



Small-scale reconnection events observed by IRIS: microflares, UV bursts and their complex configurations

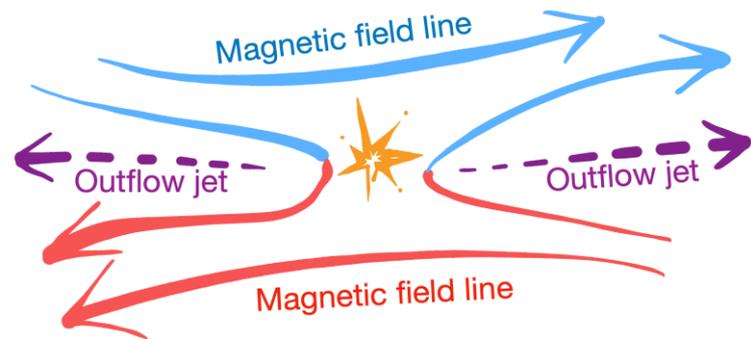
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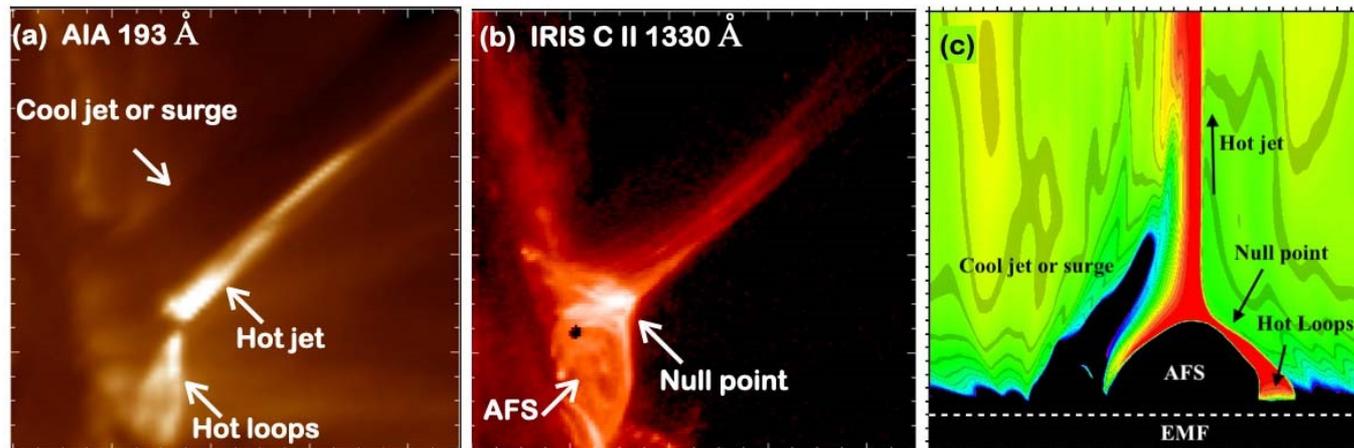
Context

- The impact of **emerging flux regions (EFRs)** on the upper atmosphere is “hot” topic in Solar Physics
- **Energy release** may occur as a result of the interaction of EFRs with the pre-existing magnetic environment
 - **brightening, ejections (surges/jets)**
 - **coronal heating?**
 - **flaring events, CMEs**
- The main responsible is **magnetic reconnection**
- Such transient enhancements all exhibit the presence of **opposite magnetic polarities** that come into contact with and/or cancel each other in the photosphere



