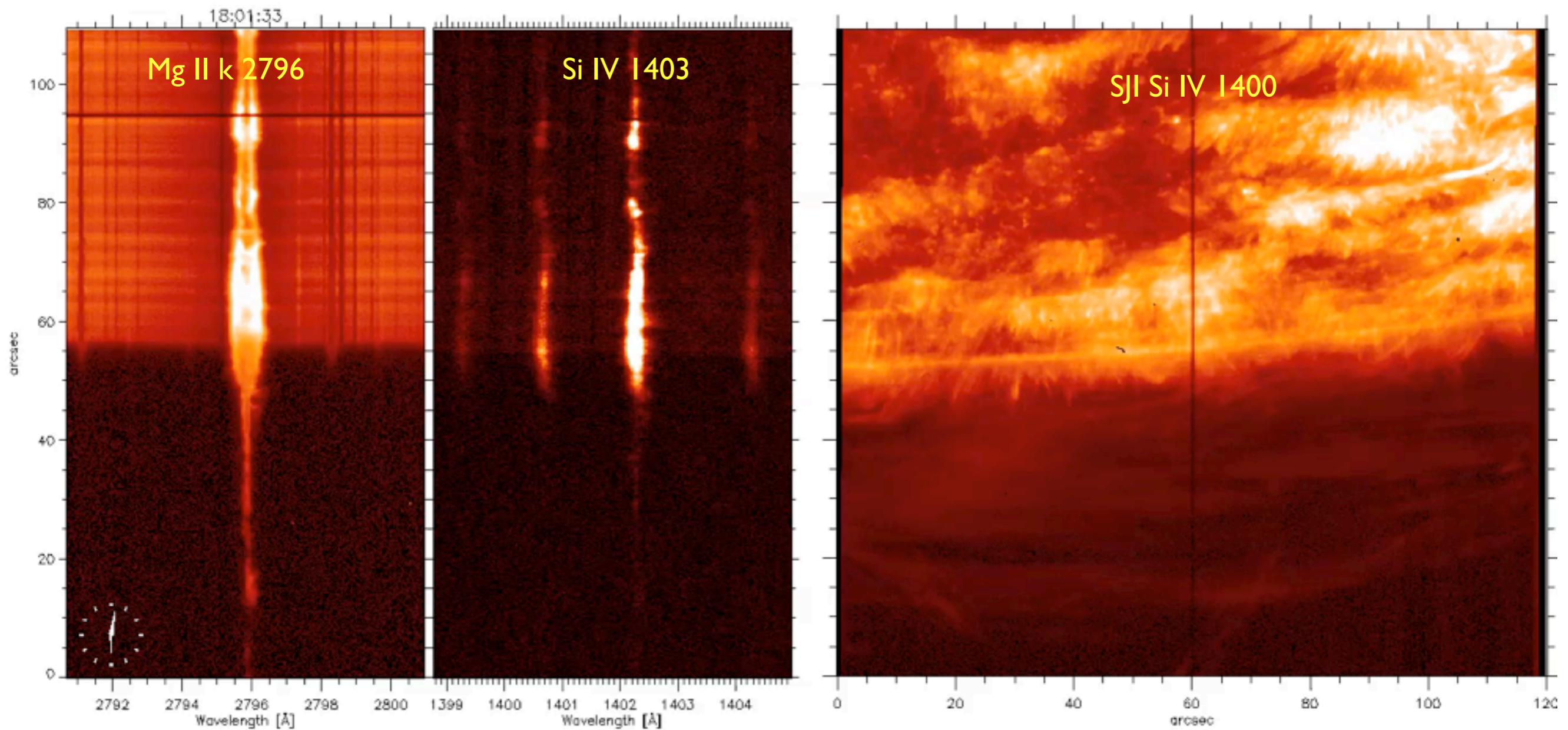


De Pontieu et al., 2012, see Skogsrud et al. poster, SST data

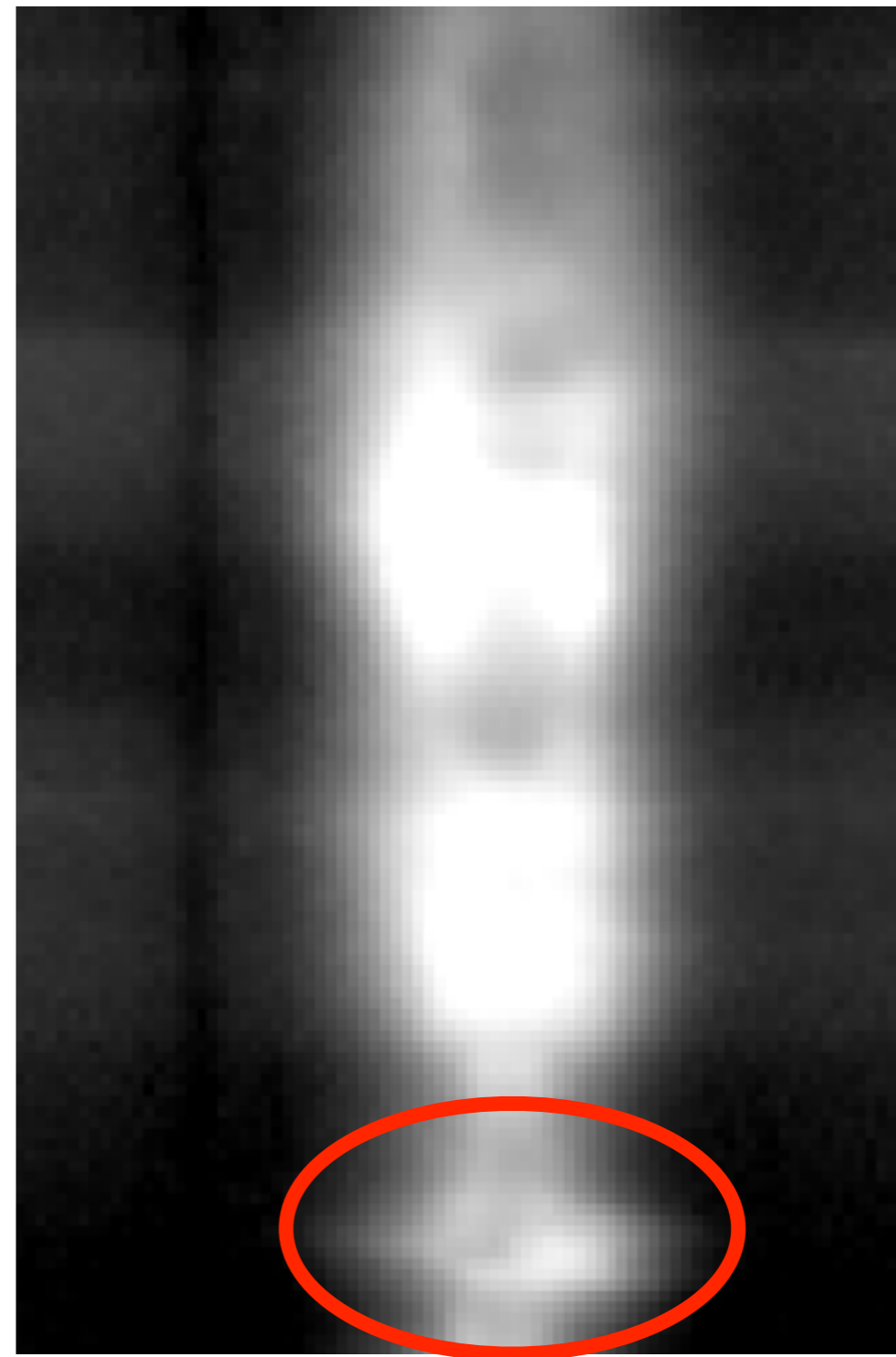
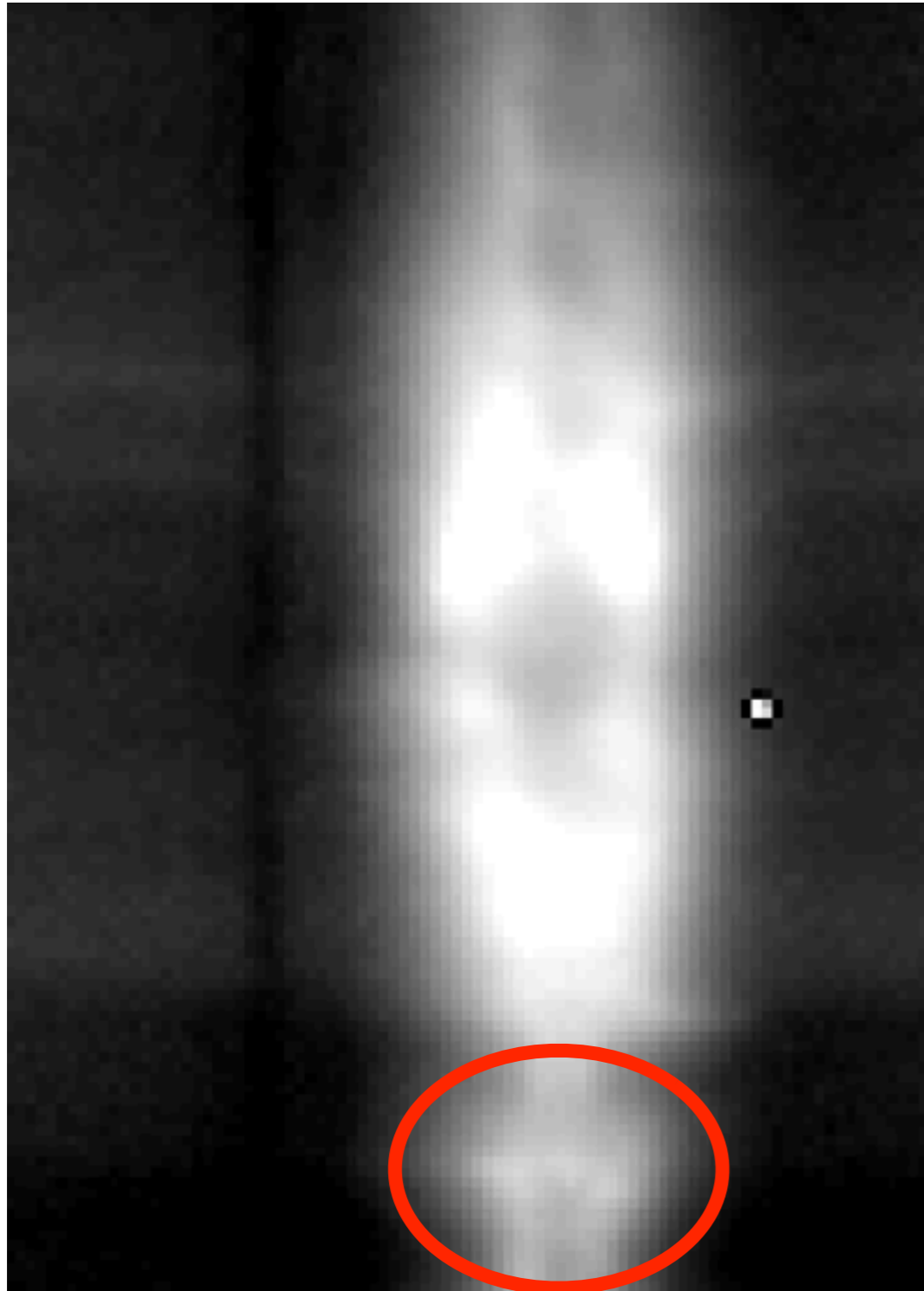
Movie Mats Carlsson

Inclined spectra in spicules indicate red/blueshift pattern across spicule compatible with strong torsional motion of 20-30 km/s

