P1-046

Evolutional Characteristics of Ca II K line in a Solar Flare

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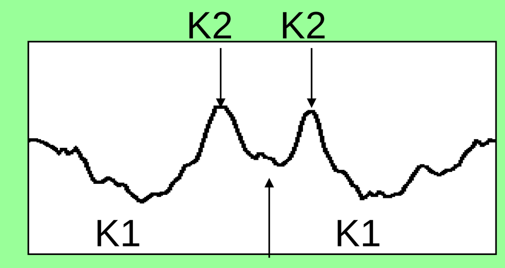
INTRODUCTION AND SCIENCE OBJECTIVE

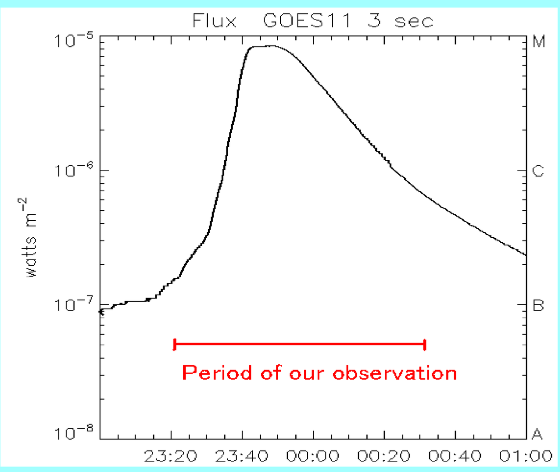
Ca II K line is a famous Fraunhofer line which tells us the physical conditions of the solar chromosphere. The line generally shows a double-reversed profile in the activated chromosphere, but becomes a single emission at flares. The line profile is known to be sensitive to temperature enhancement and to velocity field in the chromosphere.

We study the Ca II K spectra to know the evolution of the atmospheric condition at flare kernels during impulsive and decay phases.

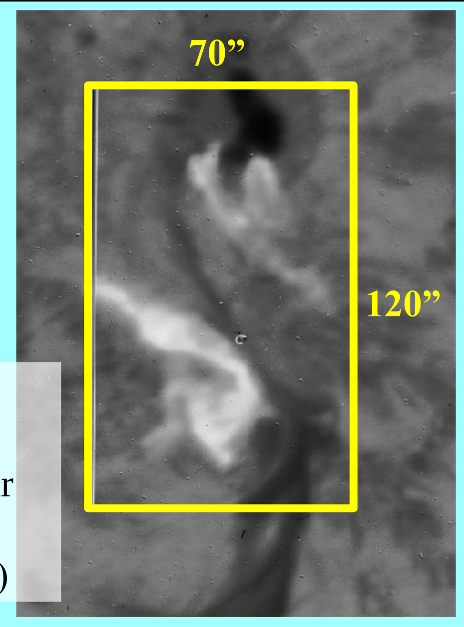


Zoom of Ca II K line core

OBSERVATION



GOES X-ray plot on 2 May 2007



02-May 23:47:38 UT (Domeless Solar Telescope Hα center)

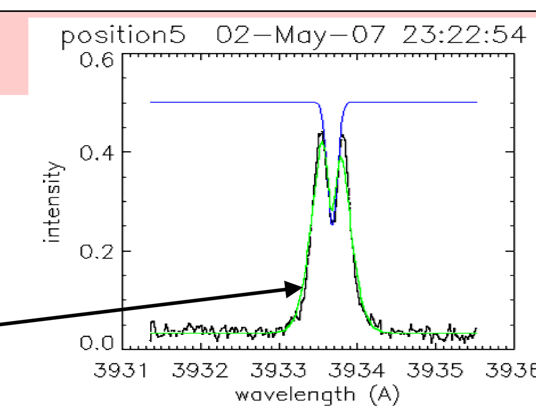
Target : A GOES class C flare with two ribbon on 2 May 2007 at NOAA 10953
Near the disk center S12 W18
#A rapid flow along the dark filament was observed.
Instrument : Domeless Solar Telescope at Hida Observatory
Observation period : 2 May 23:22 UT – 3 May 00:31 UT (covering the flare onset to decay)
Observation : Hα filtergram [15 sec cadence, 0.28”/pixel]
Ca II K spectra (spatial scanning) [scan area 70”x120”, 80 sec cadence, wavelength resolution 0.026 Å/pixel (1.98 km/s), slit width 0.2mm (1.28”)]