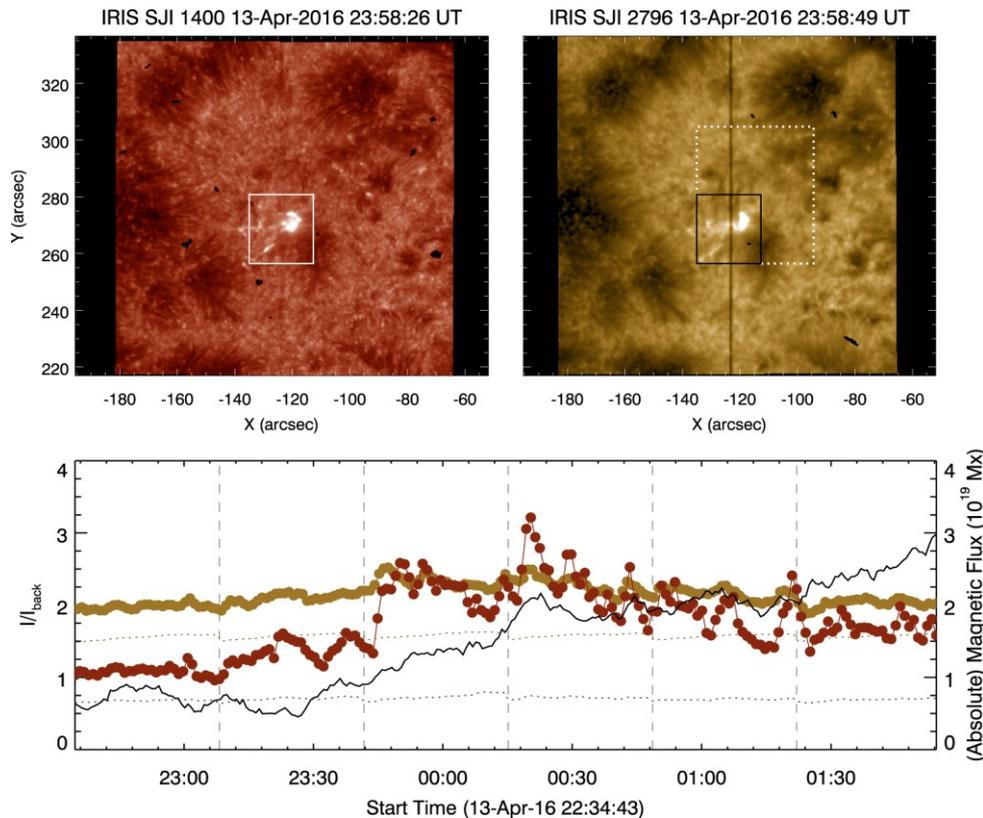
IRIS observations

- Ideal target for *Hinode* and *IRIS*, benefitting from multi-wavelength observations and spectro-polarimetry
- *IRIS* observations of small-scale EFRs and of their upper atmospheric response, allowed detecting similar events: **jets** and **UV bursts** (Young et al. 2018)



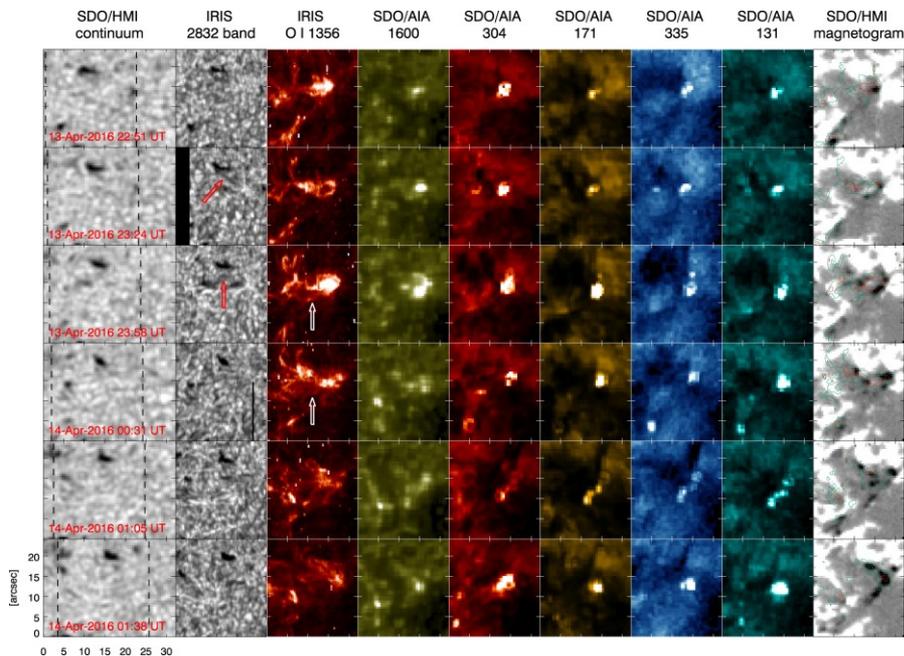
Joshi et al. (2020)

Detection of long-lasting UV bursts

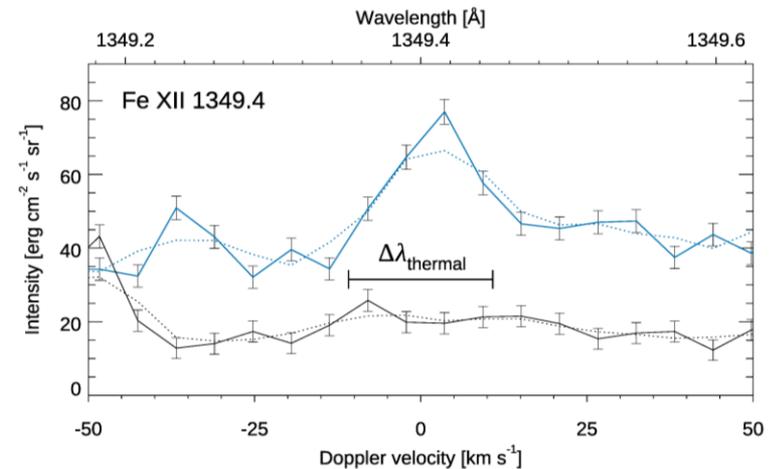


- **Guglielmino et al. (2018, 2019)** observed energy release events in an EFR emerged in a unipolar plage
- *IRIS* sequence shows **UV bursts** near the “contact” region between a pre-existing **P⁺** and new flux forming **P⁻**

