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S4- P- 20 Simultaneous observation of high temperature cusp loops and bi-directional inflow in the limb flare with Hinode/EIS and SDO/AIA

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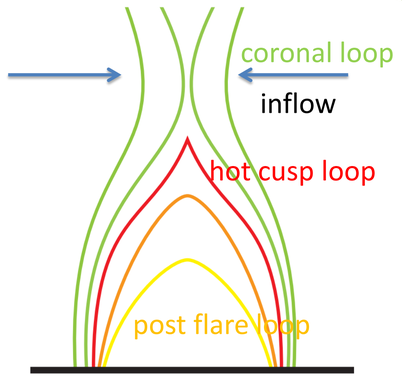
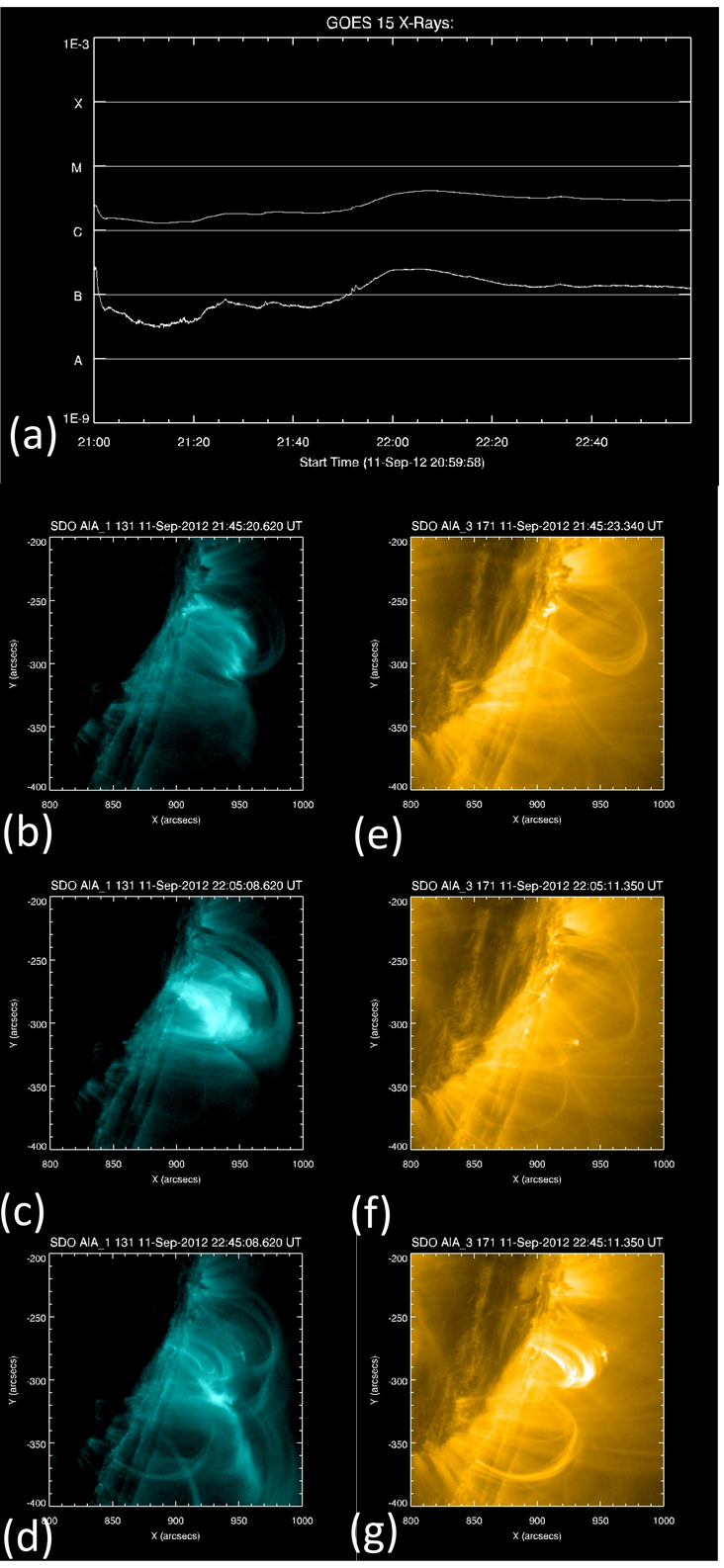
Introduction

The standard model of solar flares (Shibata and Magara 2011) based on the magnetic reconnection includes bi-directional inflow toward the reconnection point and corresponding high temperature loops like a cusp shape (Tsuneta+ 1995). Simultaneous observation of bi-directional inflow with imaging and cusp loops with spectroscopy is strong evidence for the reconnection and this is the first observation as long as we know.