# Presence of strong “bidirectional flows” at the limb supports strong torsional motions

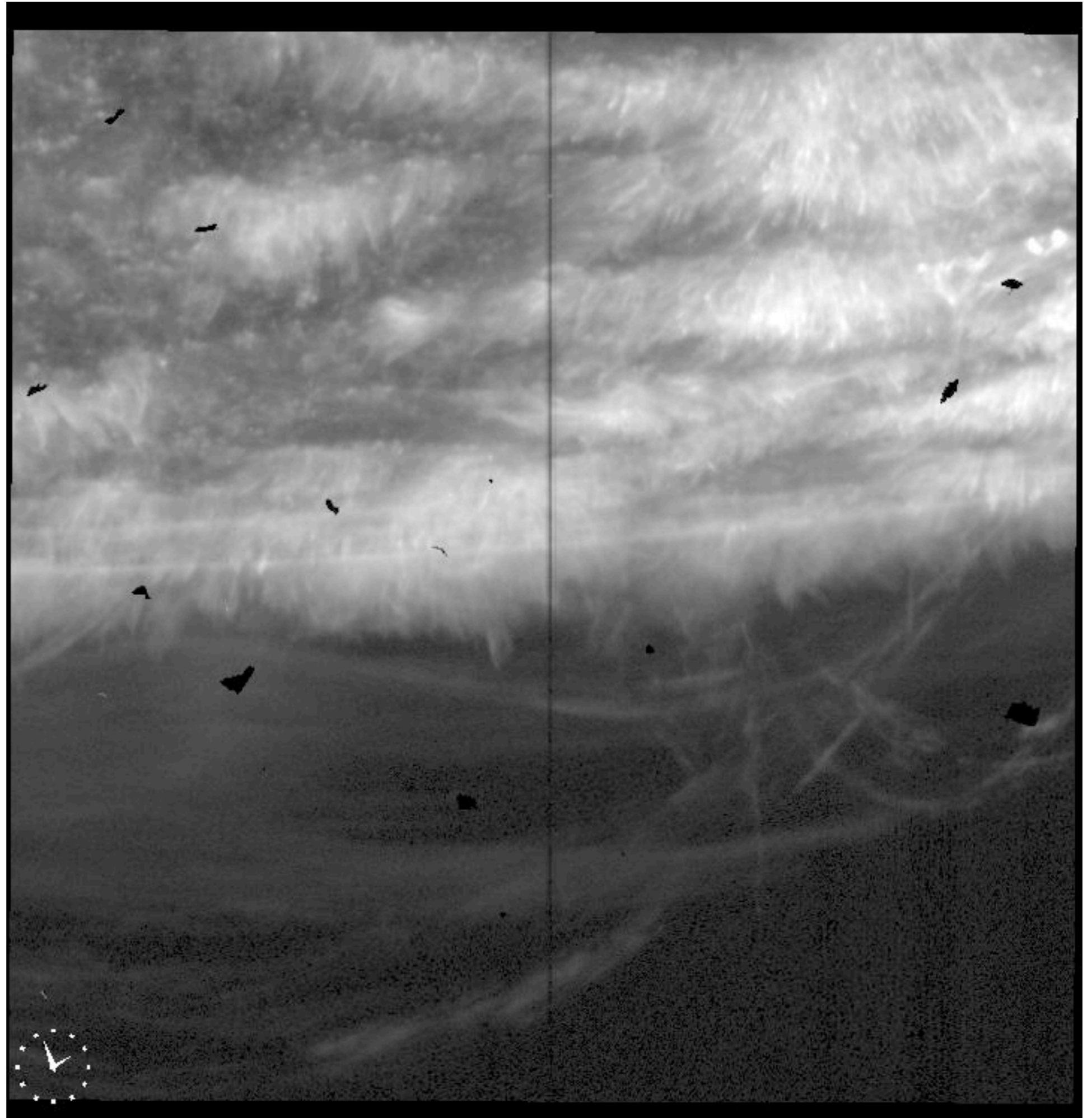


# Presence of strong “bidirectional flows” at the limb supports strong torsional motions



2-Oct-2013

Si IV 1400



2-Oct-2013

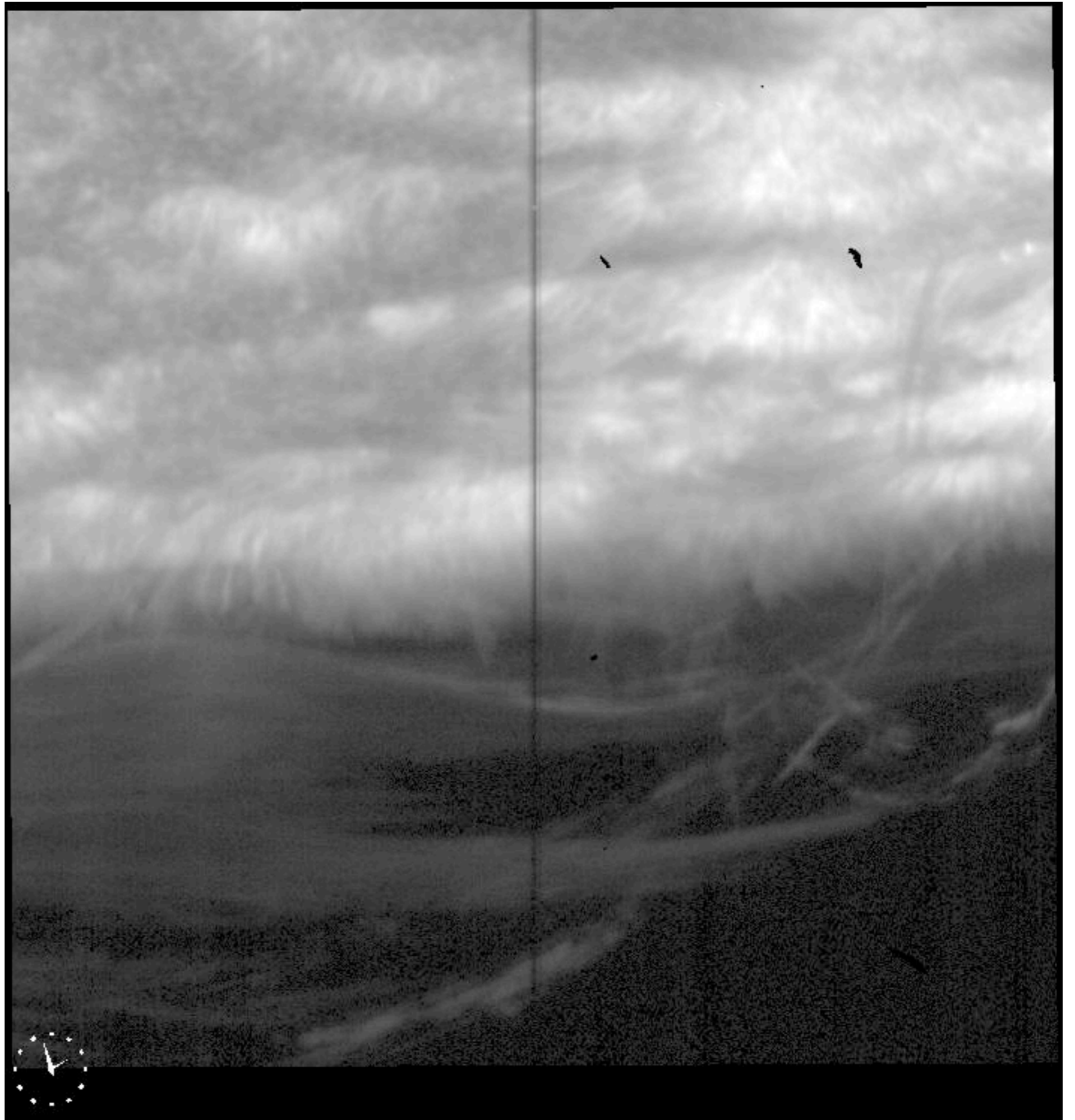
Si IV 1400, O IV

Mg II k and h

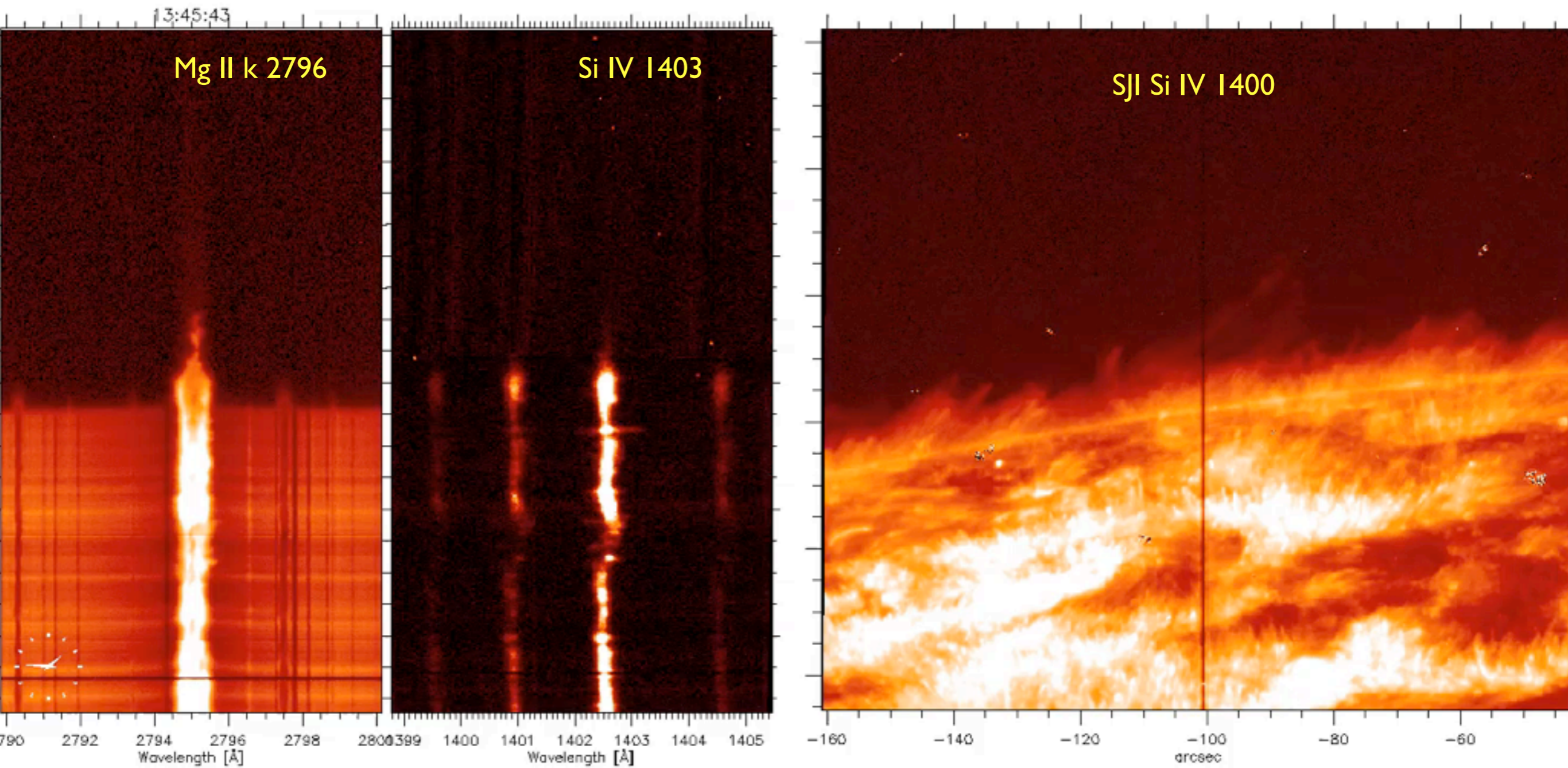


2-Oct-2013

Mg II h/k  
2796

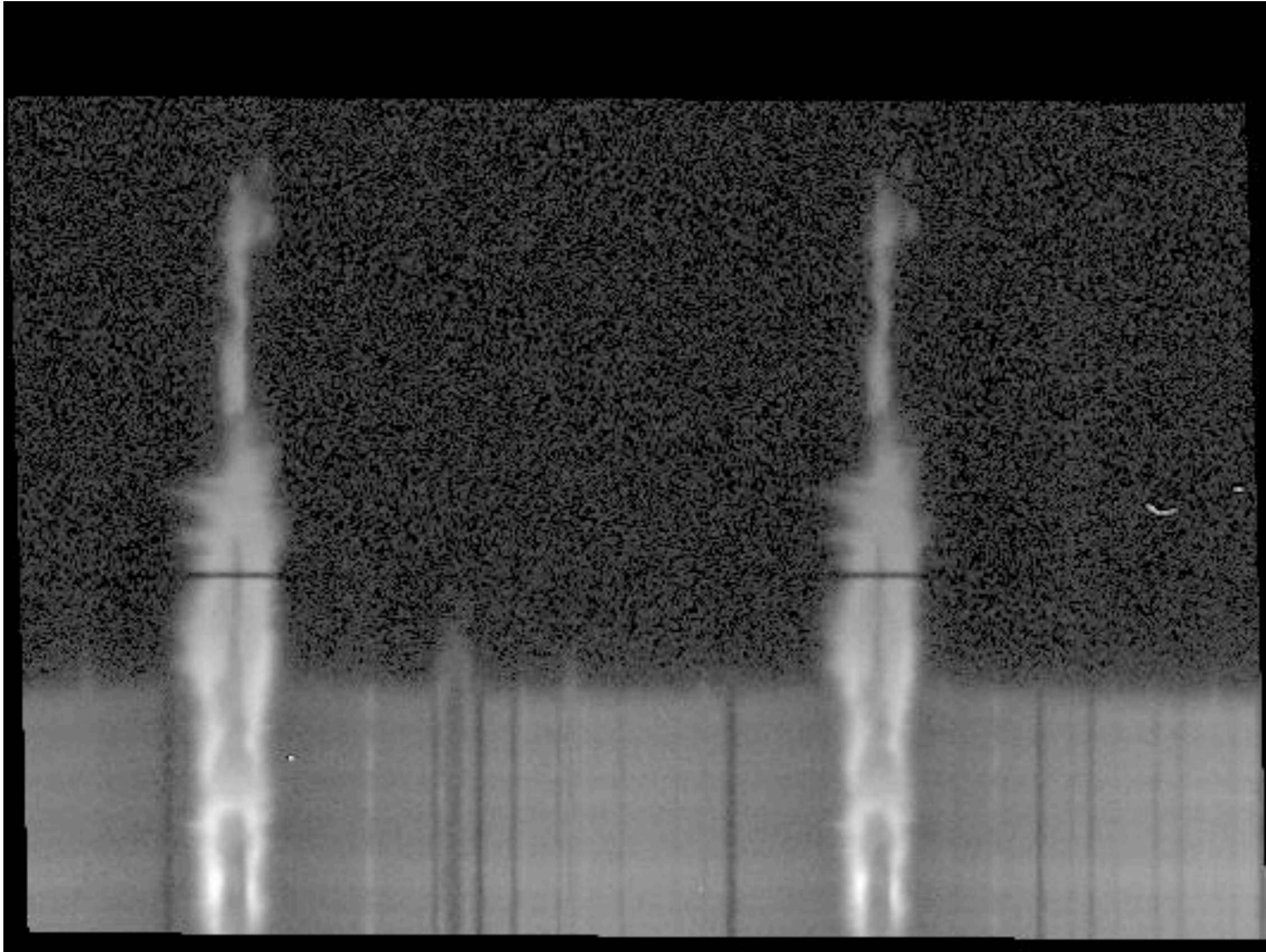


# Limb spectra suggest torsional motions ubiquitous



24-Sep-2013

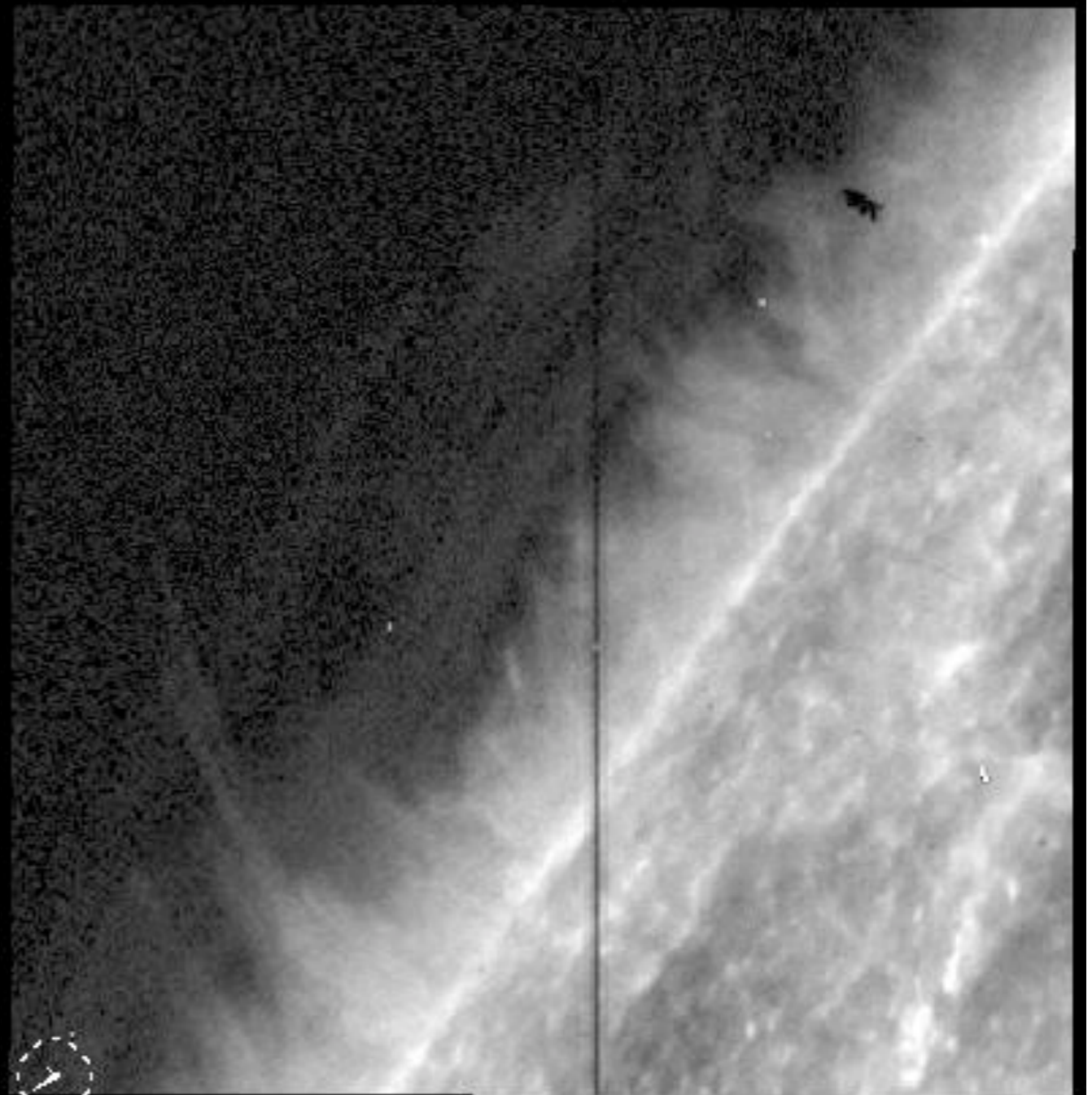
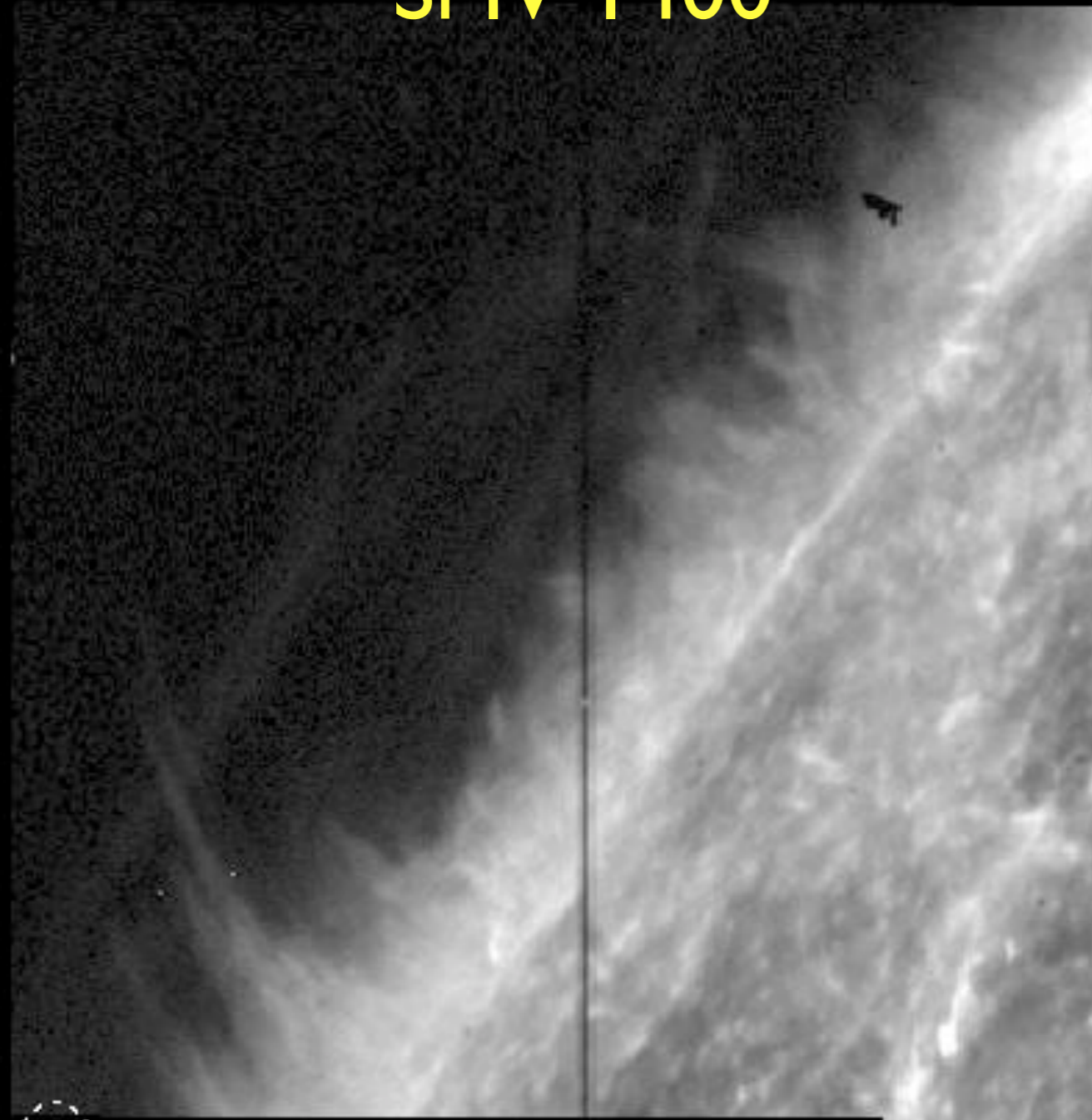
Mg II k and h