Coronal response to the UV bursts



- **All** SDO/AIA channels exhibit a counterpart of the event



- Confirmation by *IRIS*
 - spectrum around the **Fe XII coronal line**, obtained by **summing the signal** in the region around the **UV burst core**
 - **black line**: background

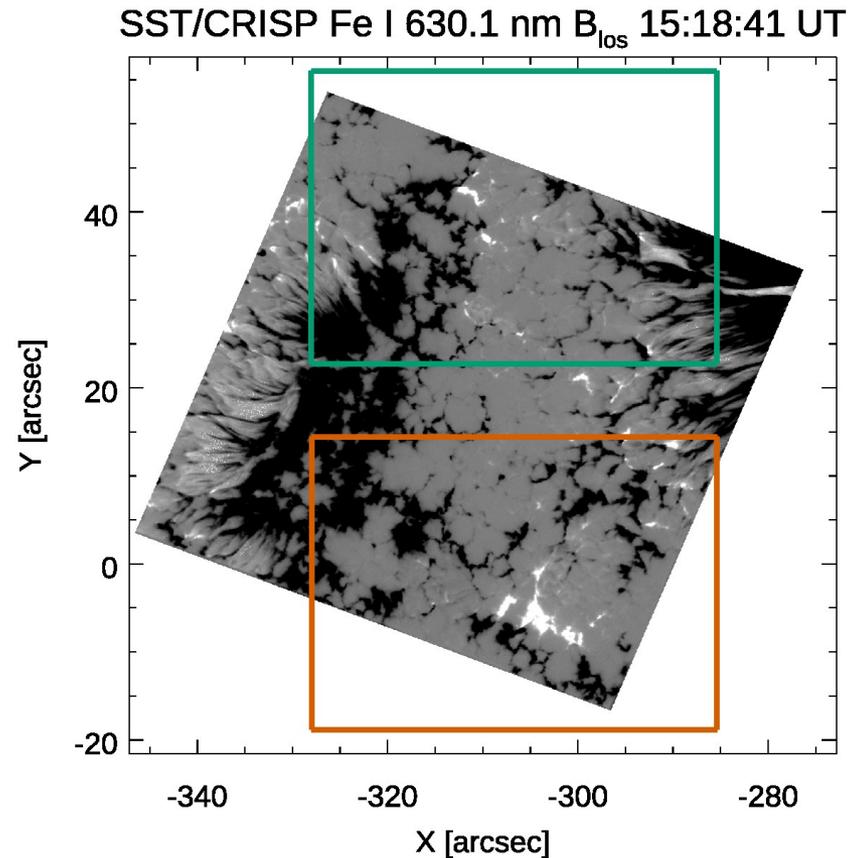
IRIS observations of reconnection events: preliminary results