1. Overview of 2012 Sep 11 flare



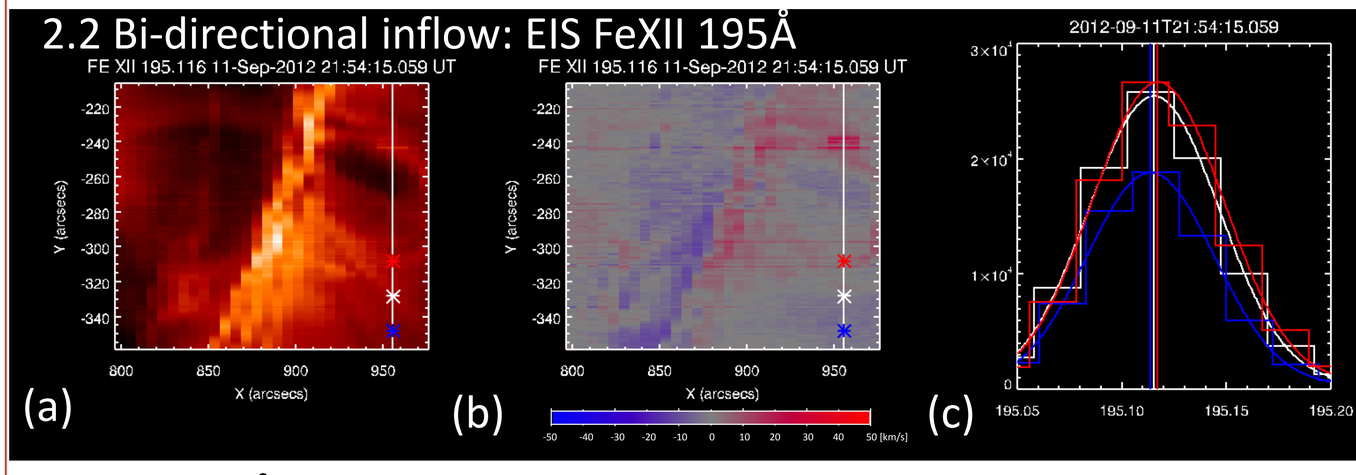
C4.1 class flare occurred beyond the west limb 2012 Sep. 11.
(a):GOES light curve
The flare peak is 22:04.
Imaging Observation
(b)-(d): hot plasma image: SDO/AIA 131Å:~10MK(+1MK)
(e)-(g):coronal temperature plasma image: SDO/AIA 171Å:~1MK
Around the flare peak, hot flare loops appeared beyond the limb (c)
Corresponding to the hot loops, inflowing coronal loops are observed (e)
After the peak of this flare, post flare loops appeared (g)

2. Results

2.1 Bi-directional inflow: AIA 171Å

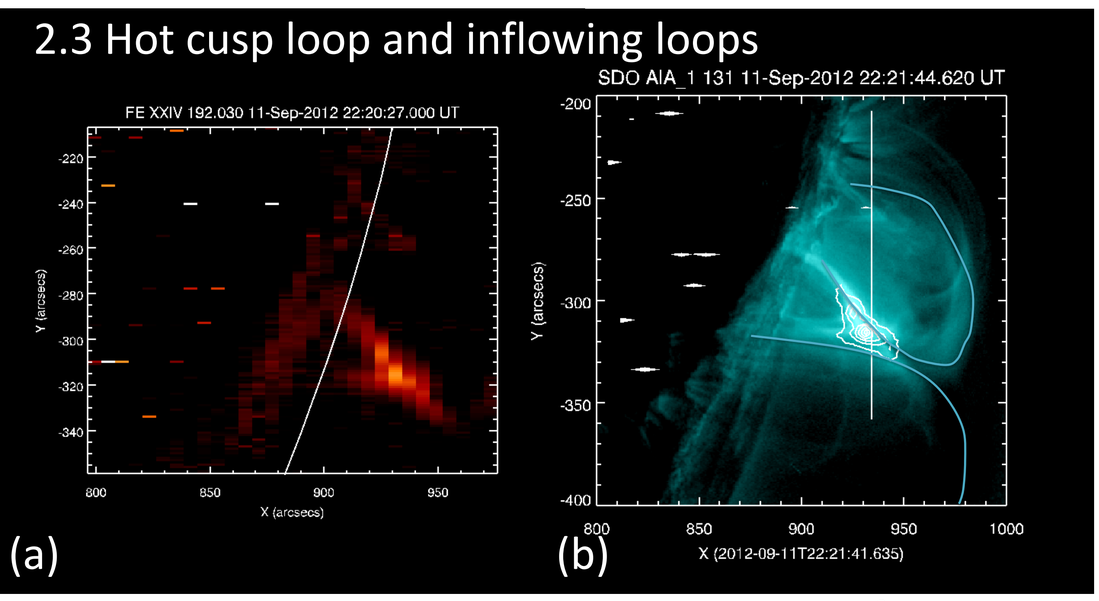
Bi-directional inflowing loops are seen in the AIA 171Å running difference images. Direction of each inflow is indicated by orange arrow. Inflowing apparent velocity is ~20km/s