# Thermal evolution of spicules

Si IV 1400

C II 1330

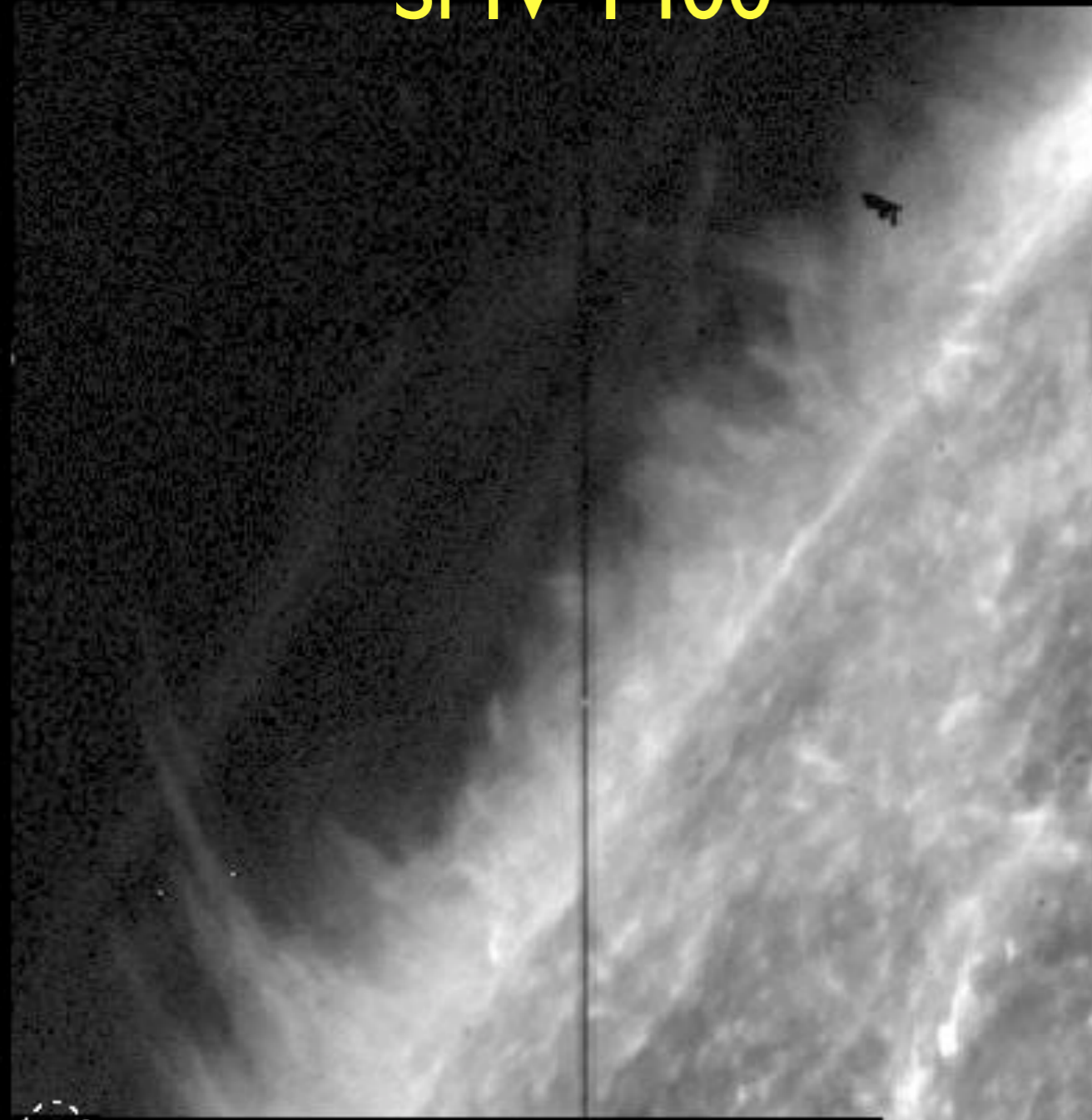


24-Sep-2013

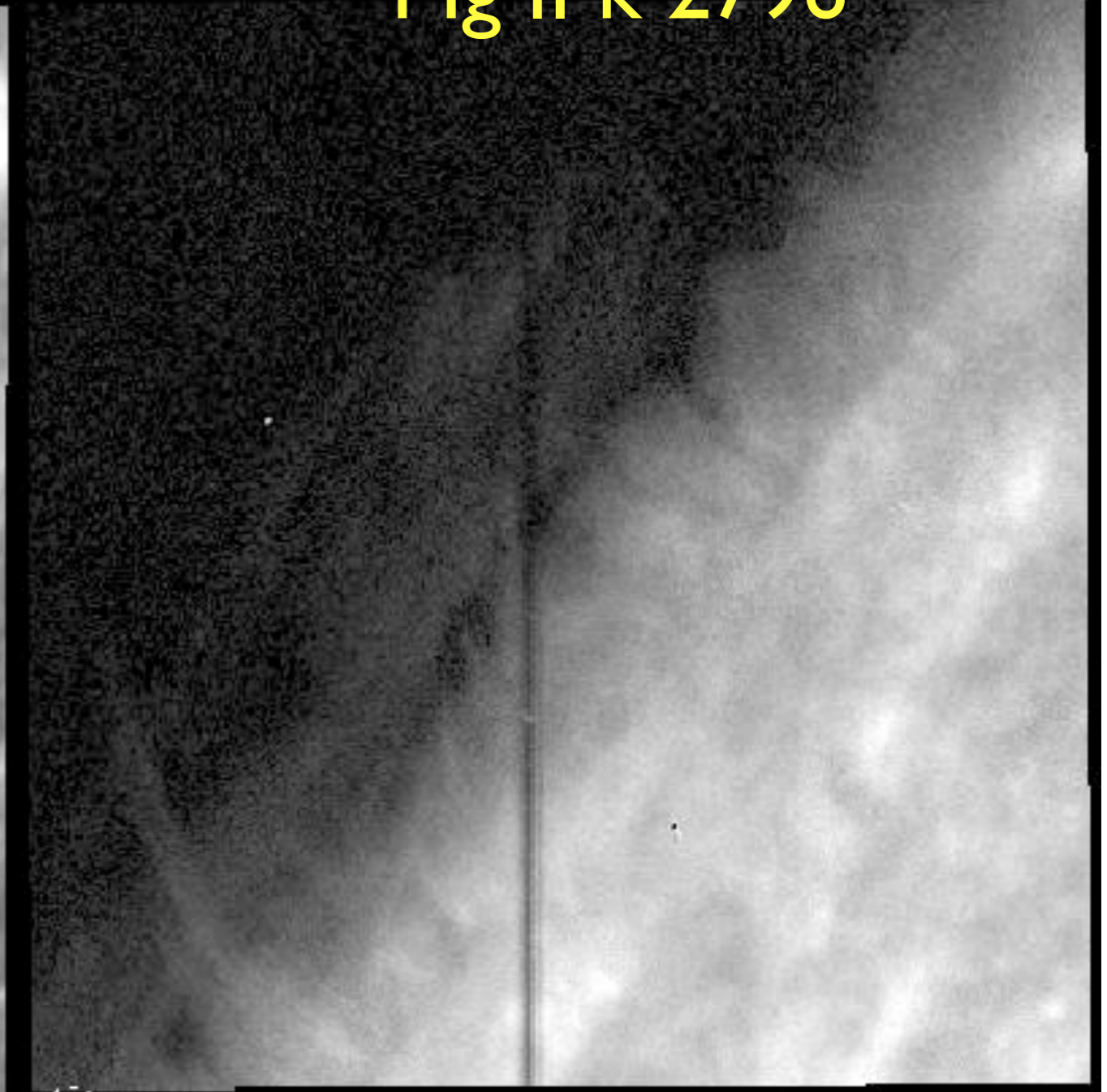
See Tiago Pereira's talk this week

# Thermal evolution of spicules

Si IV 1400

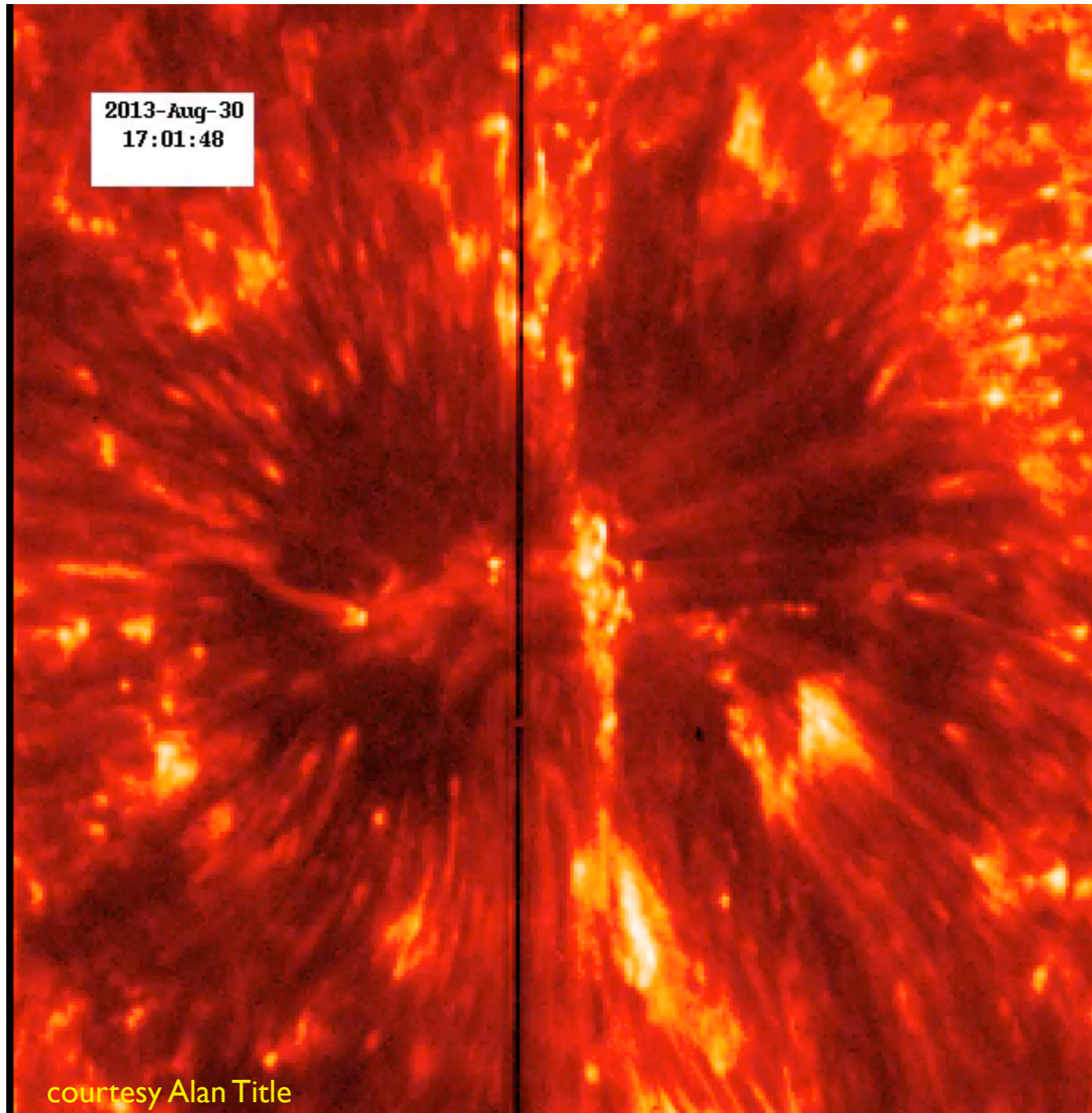


Mg II k 2796

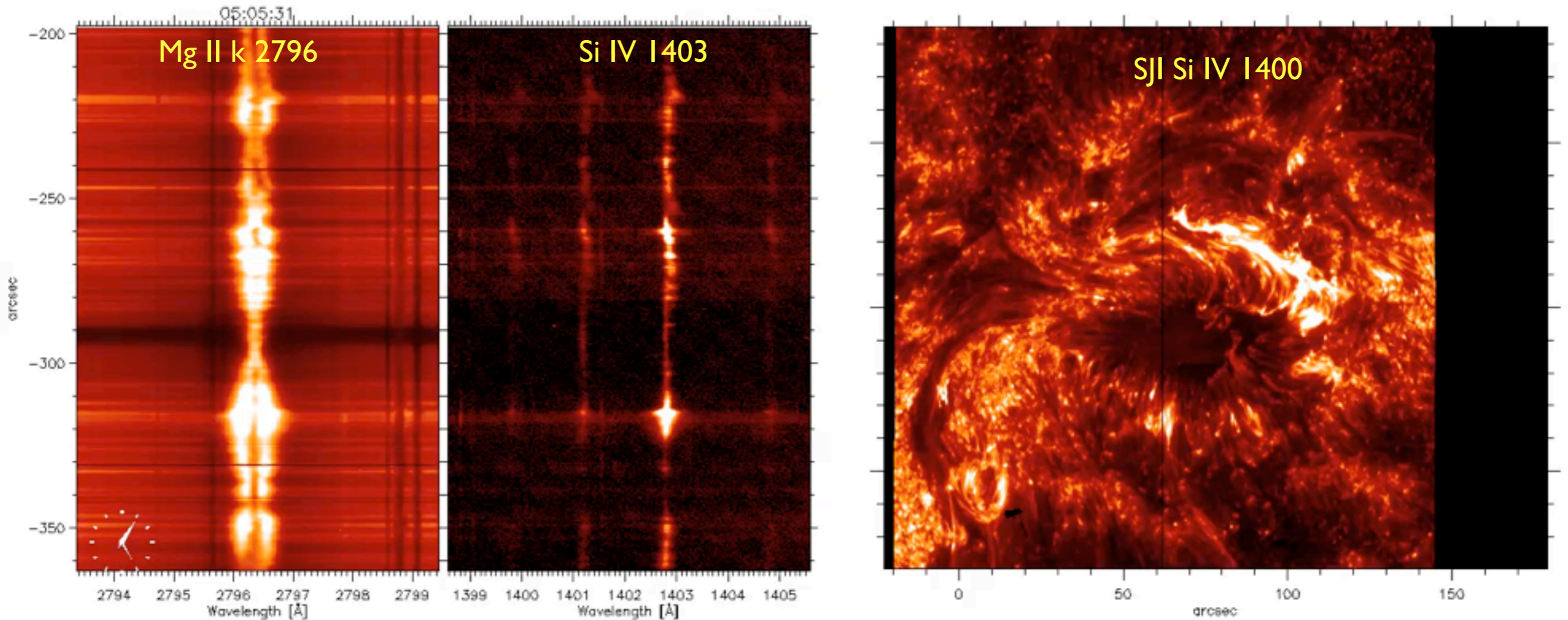


See Tiago Pereira's talk this week

# Sunspot dynamics



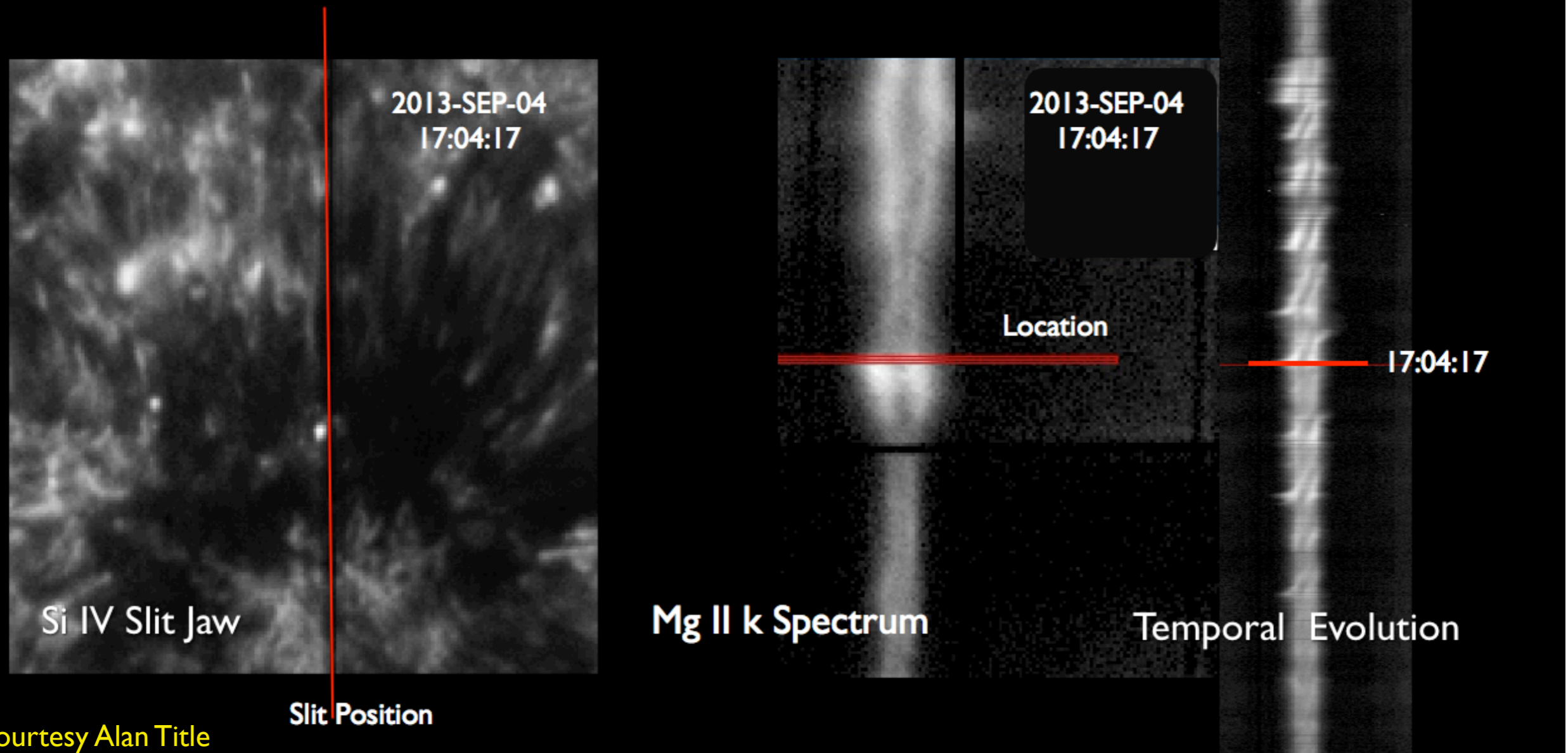
# Sunspot dynamics



Strong umbral shocks shown propagating into TR lines  
Strong downflows above sunspots (see also HRTS)

# Sunspot dynamics

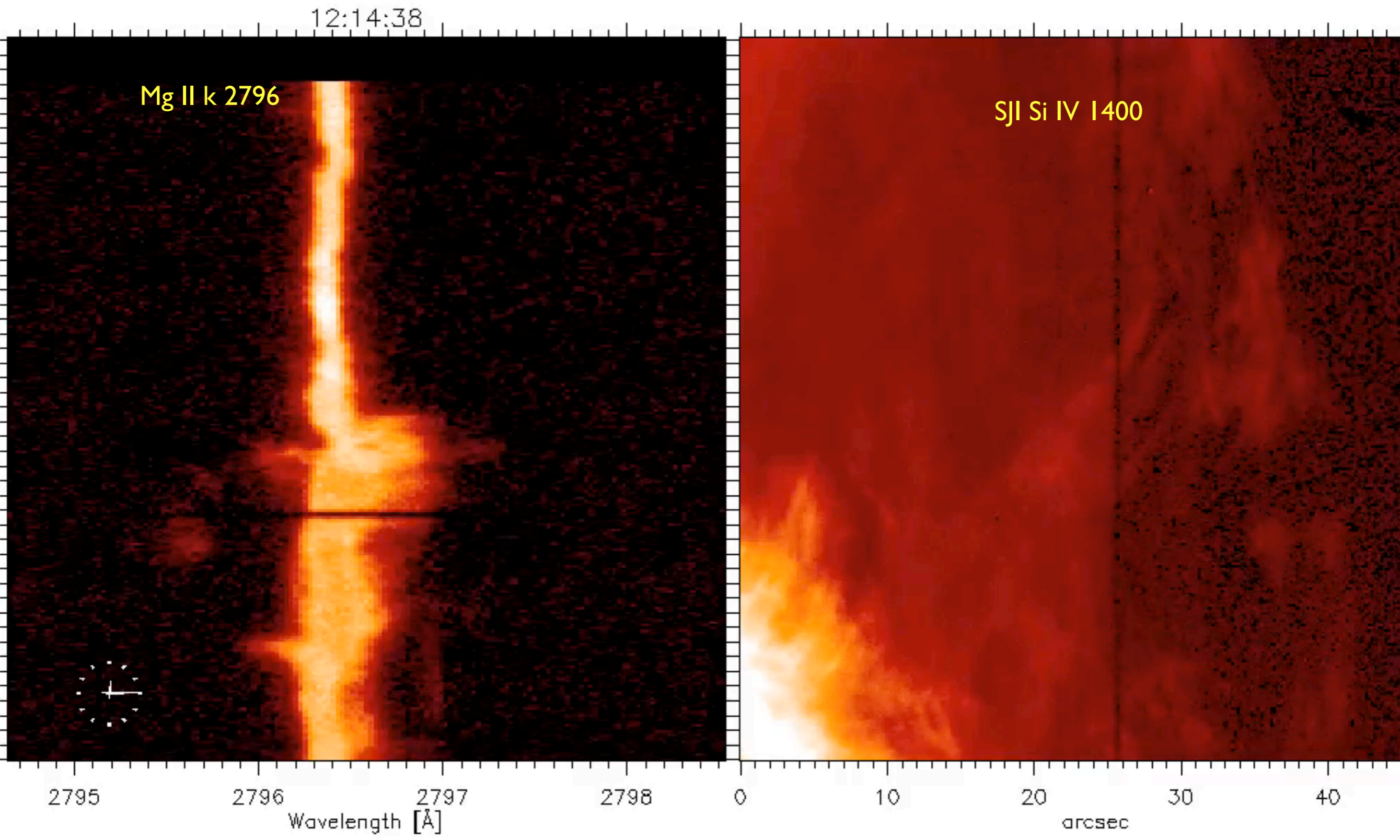
## Spatial - Spectral - Temporal Relationships



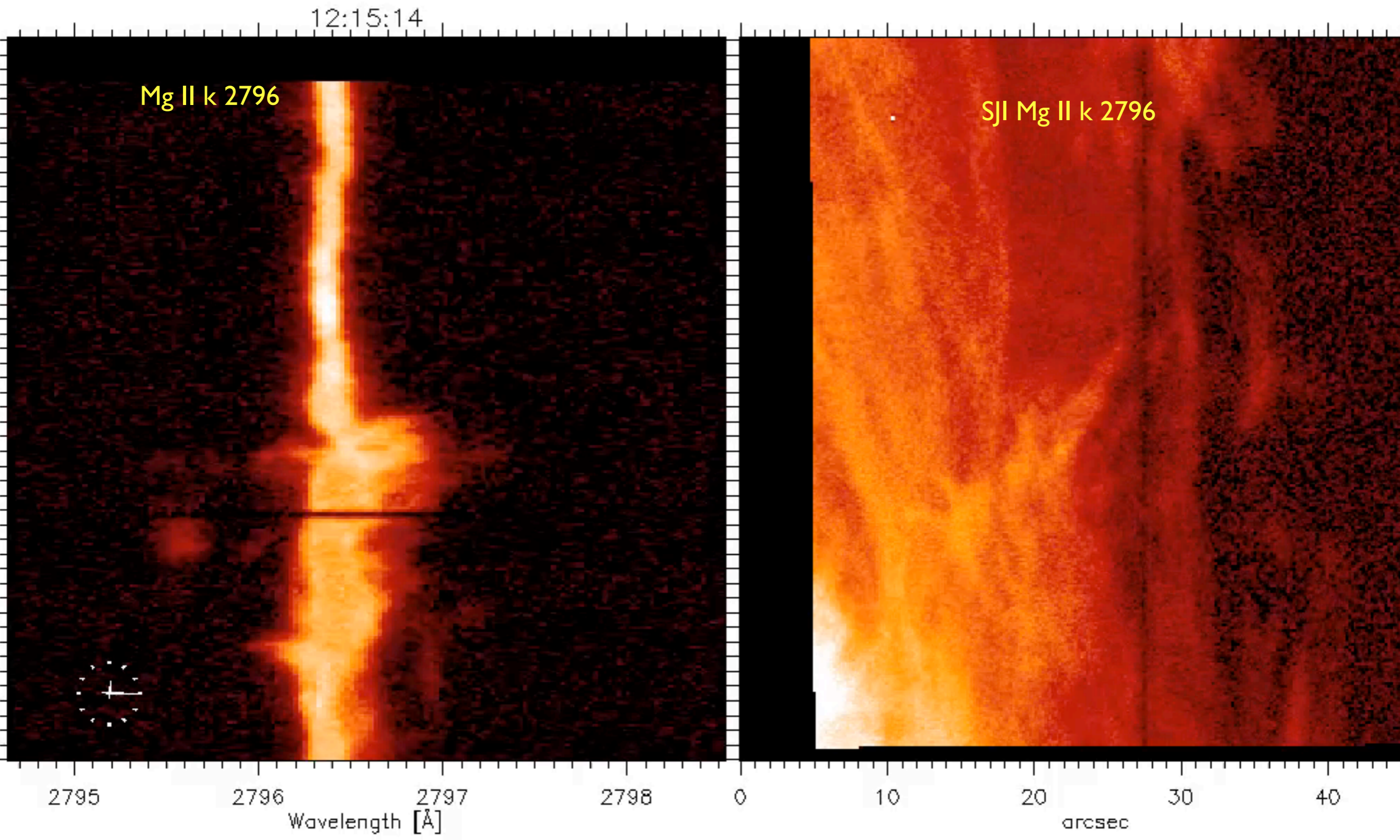
Strong umbral shocks shown propagating into TR lines