ACTIVE REGION NOAA 12585 – SEPTEMBER 2016

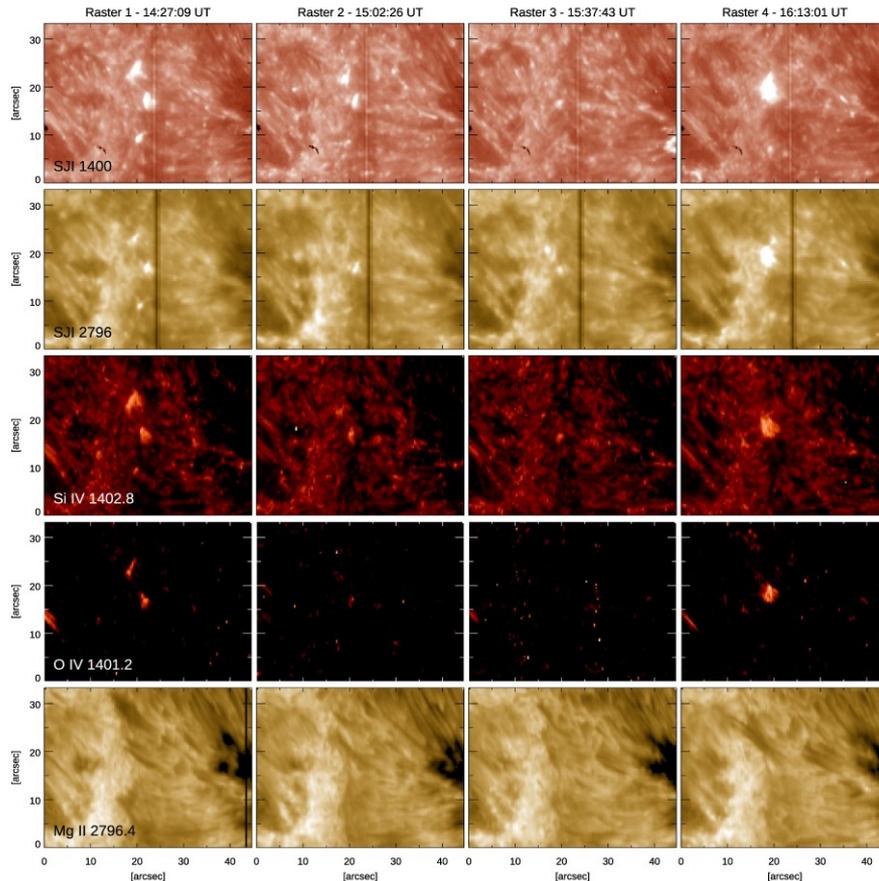
Dataset and context

- Active region NOAA 12585 observed during decay phase (Murabito et al. 2021)
- Interacting small-scale magnetic patches observed in the moat around the leading spot
- **IRIS** acquired a sequence during AR evolution
 - It consists of 4 very large dense 128-step rasters, with simultaneous slit-jaw images (SJIs) in the 1400 and 2796 Å passbands
 - The scan sequence has a 0".35 step size, a 16.5 s step cadence, and a 15 s exposure time, with a raster cadence of about 35 min
 - It was acquired between 14:09 UT and 16:39 UT on 2016 September 4
- High-resolution spectroscopic and spectropolarimetric data provided by **SST** (single frame)
courtesy of **L. Ruppe Van der Voort** and **D. Nóbrega-Siverio**