PROFILE FITTING

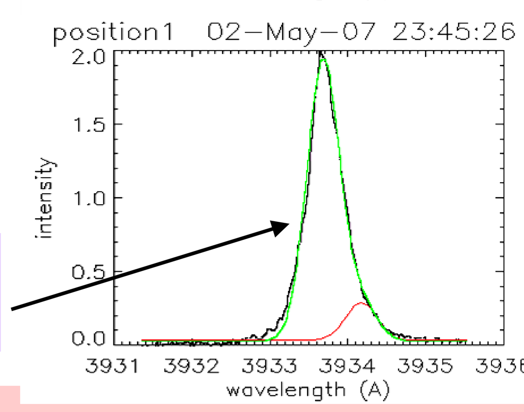
<Subtraction>
Spectral enhancement (I_{flare} - I_{quiet}) is analyzed. Typical profile of Ca II K at flare site is a single Gaussian with enhanced red-shifted component.

<Fitting>
Three components fitting to $I_{subtracted}$:
1. Main component (Central Gaussian emission)
2. Upper cloud absorption (Central narrow Gaussian absorption)
3. Sub component (When there is additional asymmetric component)

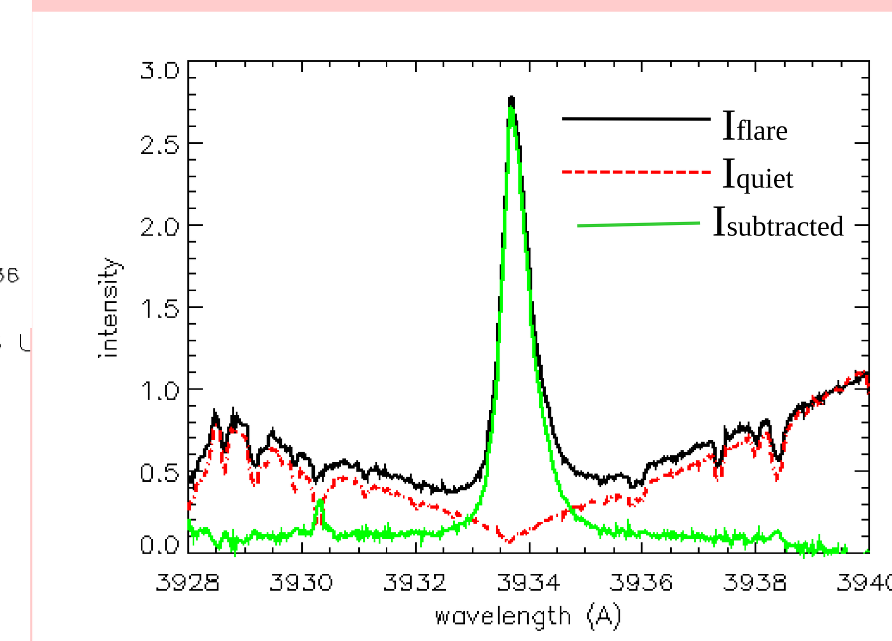
<Equivalent width> Integration of the fitted profile
<Doppler velocity> Line center of the fitted Gaussian components



(Main component)+ (Upper cloud absorption)



(Main component)+ (Sub component)



RESULTS

<Equivalent width>
Figure 2 shows the temporal evolution of emission equivalent width at five flare kernels. We found that the kernel emissions reached their maxima nearly simultaneously with that of the soft X-ray intensity.