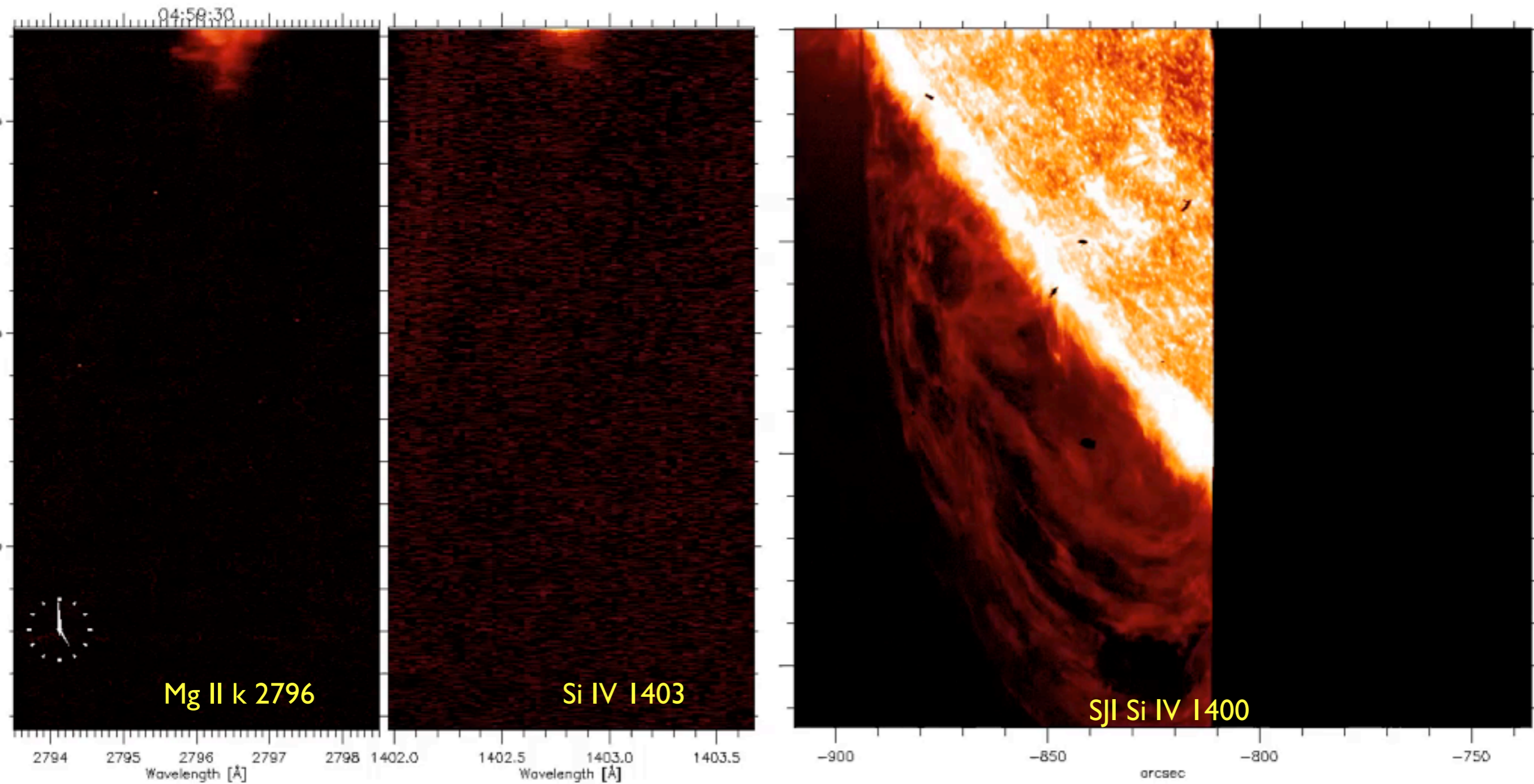
# Prominence dynamics



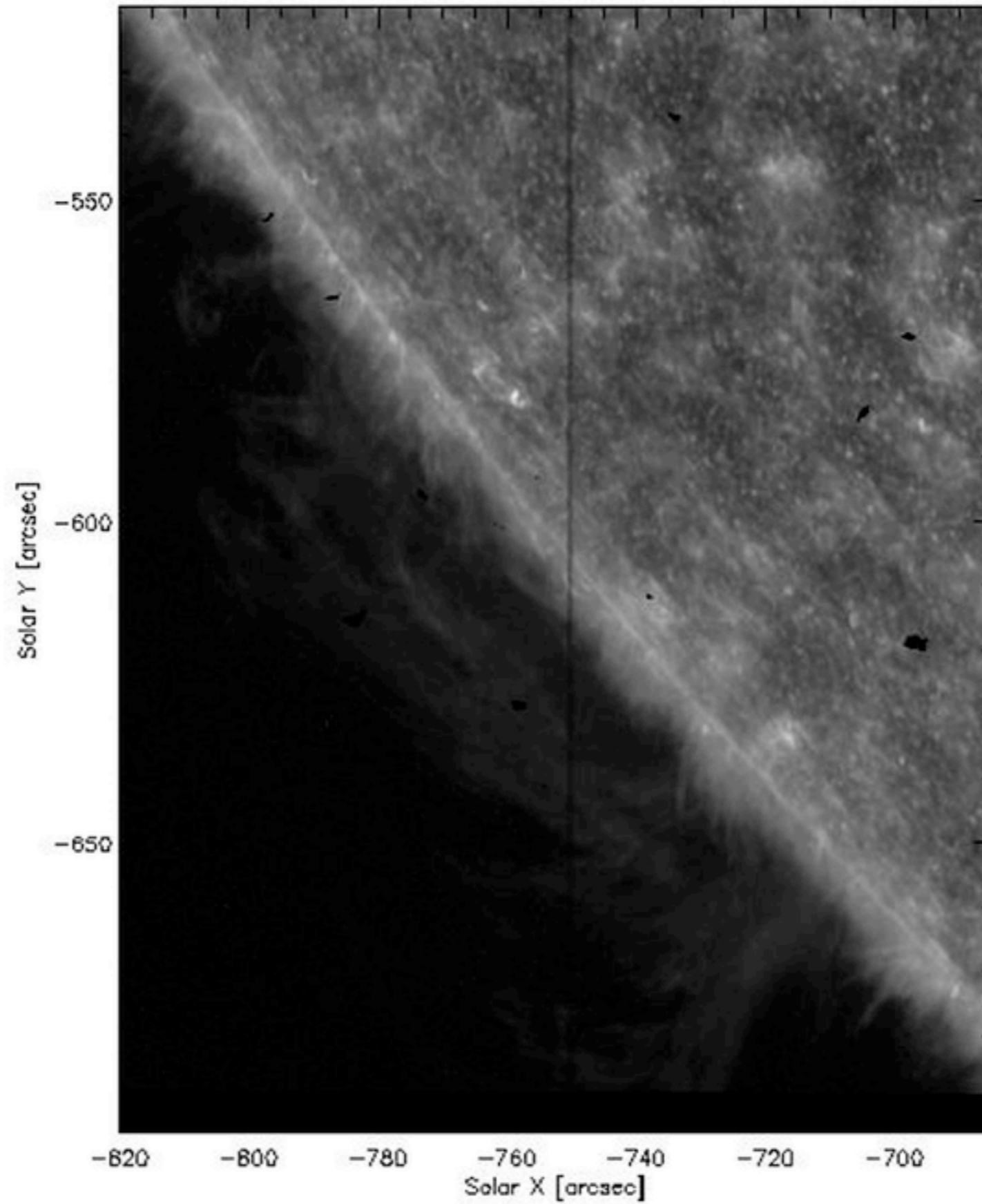
# Prominence dynamics



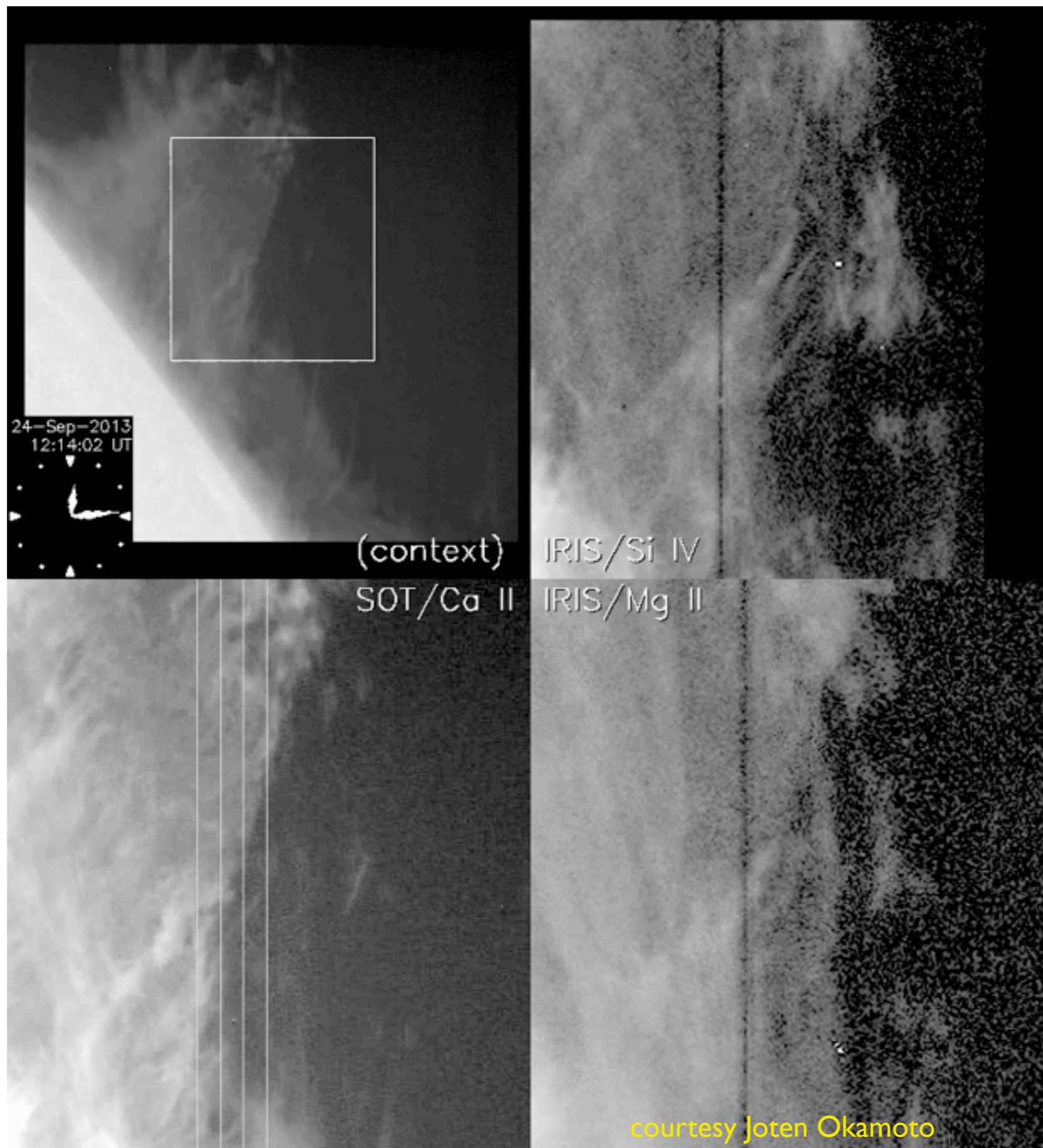
# Prominence dynamics



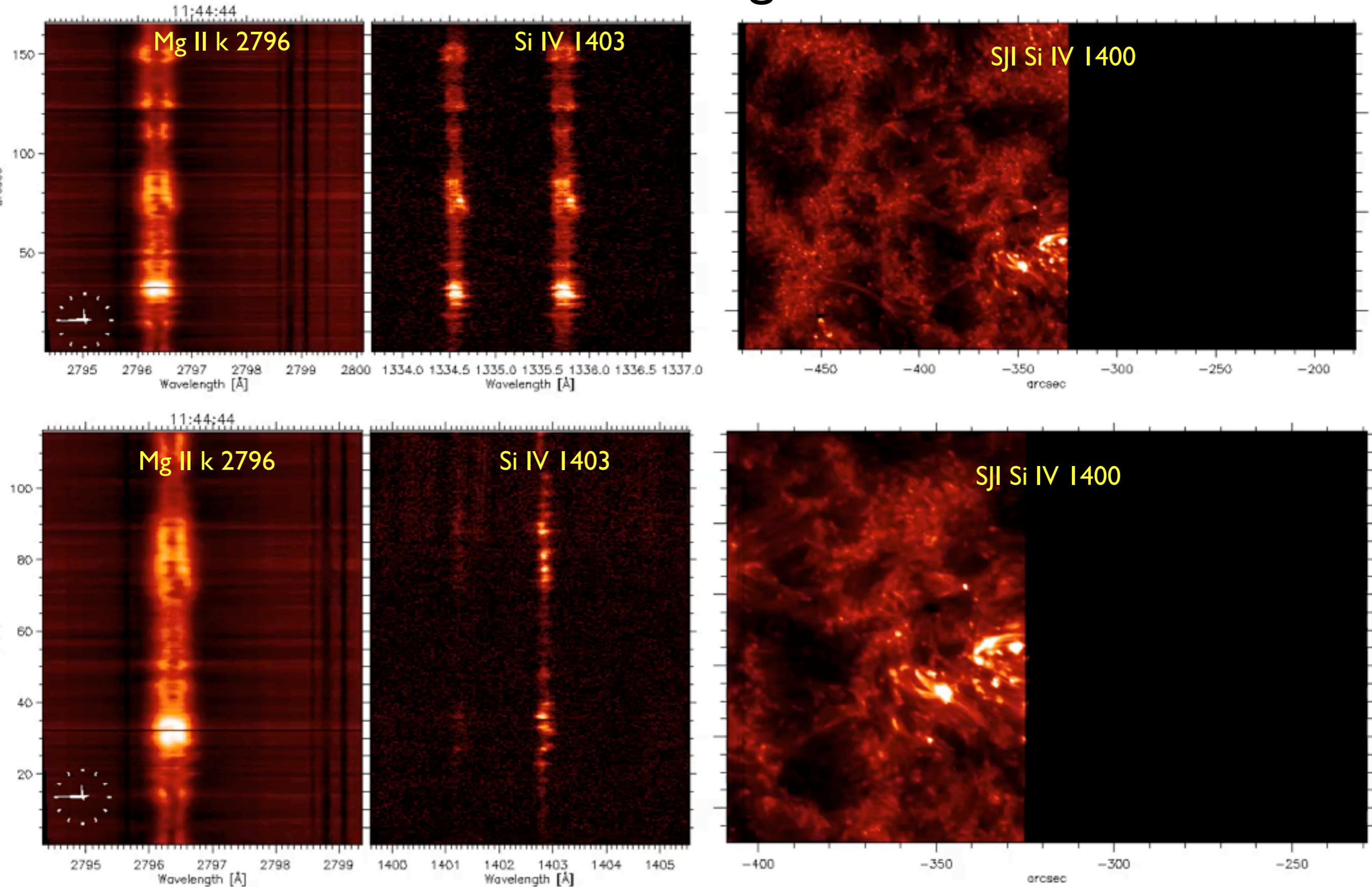
# Prominence dynamics



# Prominence dynamics, coordinated with Hinode

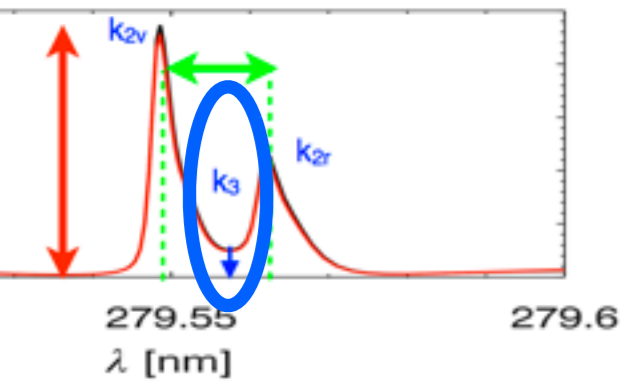
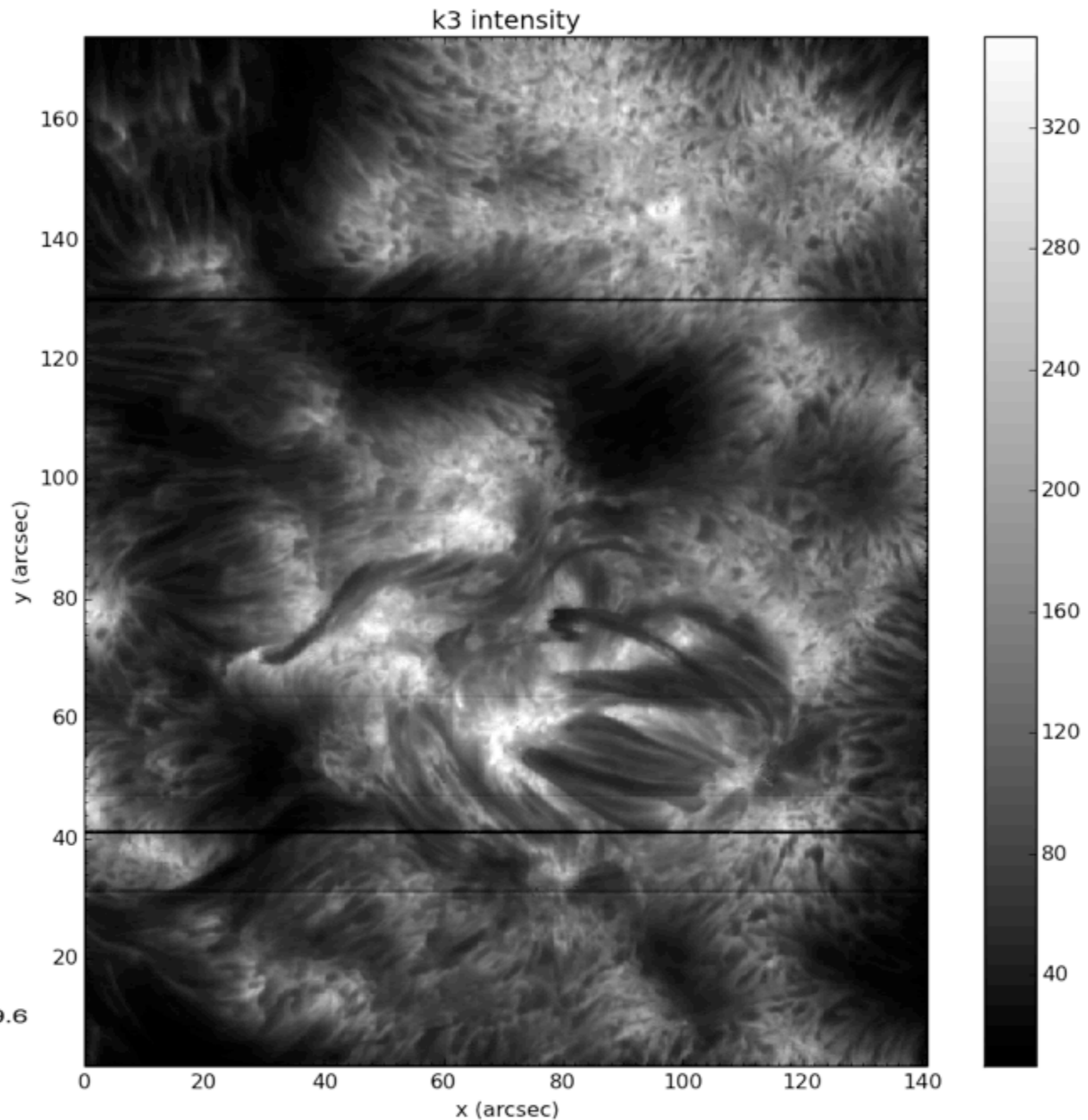


# Flux emergence



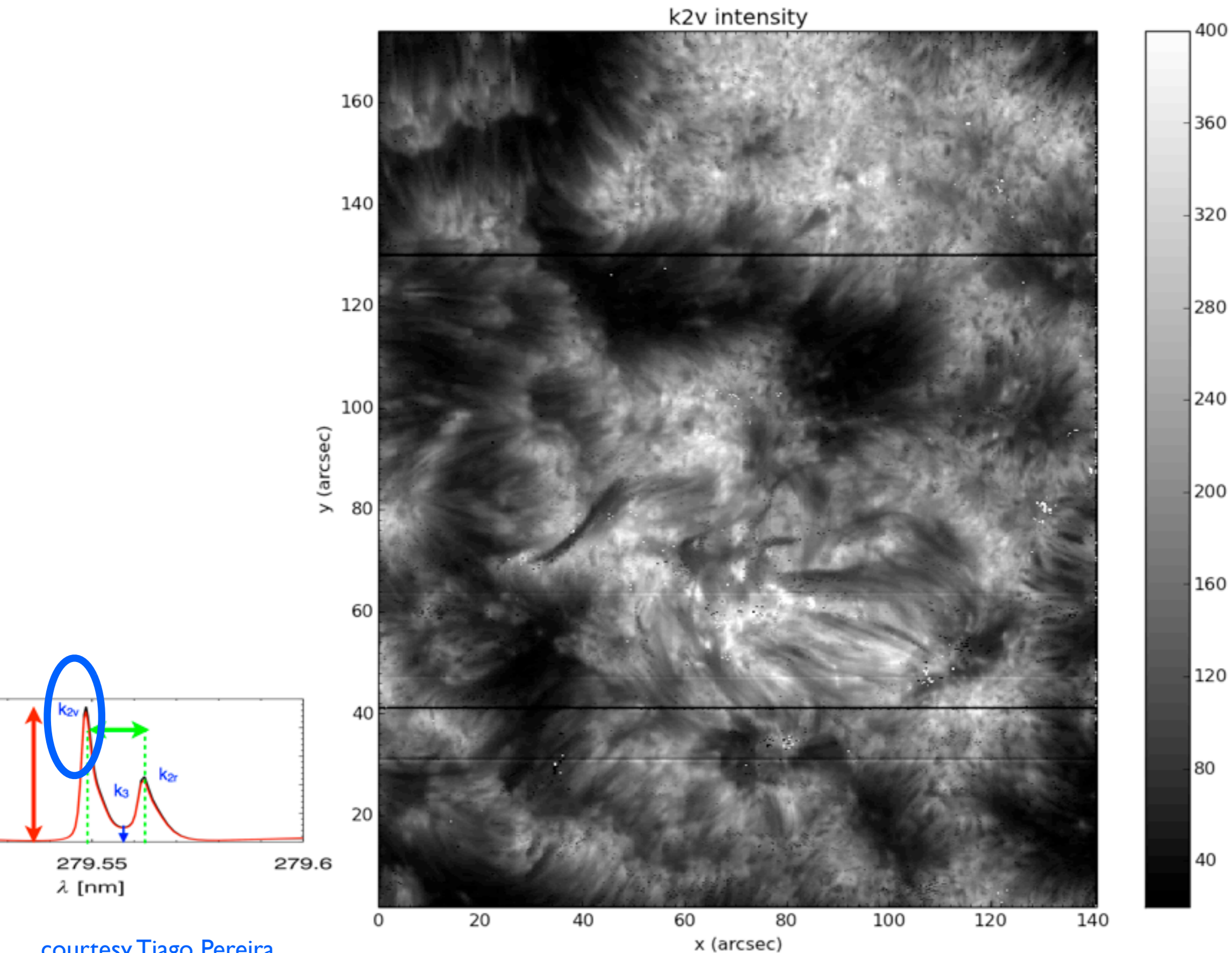
Flux emergence reveals very strange profiles suggesting multiple components and very low-lying hot plasma (Ellerman bombs)

Provides diagnostics over whole range of heights: **TR corrugation**



courtesy Tiago Pereira

Provides diagnostics over whole range of heights: **mid chromo Temperature**

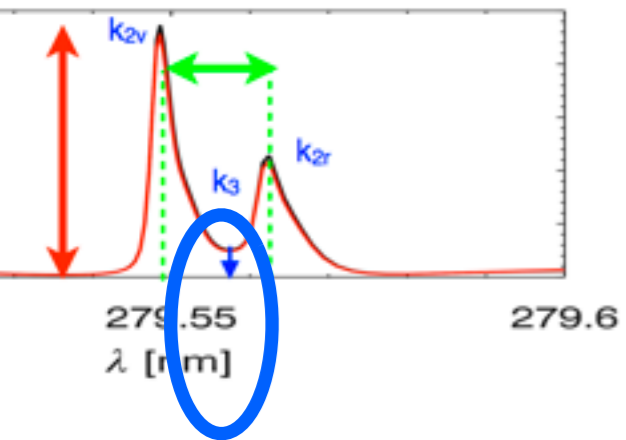
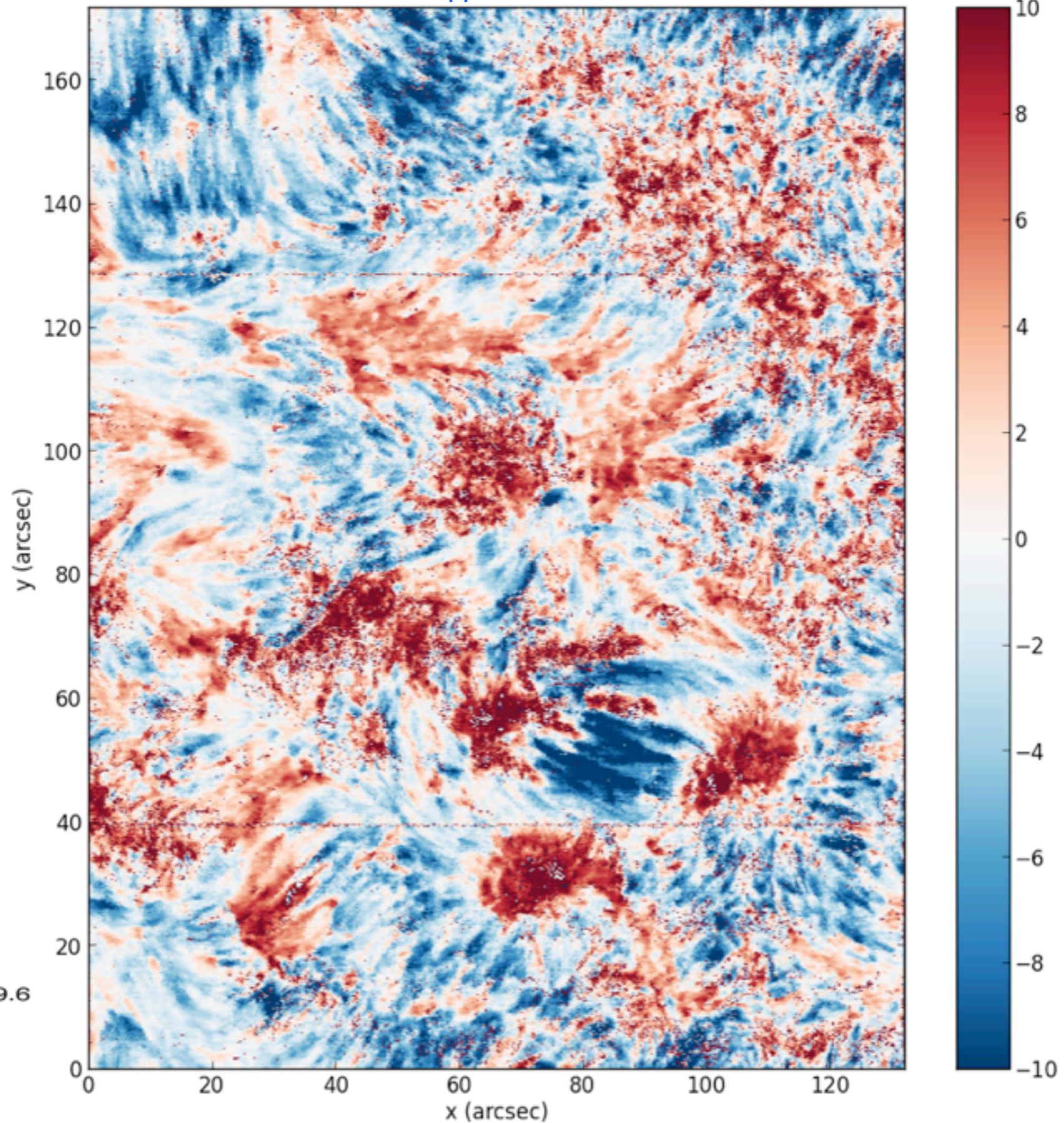