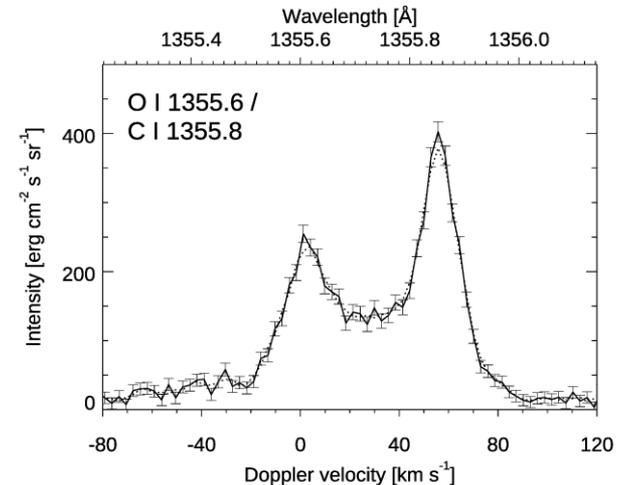
SST field-of-view



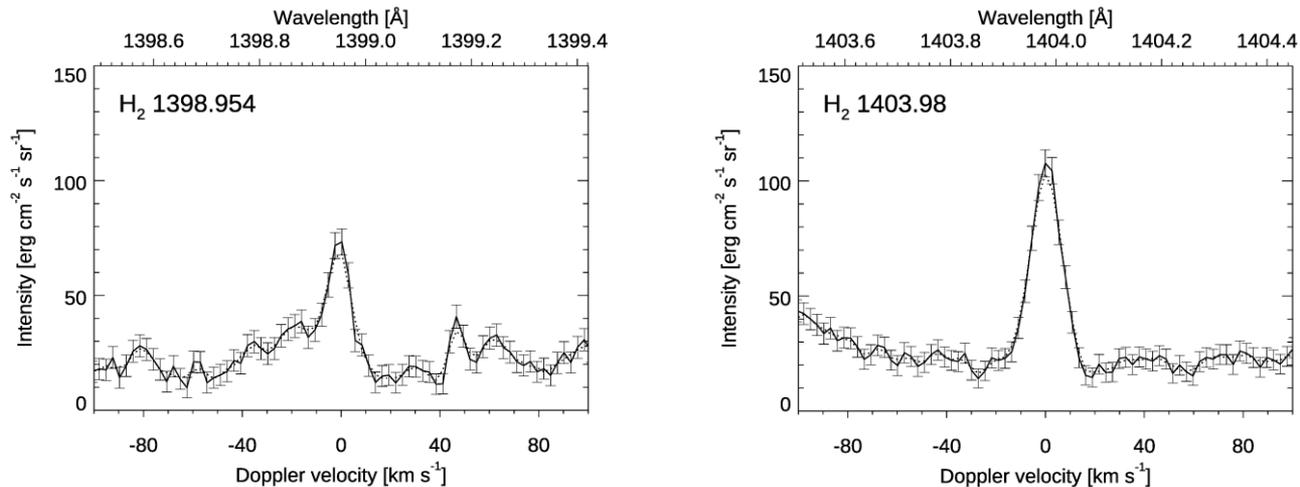
Analysis of a UV burst



- Occurring between a MMF streaming from the spot and an opposite magnetic patch
- Clearly observed in **SDO/AIA**
- Inverted C I / O I ratio as in flares (Cheng et al. 1980)



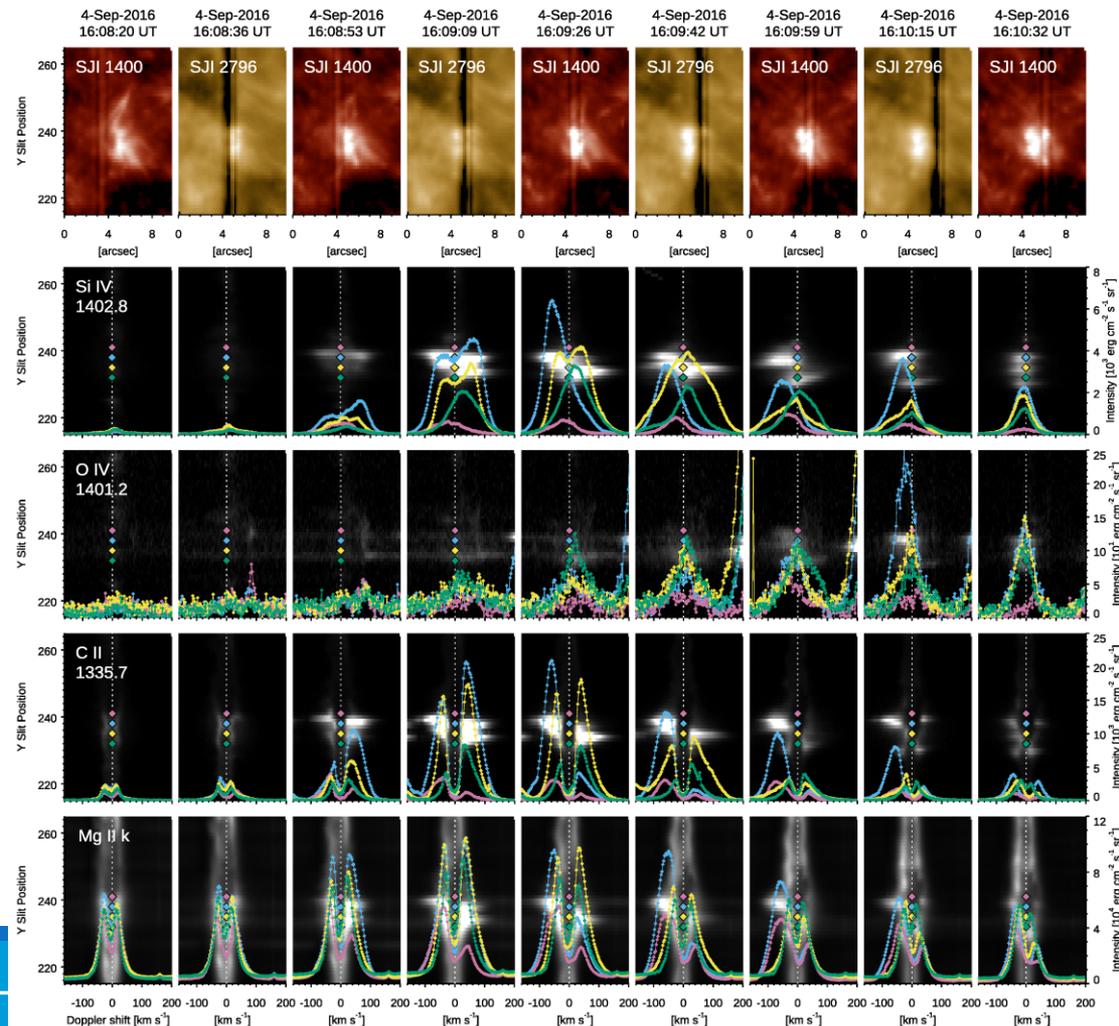
Molecular hydrogen emission lines in UV spectra