2.2 Bi-directional inflow: EIS FeXII 195Å



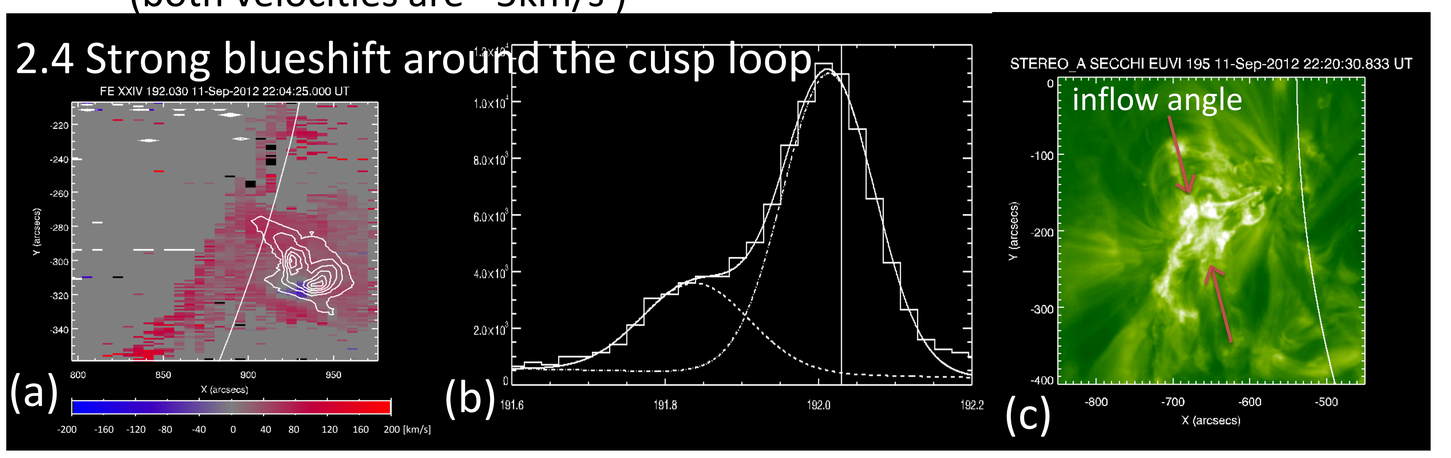
EIS FeXII 195Å (~1MK) (a) intensity and (b) Doppler maps.
(c):Line profiles of FeXII on the same slit (white line in (a) and (b)) and different position (red: ✳, white: ✳ and blue:✳, 5 pixel averaged)
We assume that white profile(✳) is located around current sheet region.
Red profile(✳) and blue profile(✳) seem to show the bi-directional flow (both velocities are ~5km/s)

2.3 Hot cusp loop and inflowing loops



(a)Hot cusp loop is observed with EIS FeXXIV 192Å (~10MK)
(b)Hot cusp loop(white contour of EIS FeXXIV 192Å intensity) is corresponding to the bi-directional inflowing loops (Section 2.1)

2.4 Strong blueshift around the cusp loop



(a) At the flare peak, strong blueshift is observed with EIS FeXXIV 192Å around the cusp loop (white contour). (b)Line profile of the strong blueshift area. Doppler velocity of strong blueshift is over 300km/s.
(c)STEREO A 195Å image of this flare region. White curve is the limb position viewing from the earth. Assuming this blueshift is vertical to the solar surface, the actual velocity is ~ 2000km/s.

3. Discussion

- Bi-directional inflows are spatially corresponding to the hot cusp loop with spectroscopic observation, which is clear evidence that coronal temperature loops are heated over 10MK by the magnetic reconnection.
- A strong blueshift around the cusp loop is likely to be the reconnection outflow.
- Reconnection rate is ~0.01, estimated from outflow velocity ~2000km/s and inflow velocity ~20km/s.
- The ratio of Doppler velocity and apparent velocity of inflow is consistent to the direction of flare ribbon observed with STEREO A (Section 2.4, (c)).

4. Summary

These results indeed support the standard model and are the first direct spectroscopic observation of the heating from magnetic reconnection.

5. References

Shibata, K., & Magara, T. 2011, LRSP, 8, 6
Tsuneta, S., Hara, H., Shimizu, T., et al. 1992, PASJ, 44, 63