courtesy Tiago Pereira



Provides diagnostics over whole range of heights: **upper chromo velocity**

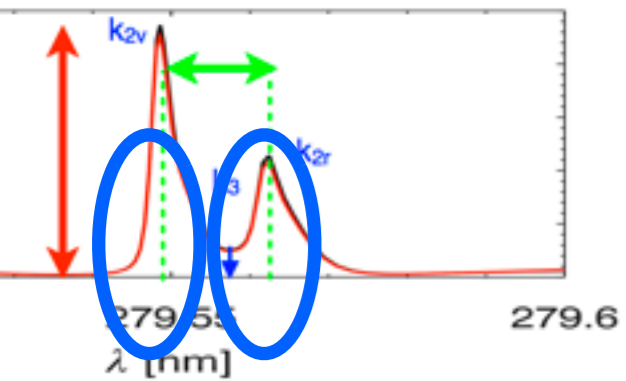
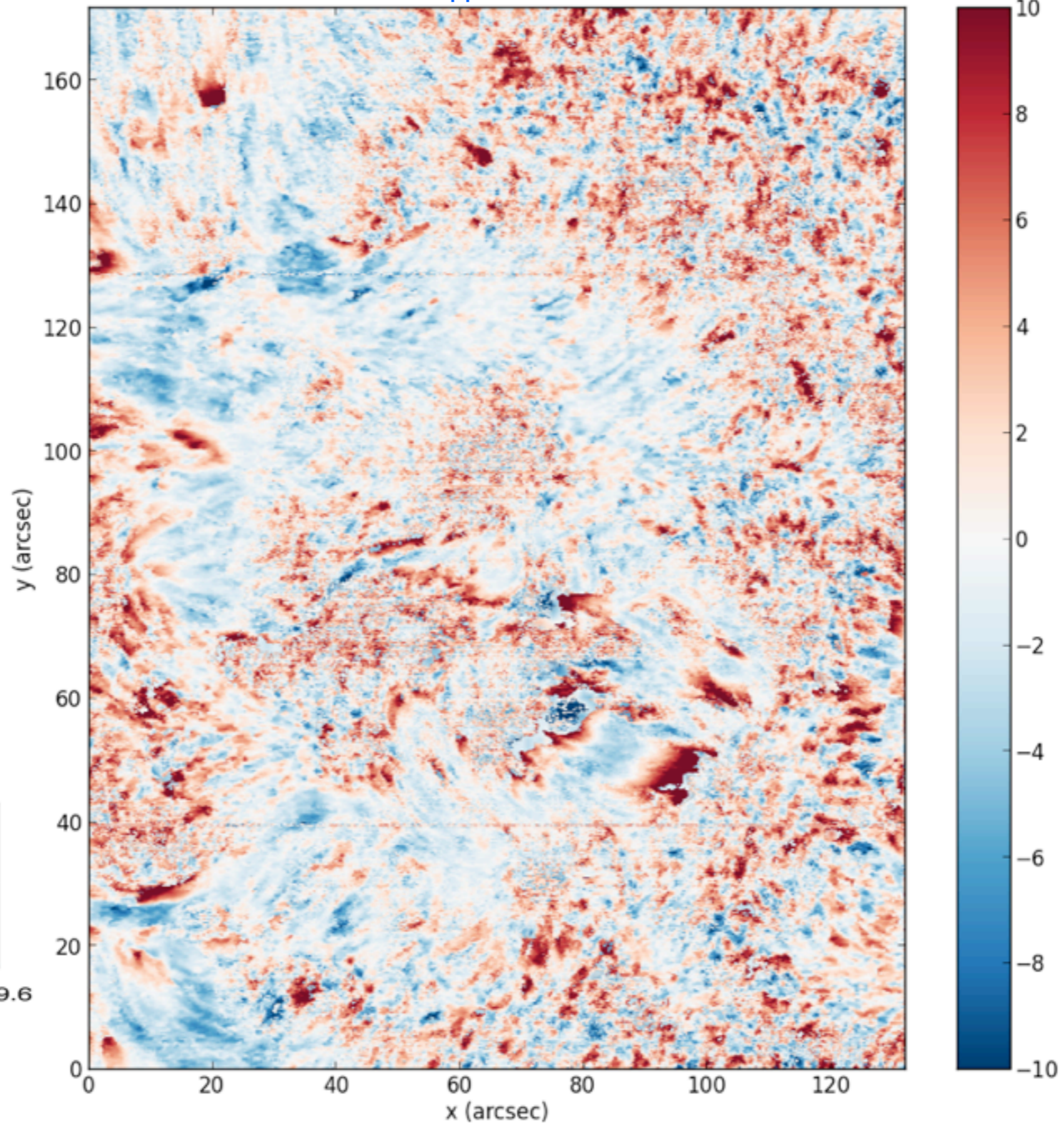
k3 Doppler shift



courtesy Tiago Pereira

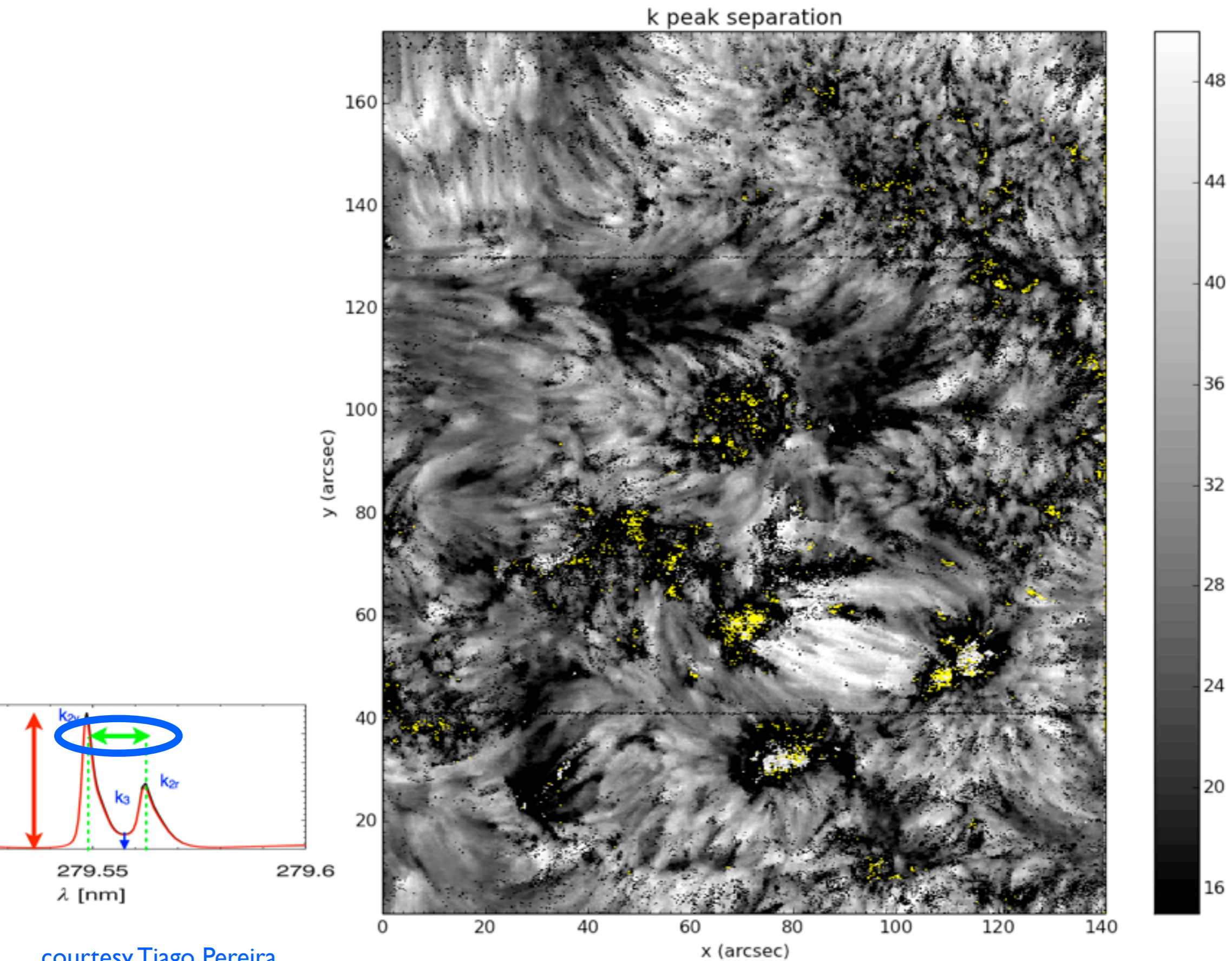
Provides diagnostics over whole range of heights: **mid chromo velocities**

k2 Doppler shift



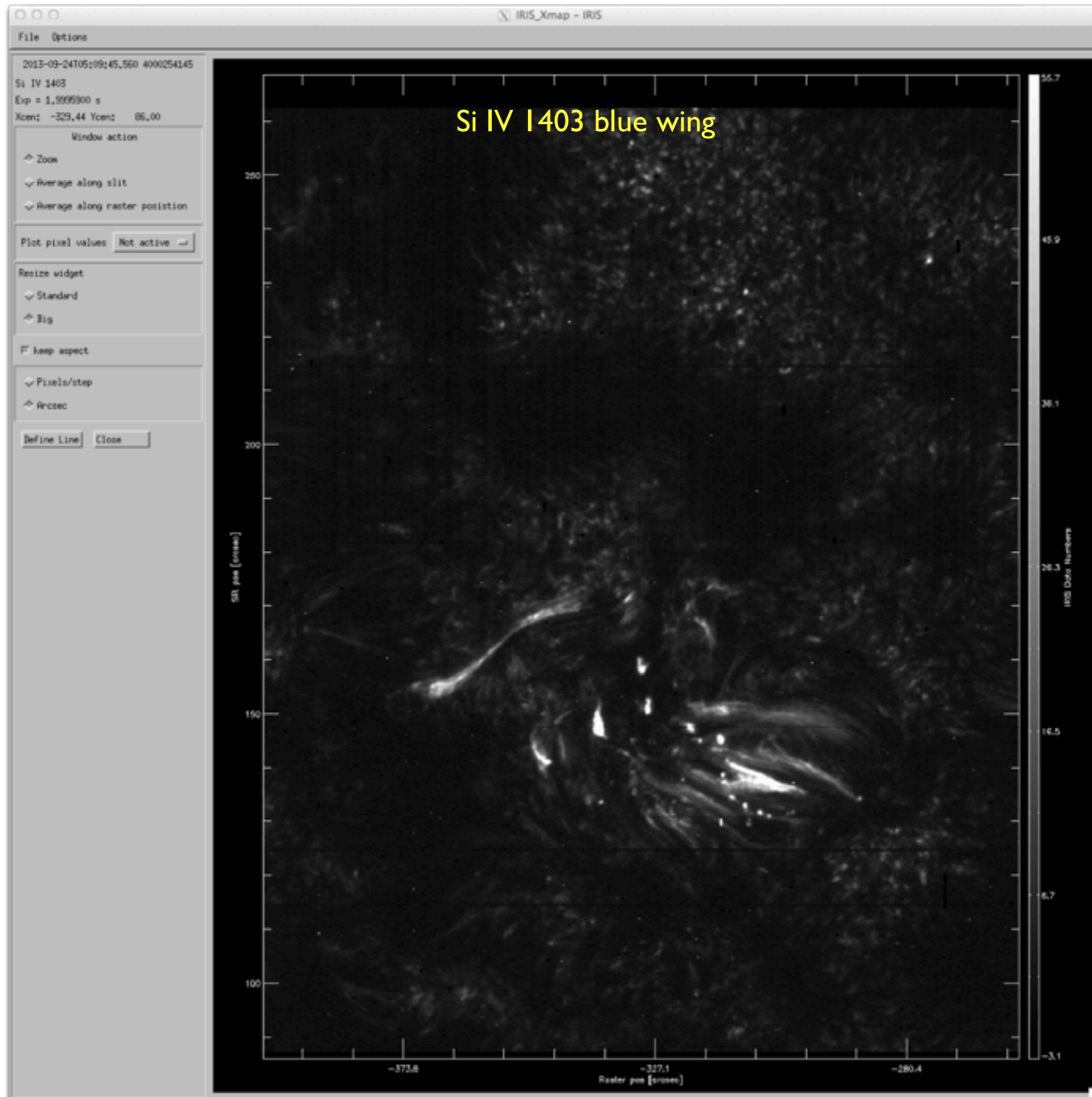
courtesy Tiago Pereira

Provides diagnostics over whole range of heights: **turbulence**



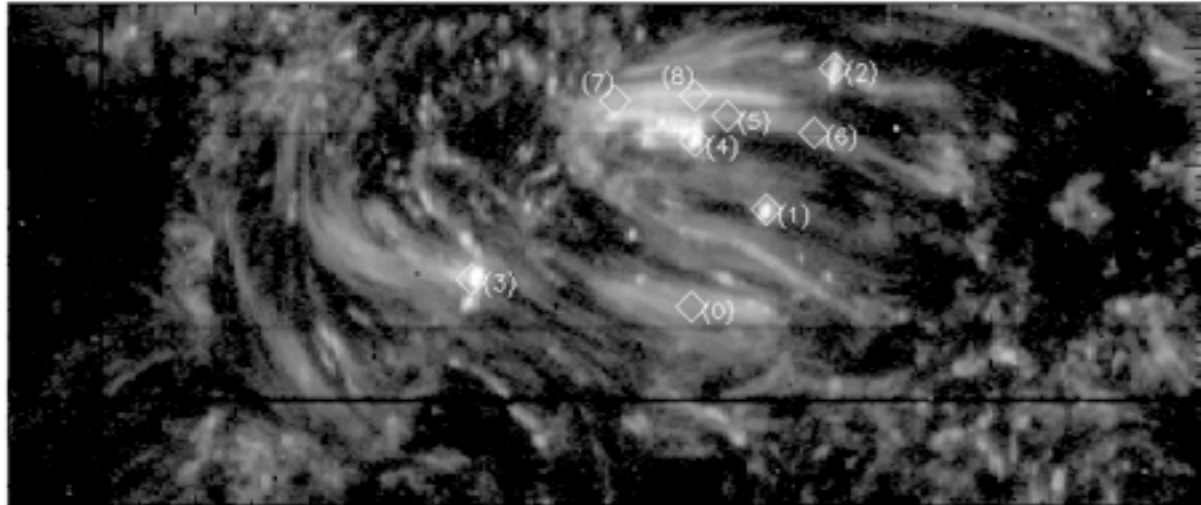
courtesy Tiago Pereira

# Importance of temperature coverage

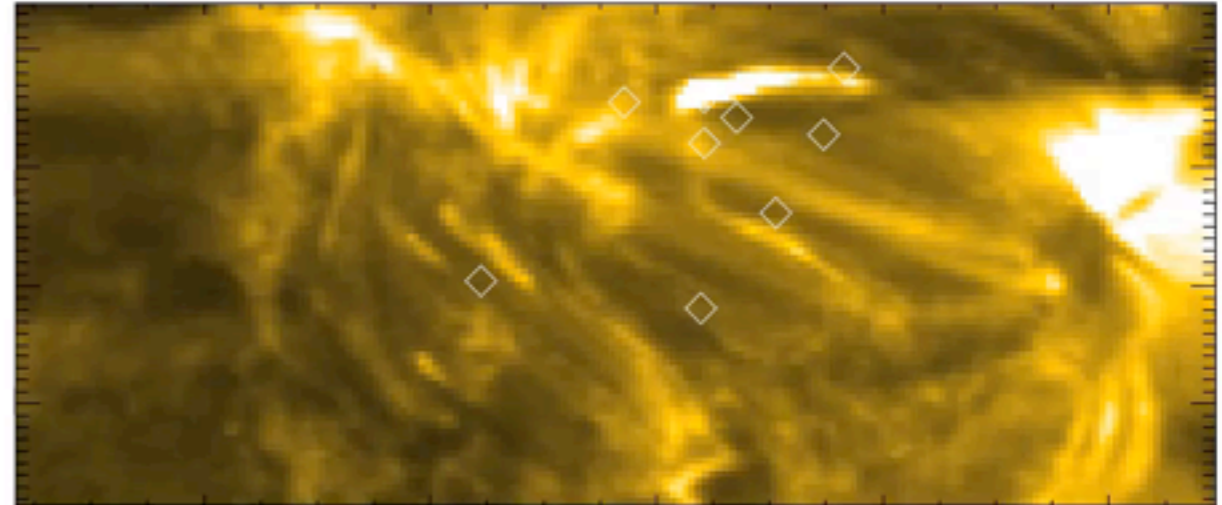


# Flux emergence

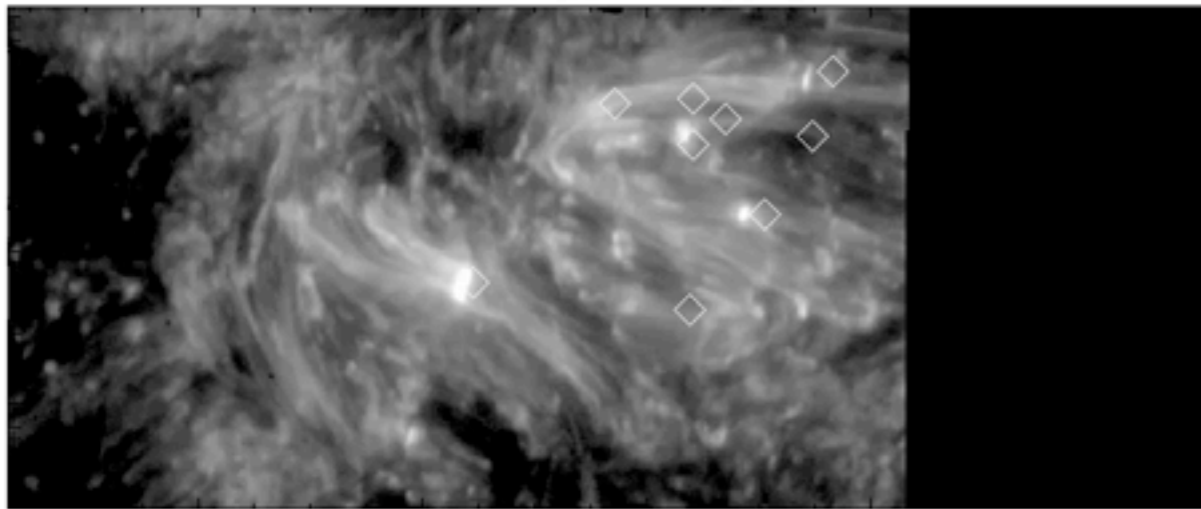
IRIS spectroheliogram: Si IV



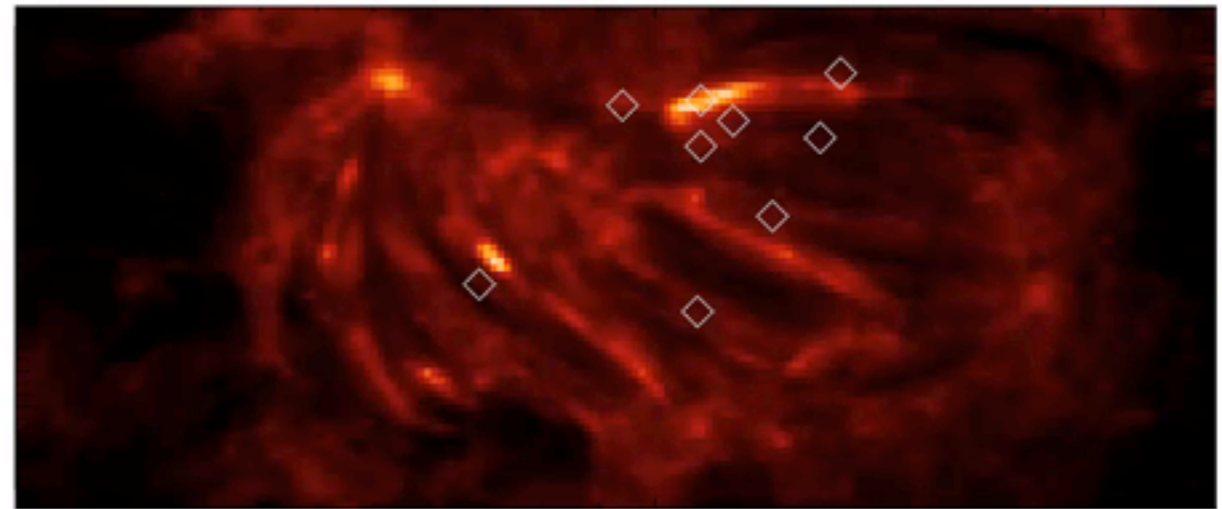
AIA 171



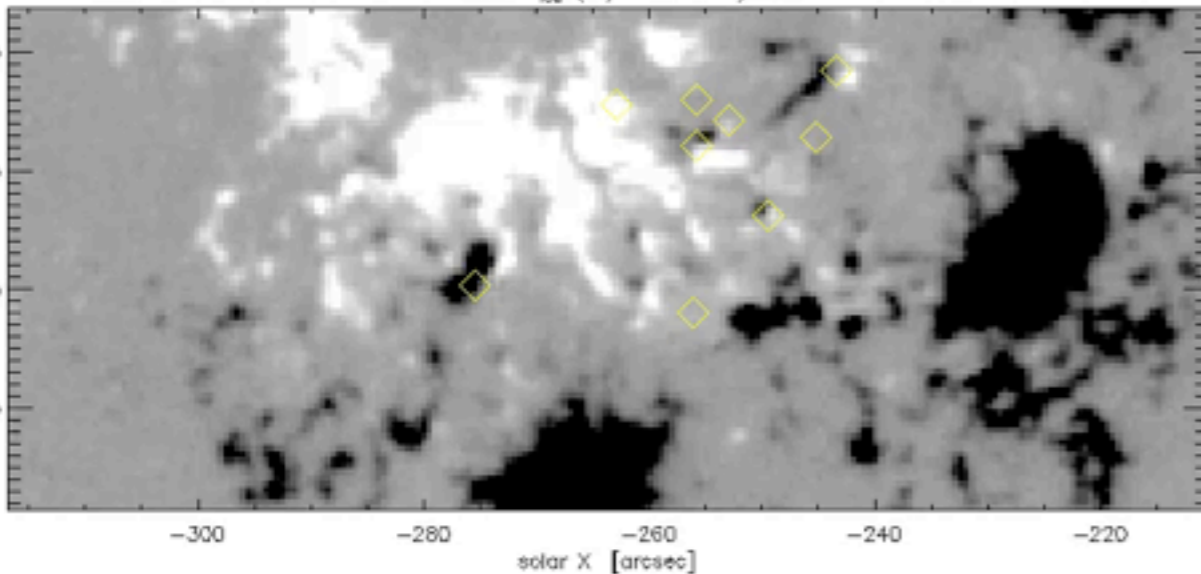
IRIS SJI 1400 151 s



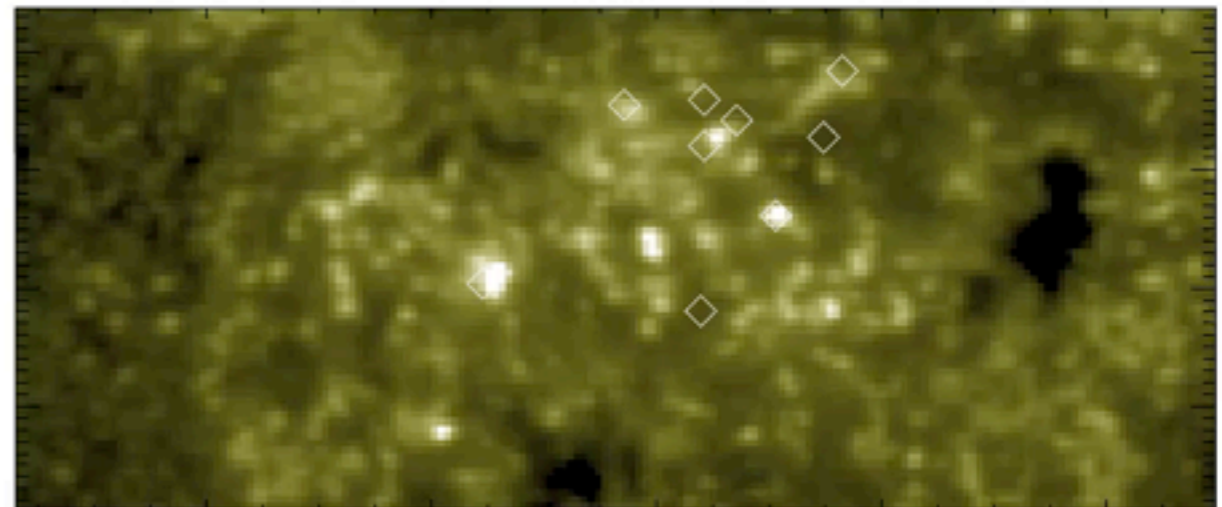
AIA 304



HMI B<sub>los</sub> (+/- 300 G)