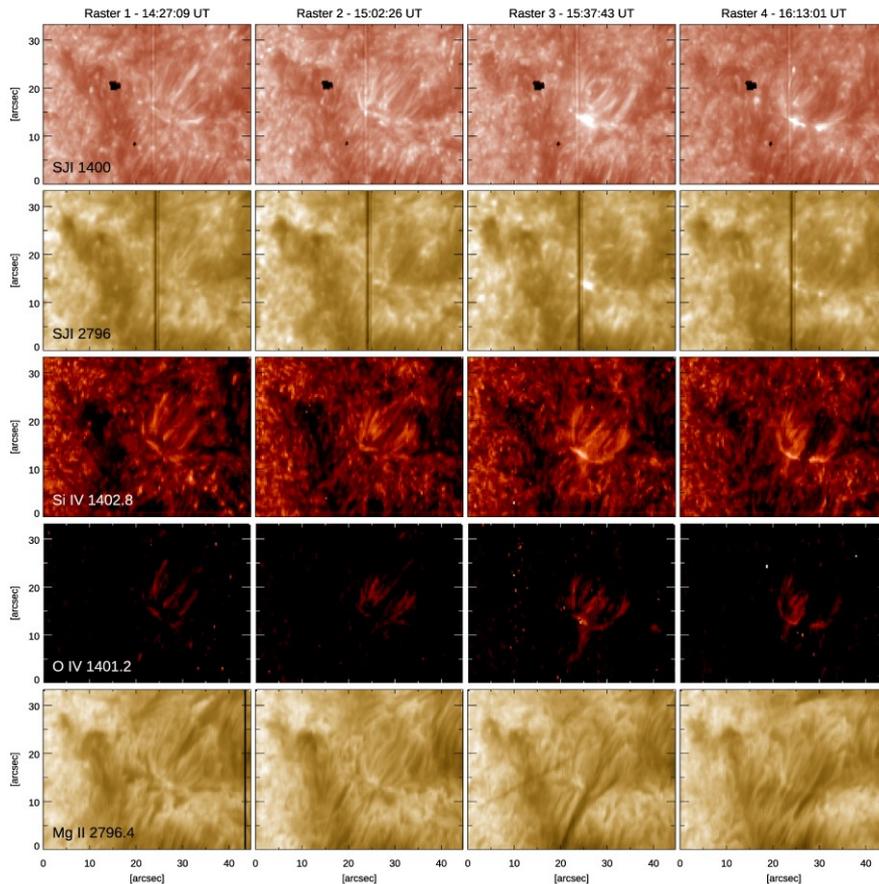
- Noticeably, **H₂ emission lines** are found in the UV burst spectra: which correlation with H₂ in flares?
- Origin: fluorescence effects?
- Need to be supported by **other observations**

Evolution of UV spectra

- Bi-directional flows up to $\pm 100 \text{ km s}^{-1}$
- O IV line mainly at the edge
- C II with asymmetry
- Enhancements also at the chromosphere

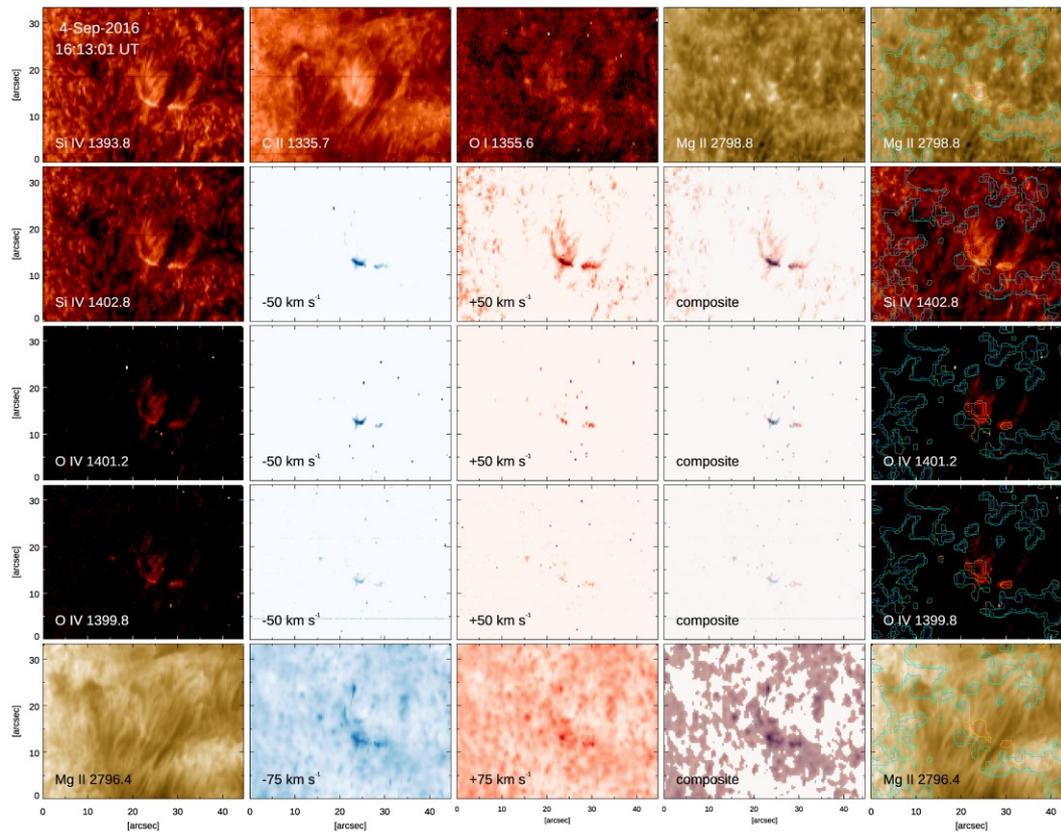


Reconnection in an arch filament system



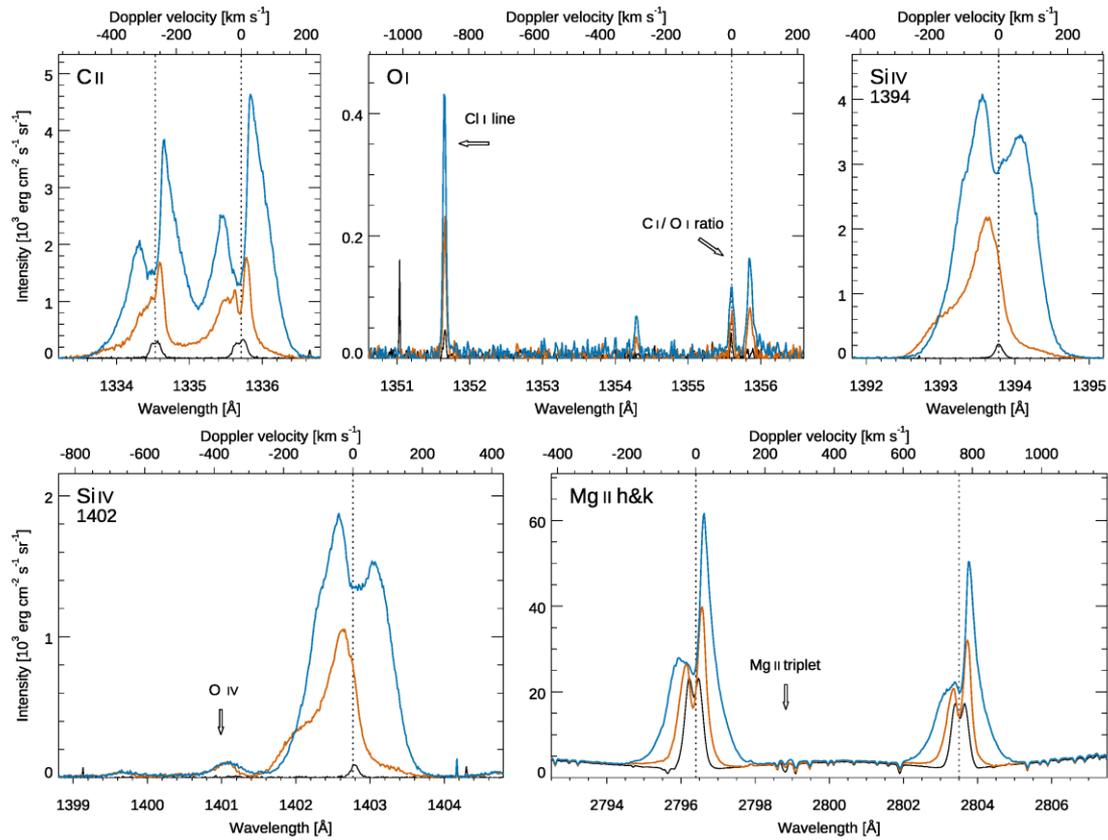
- Occurring at the base of one footpoint of an AFS observed in the chromosphere
 - The AFS is due to secondary emergence
 - The event begins when one **AFS** leg meets the **opposite ambient diffuse field**
- Long duration, with a peak
- The O IV line emission can be used as a **tracer of plasma heating**, revealing an unexpected complex configuration