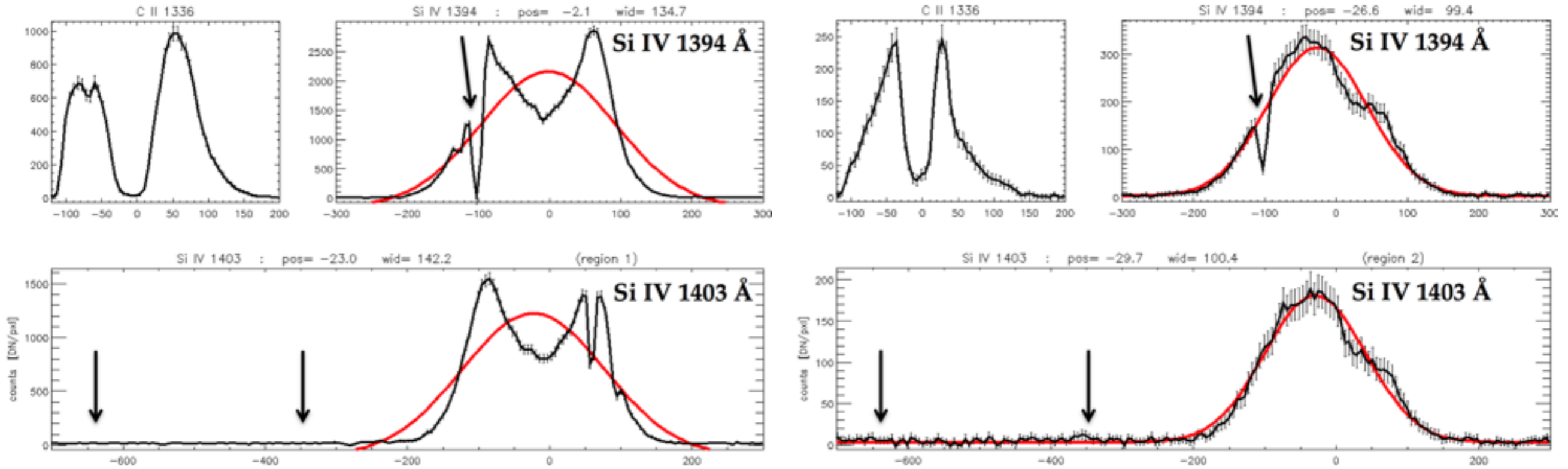
AIA 1600



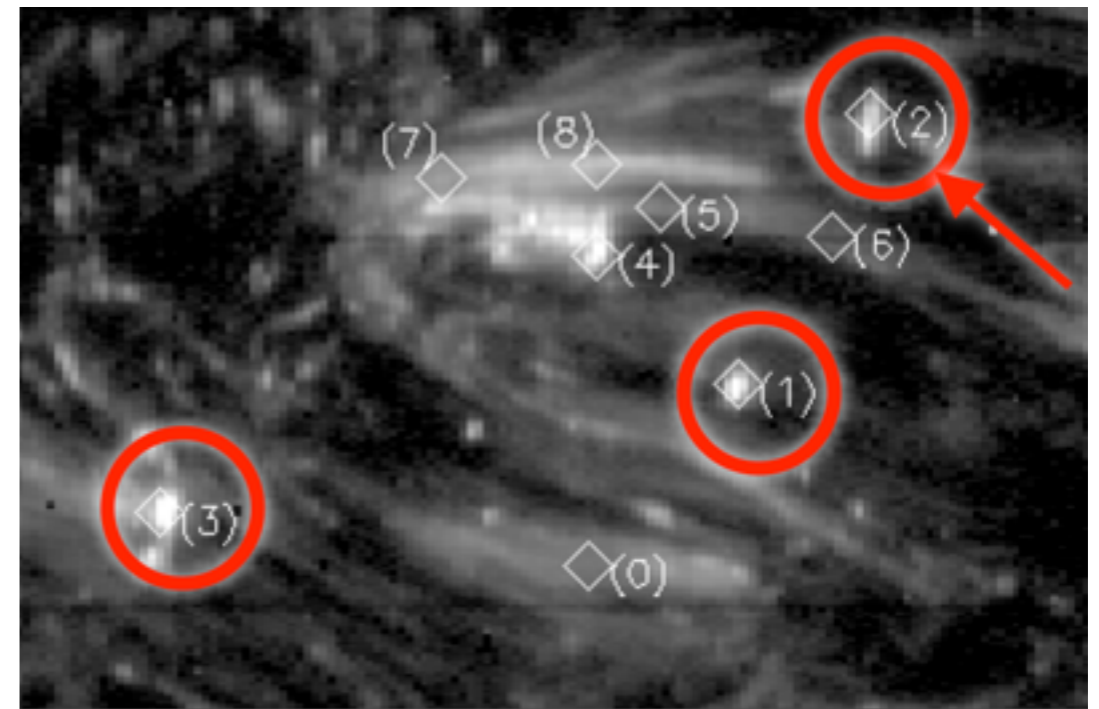
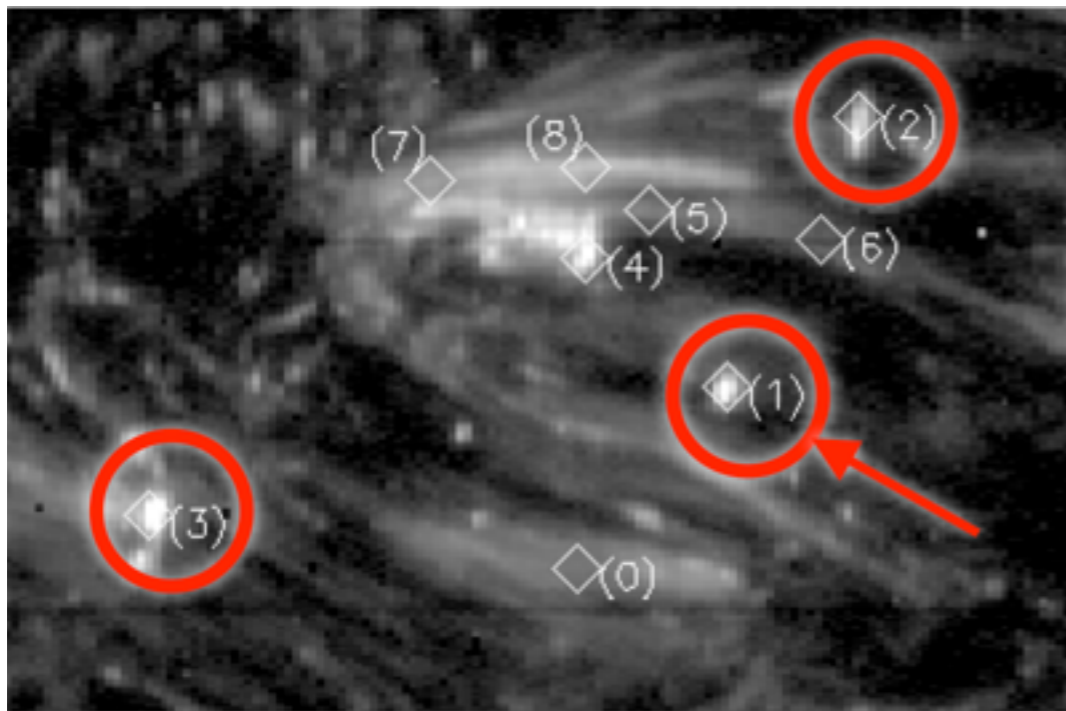
courtesy Hardi Peter

Overlying corona initially barely disturbed by emergence of TR loops

# Flux emergence and Ellerman Bombs



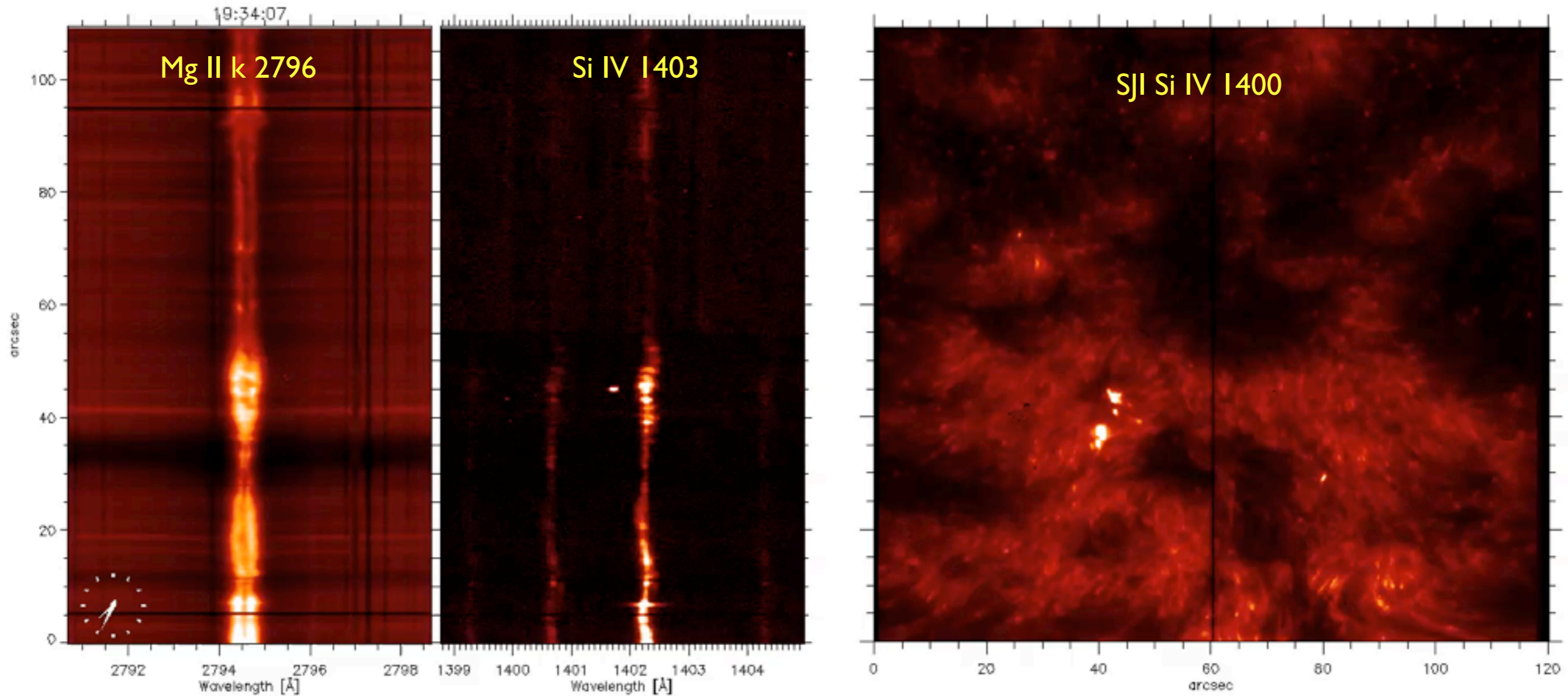
courtesy Hardi Peter



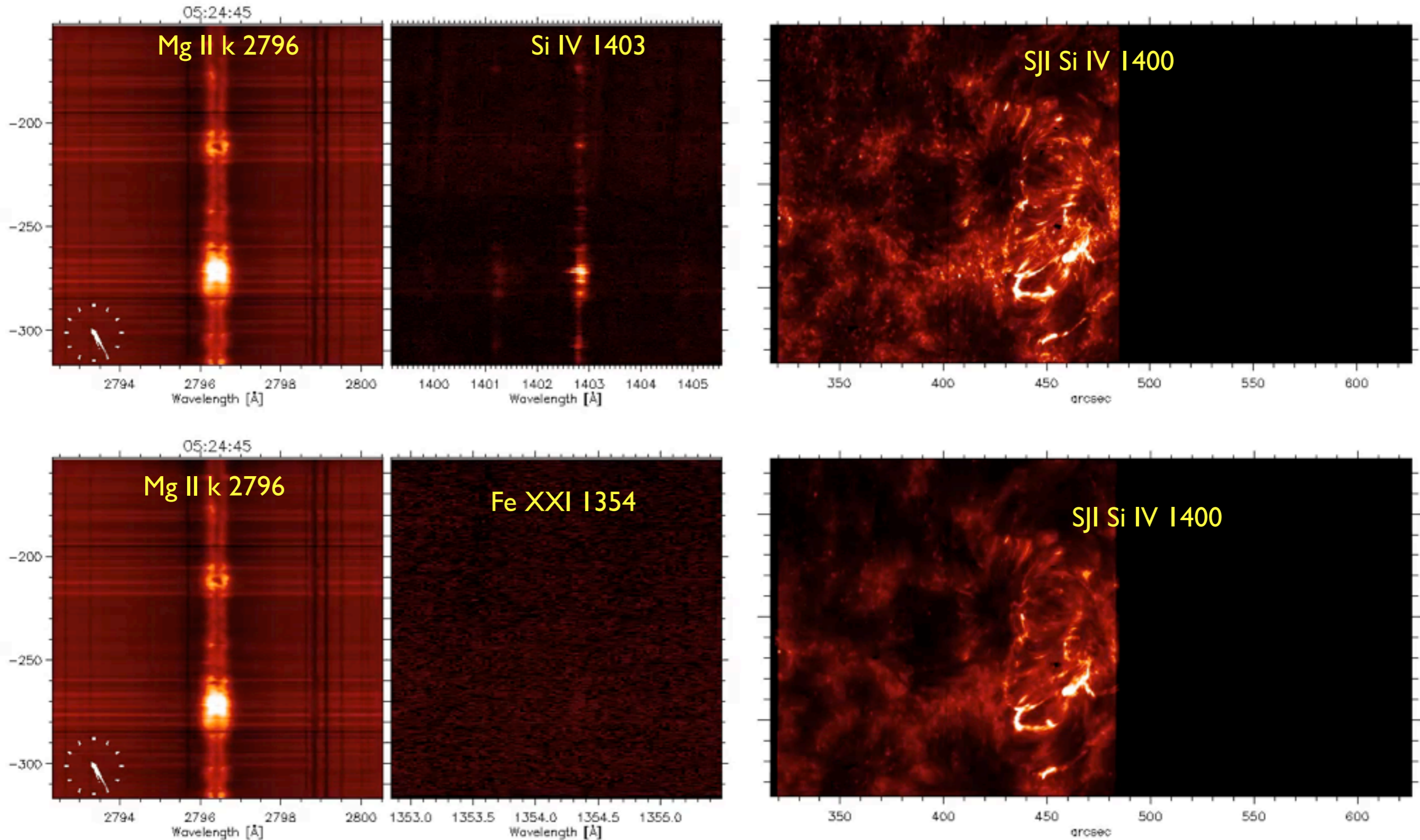
Bi-directional flows not always present

Presence of absorbing Ni II line suggests 0.1 MK formed at low chromospheric heights

Flare evolution very complex with both red- and blueshifts present in closely neighboring locations

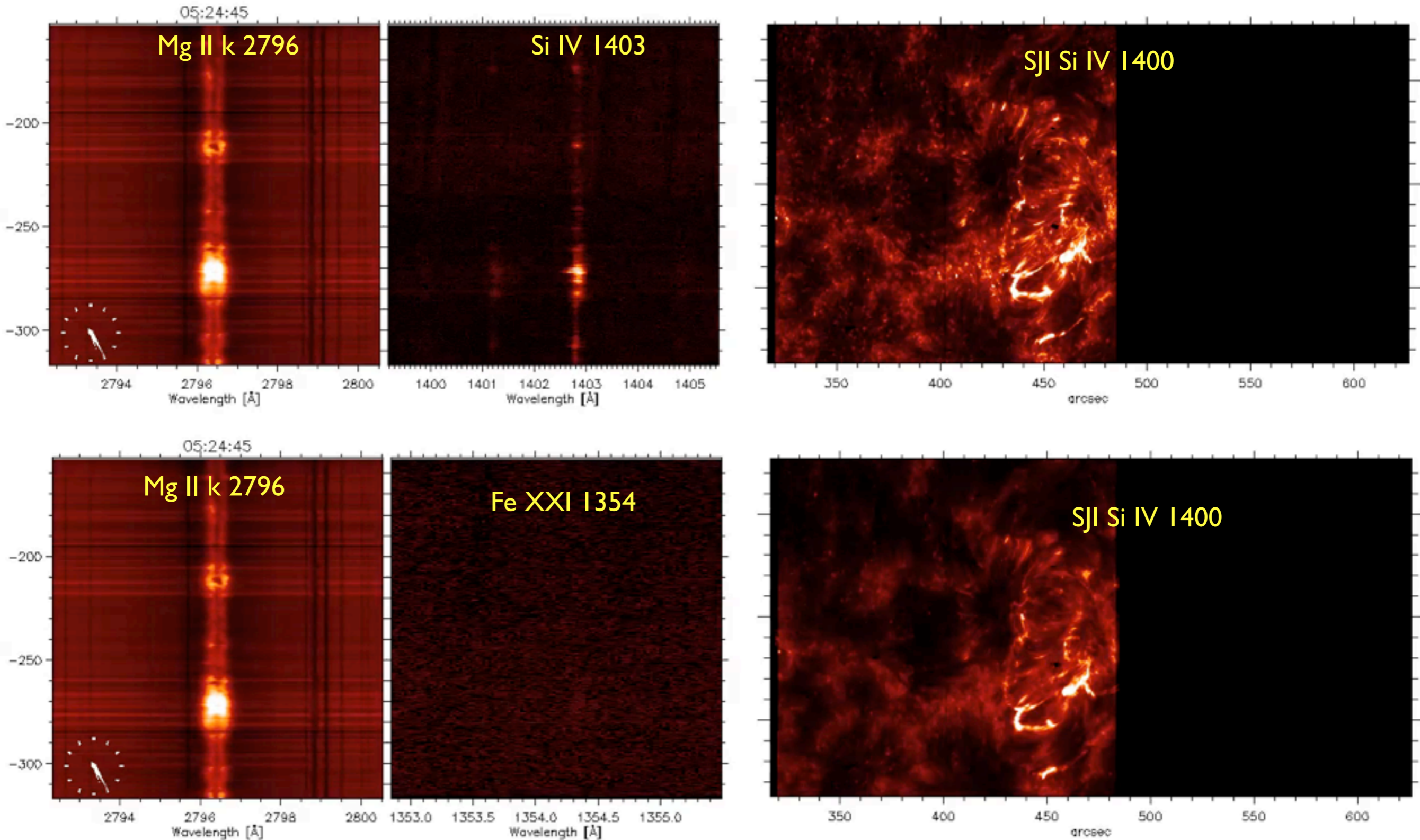


Flare evolution very complex with both red- and blueshifts present in closely neighboring locations  
Hot ( $> 10$  MK) plasma present even in small C flares