Multi-wavelength imaging spectroscopy



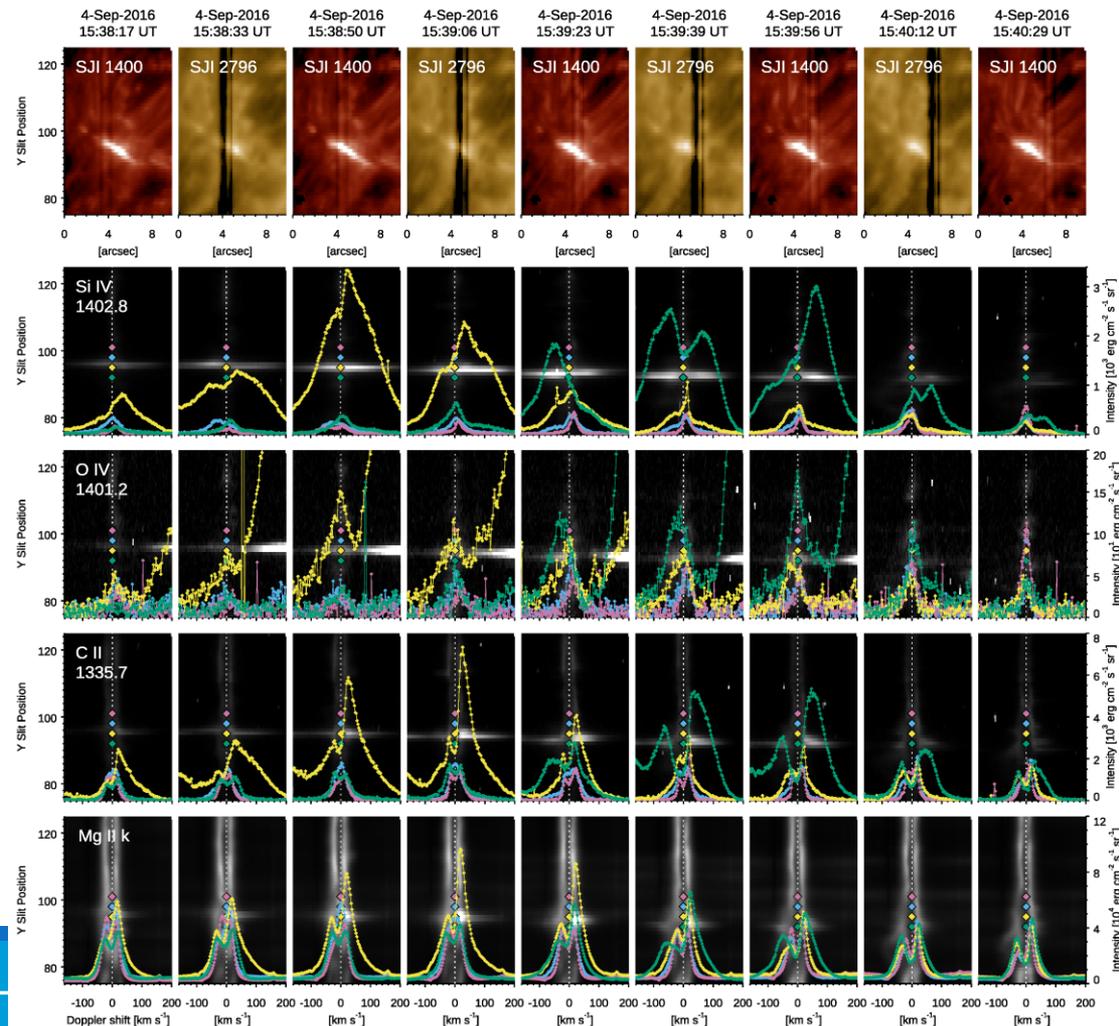
- A multi-wavelength approach reveals the complex behavior during reconnection
- Indication for **jet/surge activity** is clearly detected in the line wings
- Still, the geometry of the reconnection event is **puzzling**
- To be compared to SST H α and Ca II

UV spectrum at the brightest zone in the AFS



Evolution of UV spectra in the AFS

- Localized bi-directional flows, up to **+150 km s⁻¹**
- O IV line at any location
- C II strongly asymmetric
- Asymmetry is also found at chromospheric level



Preliminary conclusions

- *IRIS* observations indicate the occurrence of small-scale energy release events, visible in UV with a clear counterpart in the SDO/AIA channels
- **Specific spectral signatures**, like the emission/absorption in the Mg II 279.8 nm triplet, the C I / O I ratio and the H₂ emission can help us to analyze different triggering mechanisms and similarities with (micro)flares
- **O IV emission** can represent a tracer of plasma heating
- **Complex configuration** in some reconnection events is revealed, deserving further investigations

THANK YOU
FOR
YOUR KIND ATTENTION