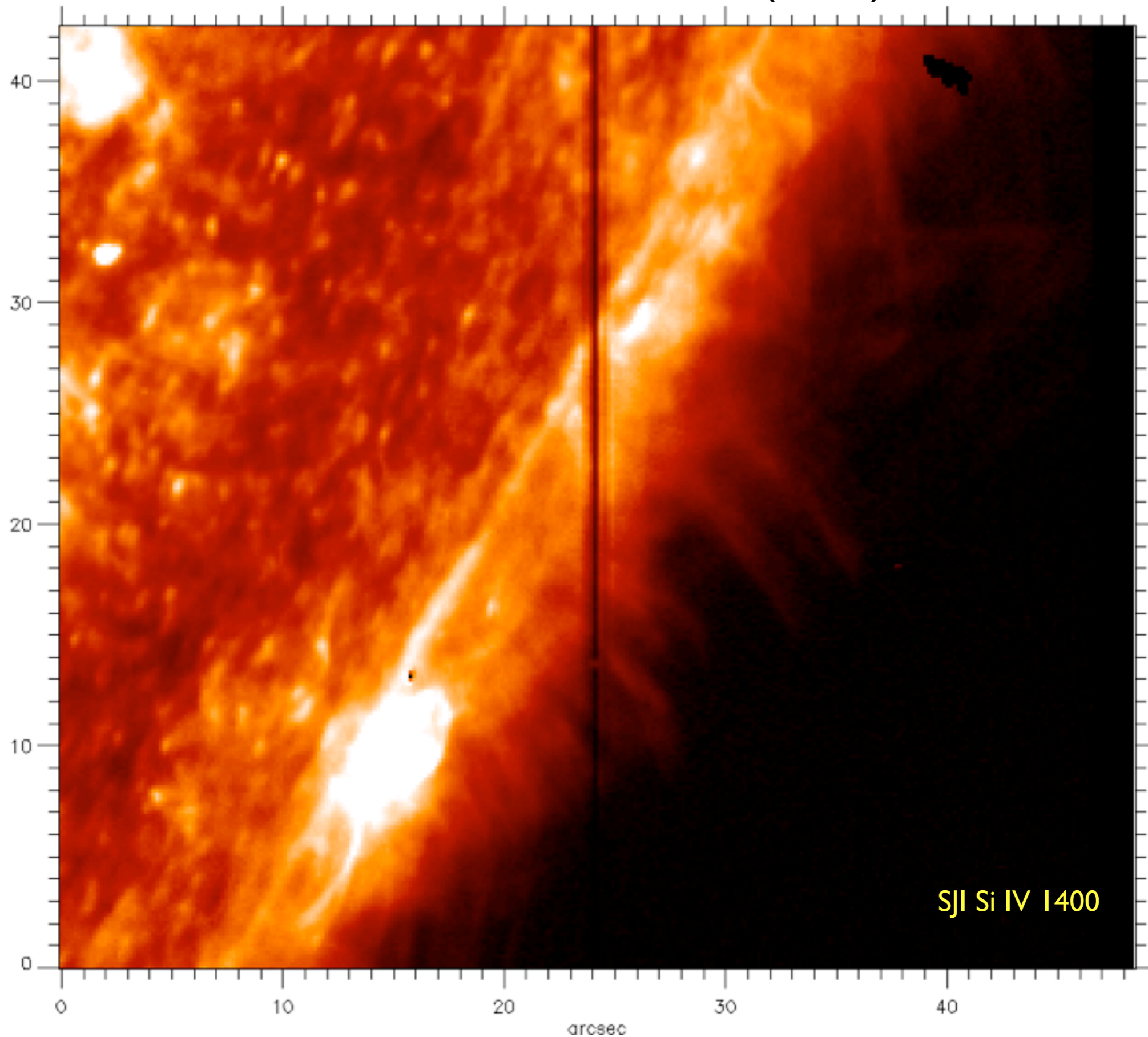




Flare evolution very complex with both red- and blueshifts present in closely neighboring locations  
Hot ( $> 10$  MK) plasma present even in small C flares

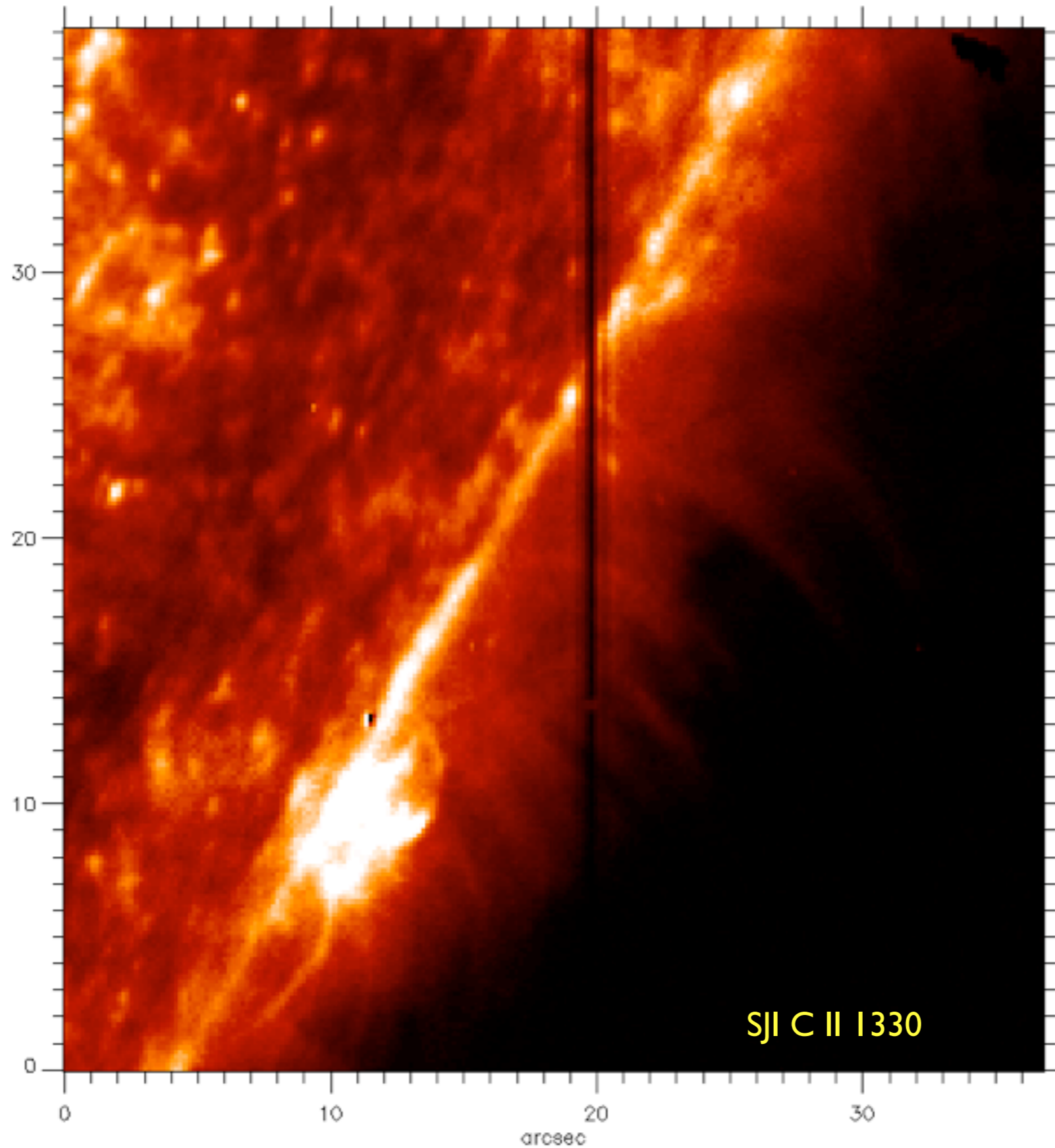


# Short, small-scale and dynamic loops prevalent at the limb Unresolved Fine Structure (UFS) resolved?



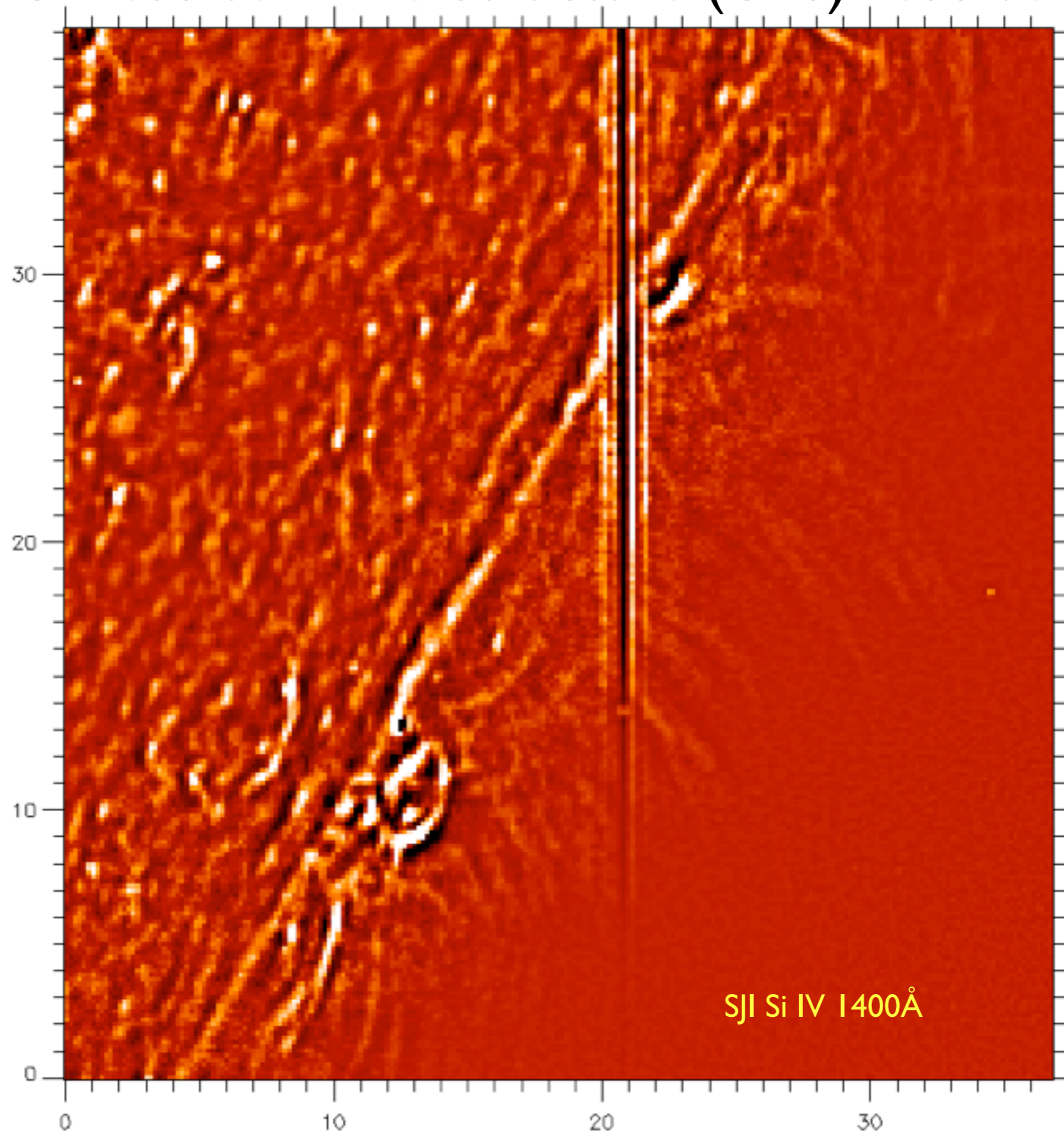
See Viggo Hansteen's talk this week

# Short, small-scale and dynamic loops prevalent at the limb Unresolved Fine Structure (UFS) resolved?



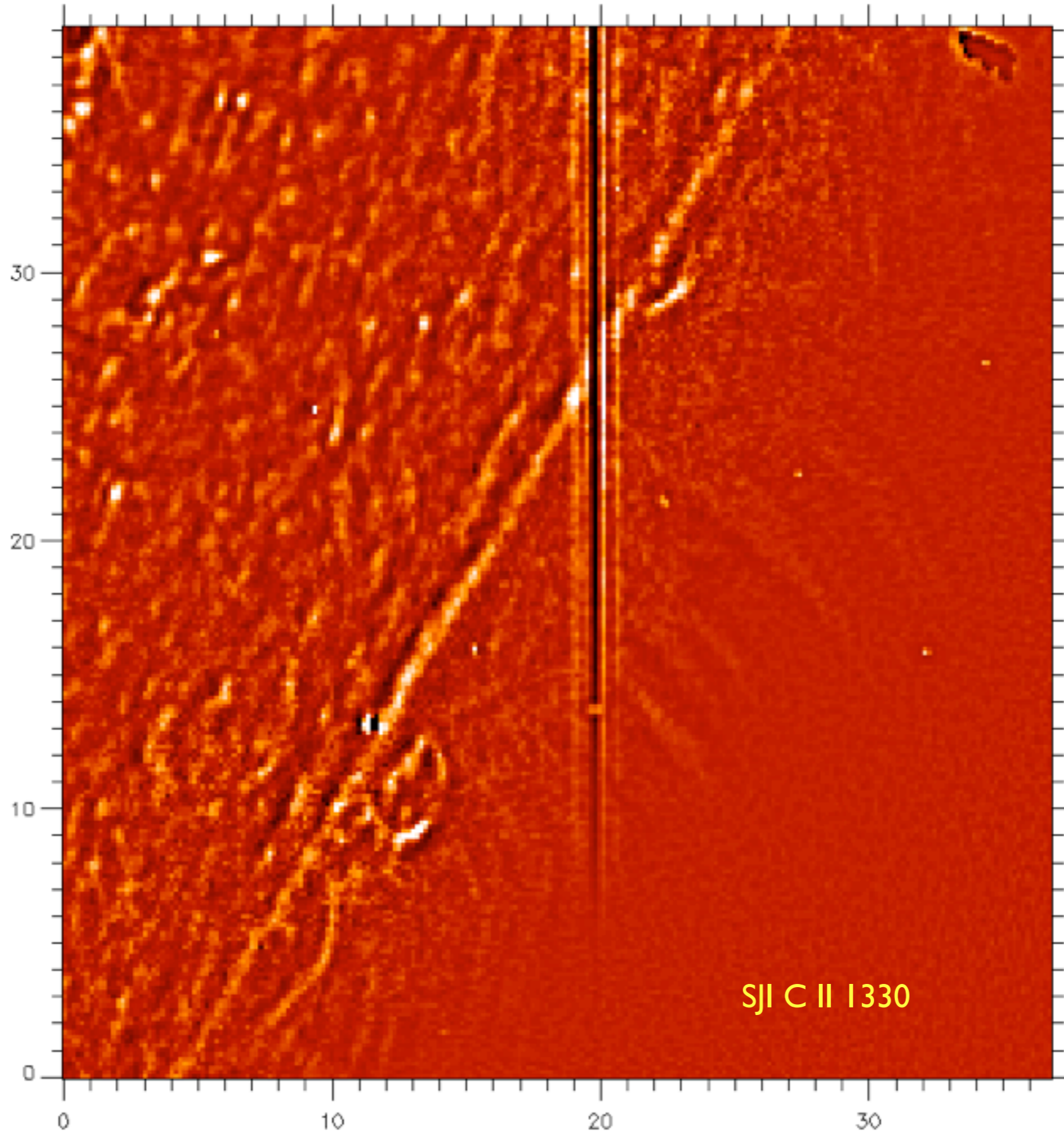
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# Short, small-scale and dynamic loops prevalent at the limb Unresolved Fine Structure (UFS) resolved?



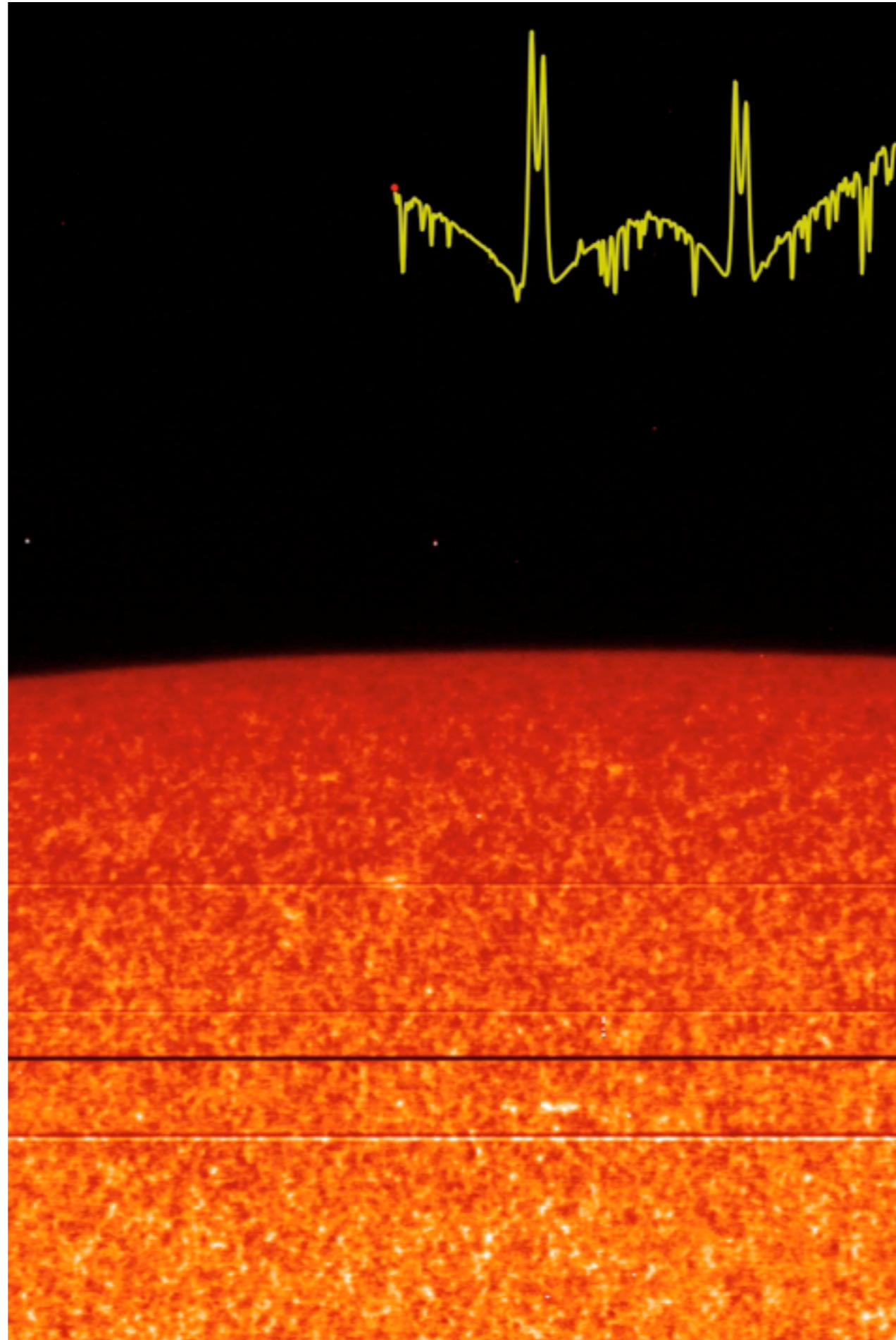
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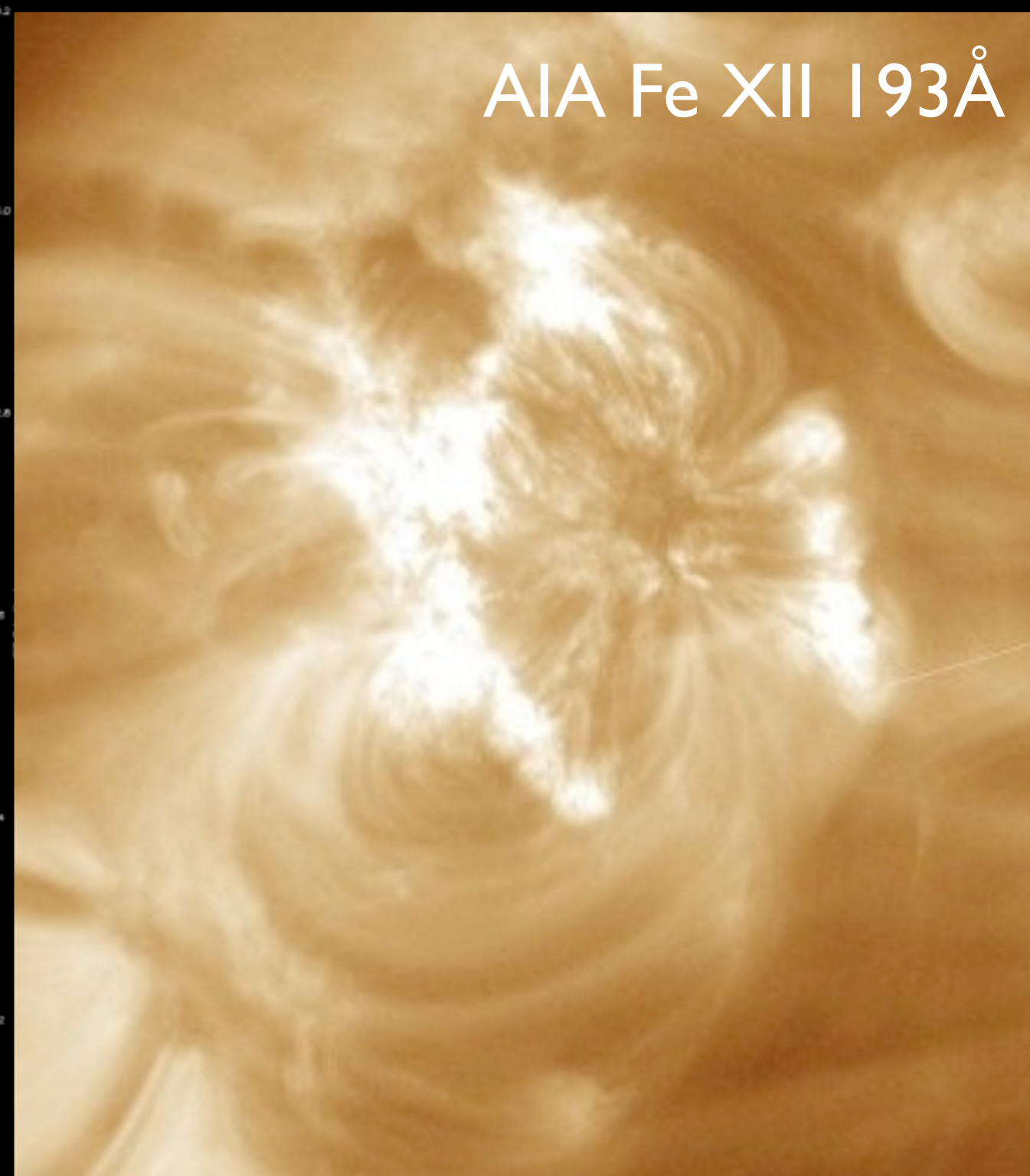
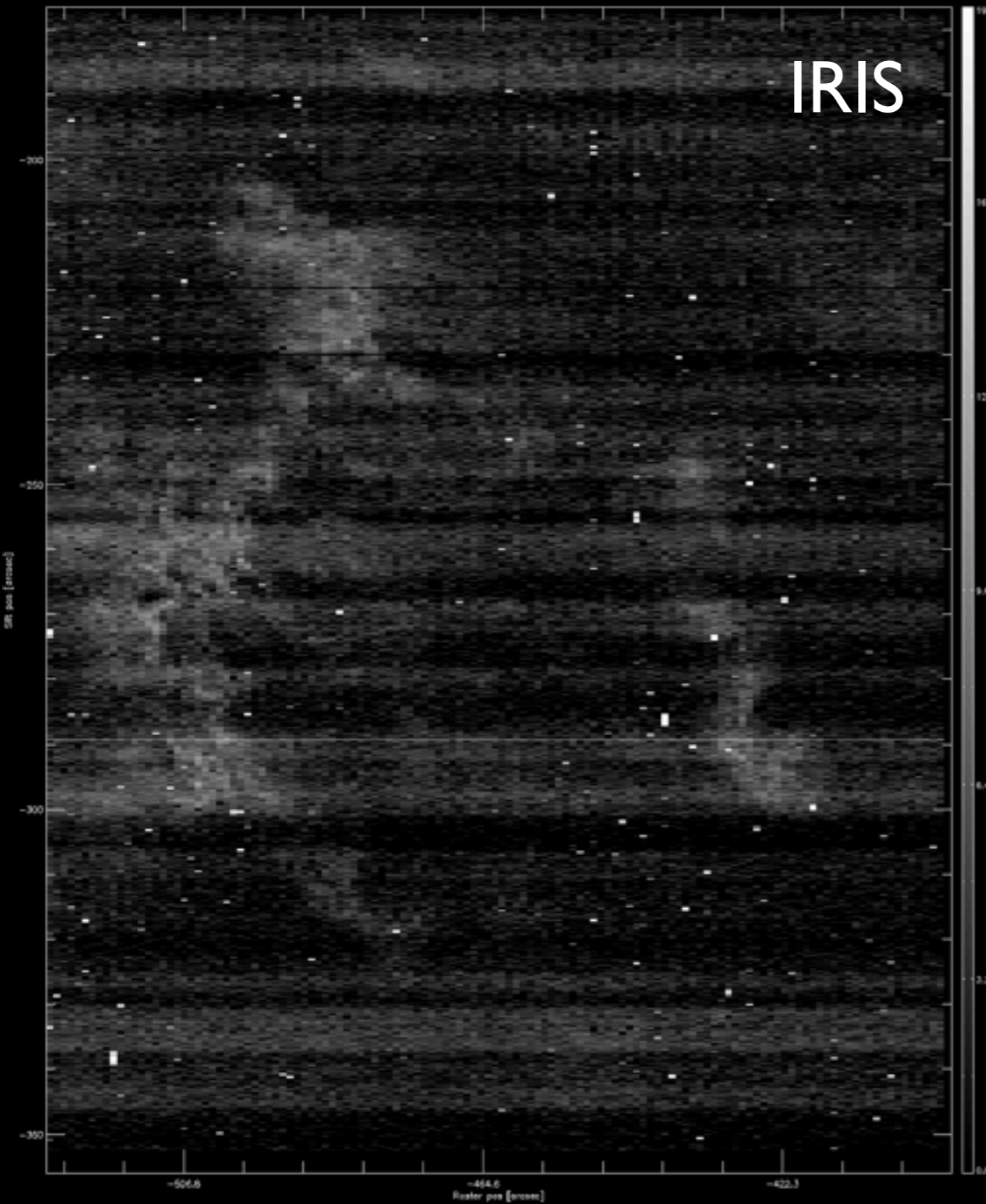
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# Diagnostic capabilities of NUV spectra



courtesy Tiago Pereira

# Coronal line Fe XII 1349Å



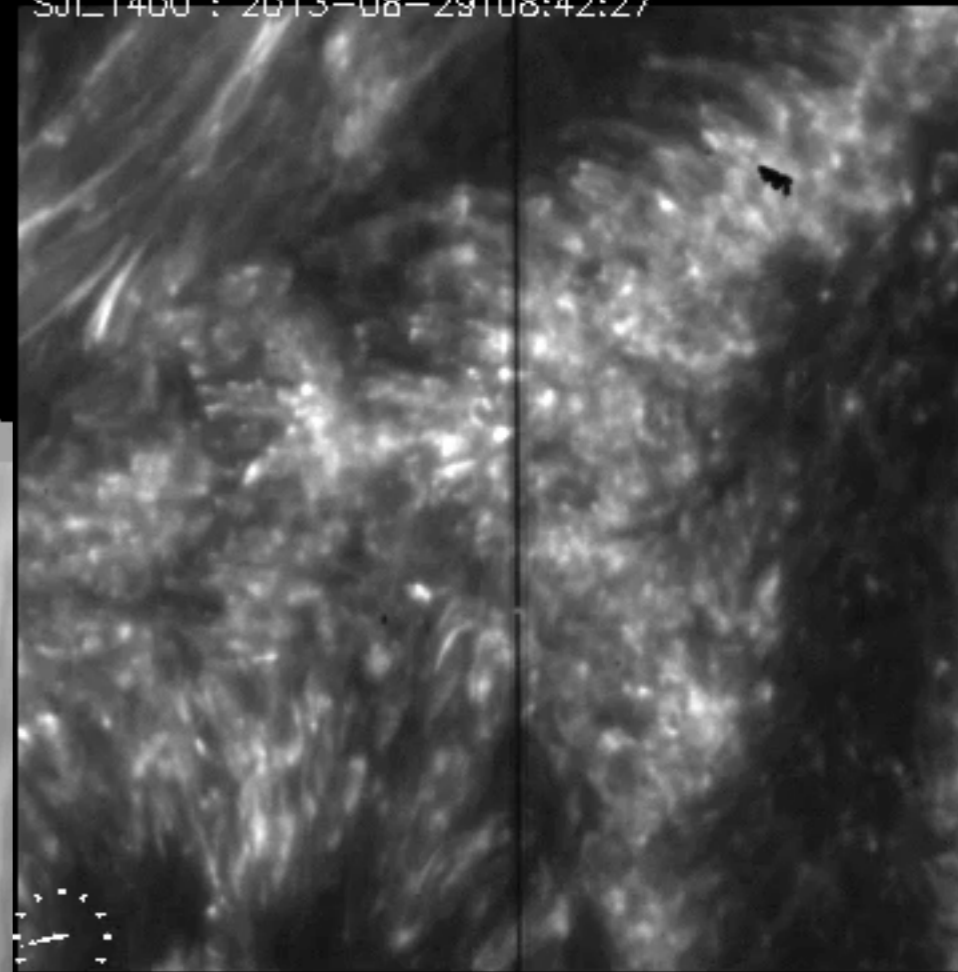
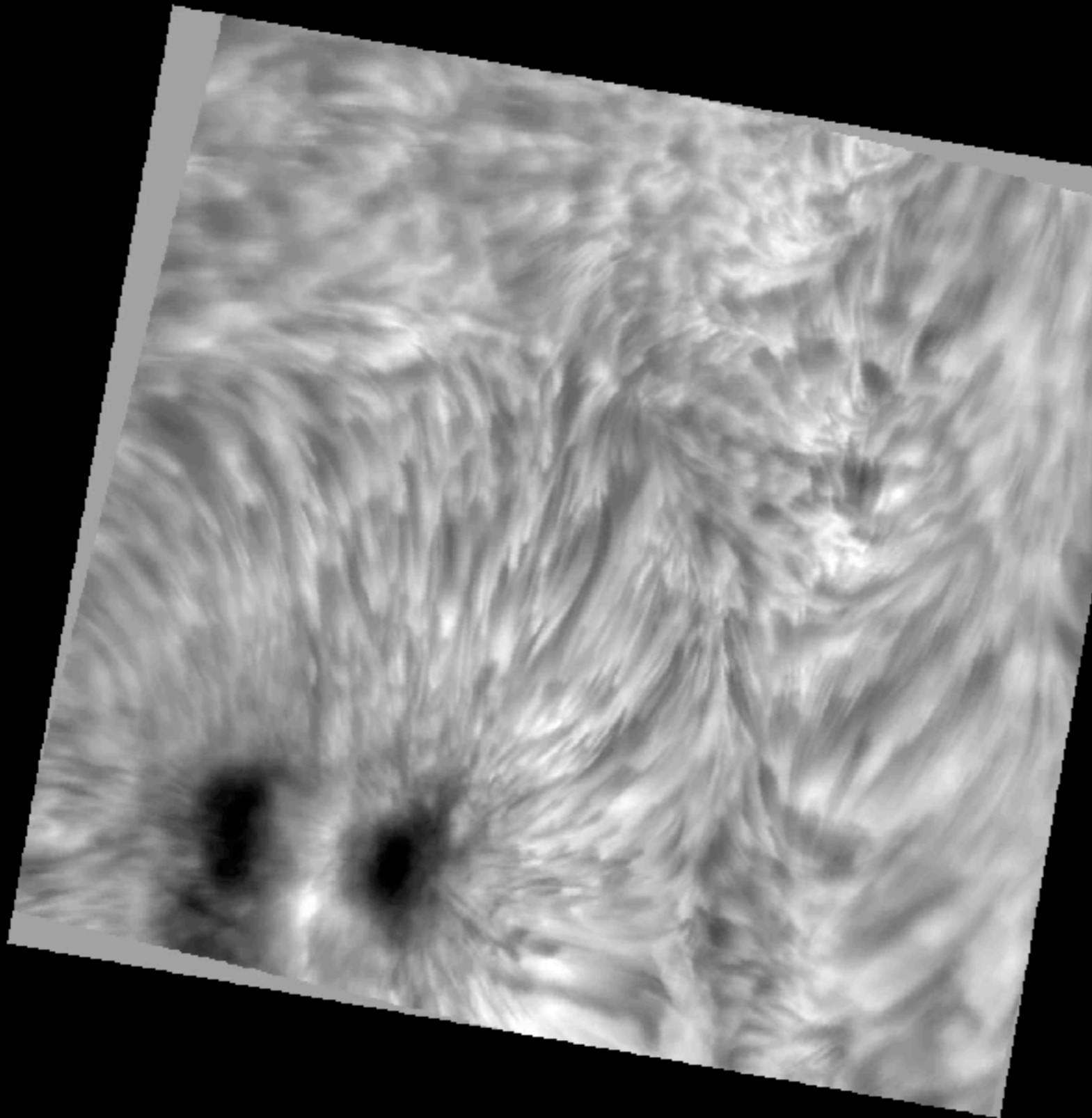
High resolution spectral scans possible,  
but line too faint for high cadence spectroscopy

# Conclusions

- IRIS functioning well: high resolution spectra and images obtained daily
- Preliminary analysis highlights include:
  - prevalence of high velocity events in chromosphere and TR
  - prevalence of twist and associated heating everywhere
  - UFS resolved?
  - Mg II k/h excellent diagnostics of chromospheric dynamics and energetics
  - connection between chromosphere and corona requires high throughput, high cadence, high resolution spectra
- IRIS data available at: <http://iris.lmsal.com/search>



# Large FOV 2D spectroscopy important

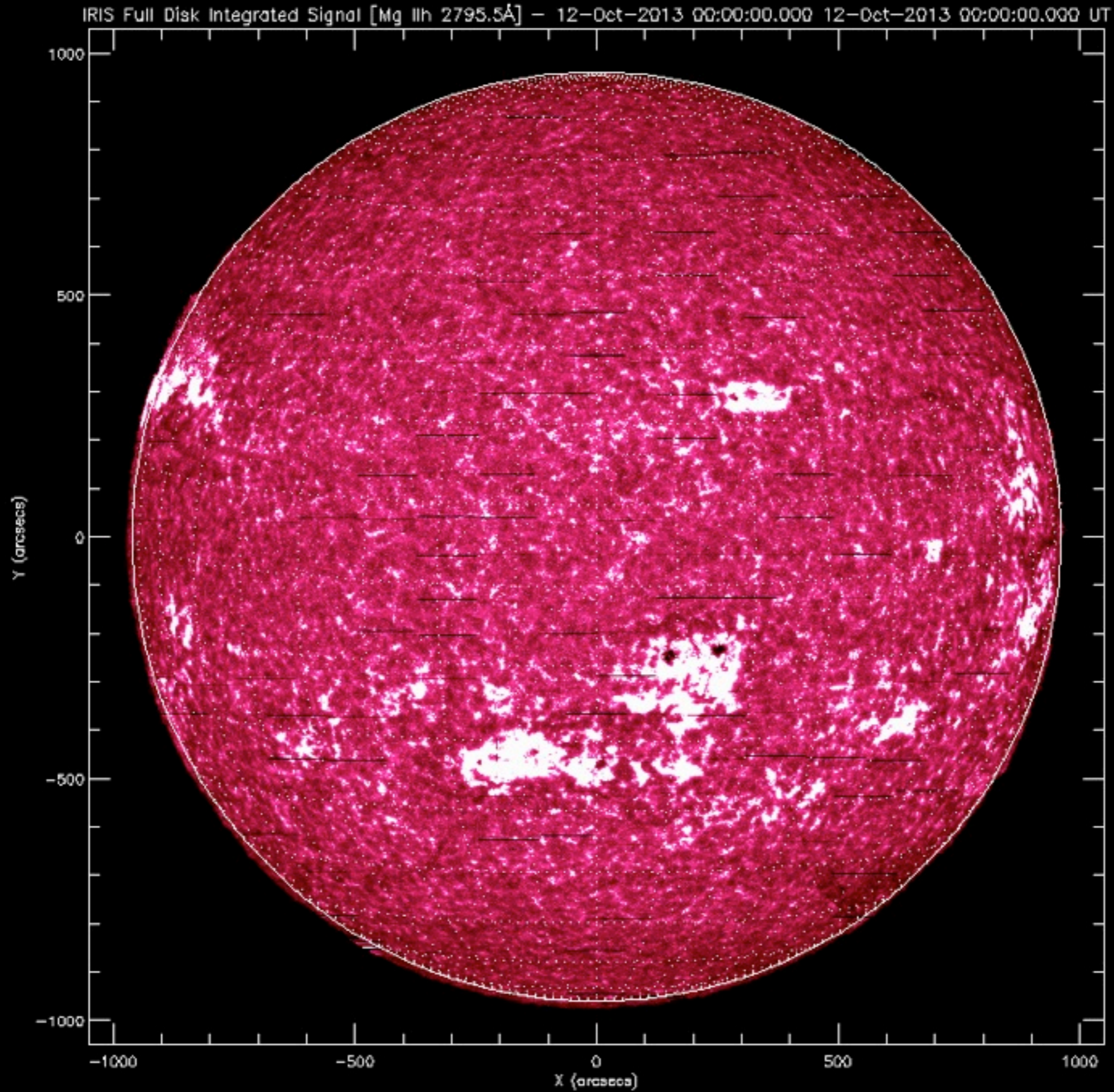


courtesy Luc Rouppe van der Voort

CRISP / IRIS not same scale / cadence



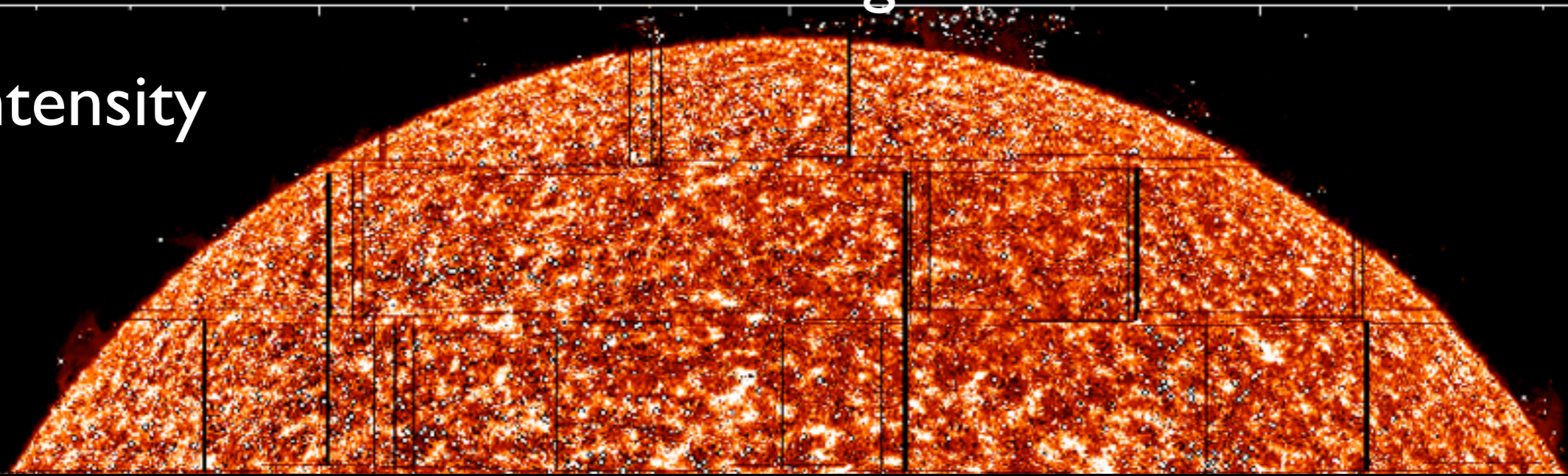
# Full disk mosaic Mg II k 2796Å



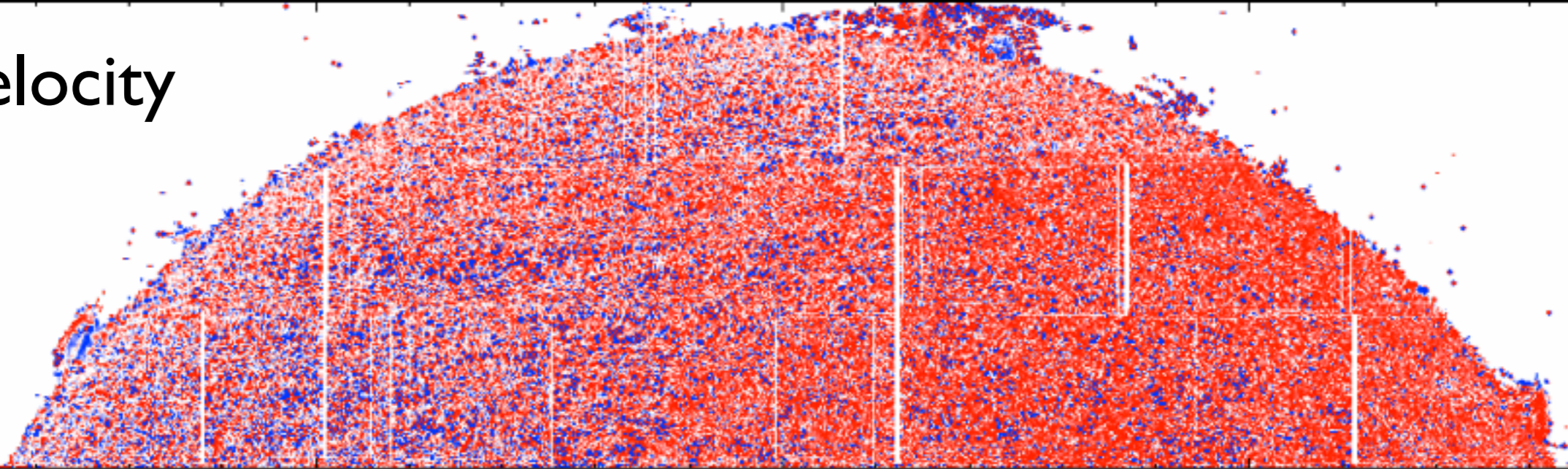
courtesy Scott McIntosh

# Full disk mosaic Mg II k 2796Å

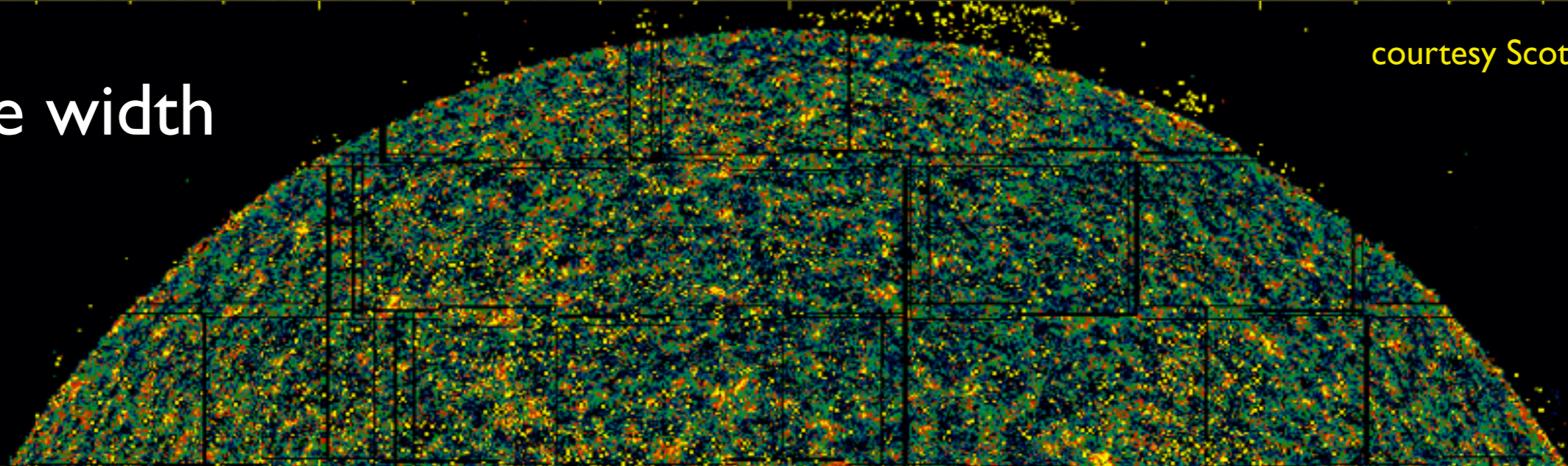
Intensity



Velocity



Line width



courtesy Scott McIntosh