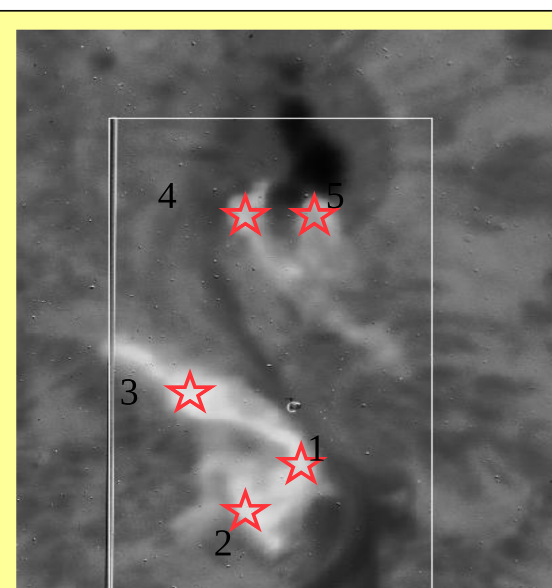


Fig 1. Position of five flare kernels we analyzed

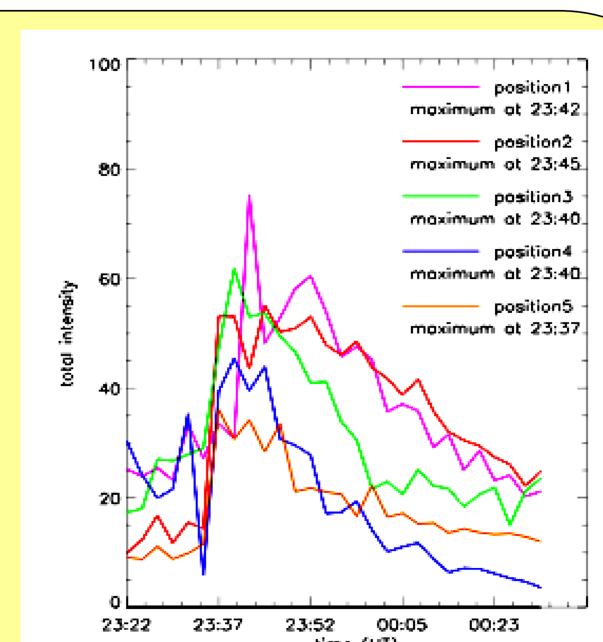


Fig 2. Equivalent width

<Doppler velocity>
Figure 3 show the temporal evolution of Doppler velocity at five different flare kernels. Black asterisks indicate the Doppler velocity of the main component, blue diamonds for upper cloud absorption, and red triangles for sub components. Solid line indicates equivalent width of shifted sub components, which is a measure of the degree of asymmetry.

In all cases, Doppler velocity for main components and upper cloud absorption is almost zero (less than 5 km/s). Red-shifted sub components existed both during impulsive and decay phases. The equivalent width of sub components reaches its peak at almost the same timming of that of main components. The Doppler velocity of sub components takes its maximum value a little before the flare maximum.

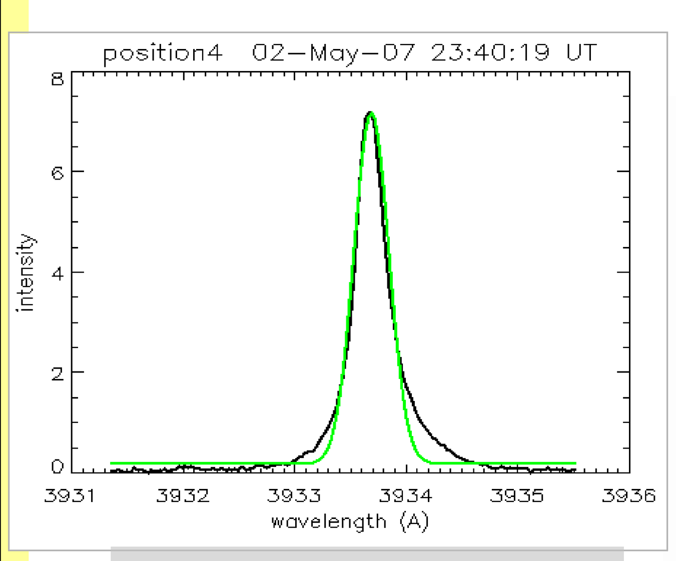
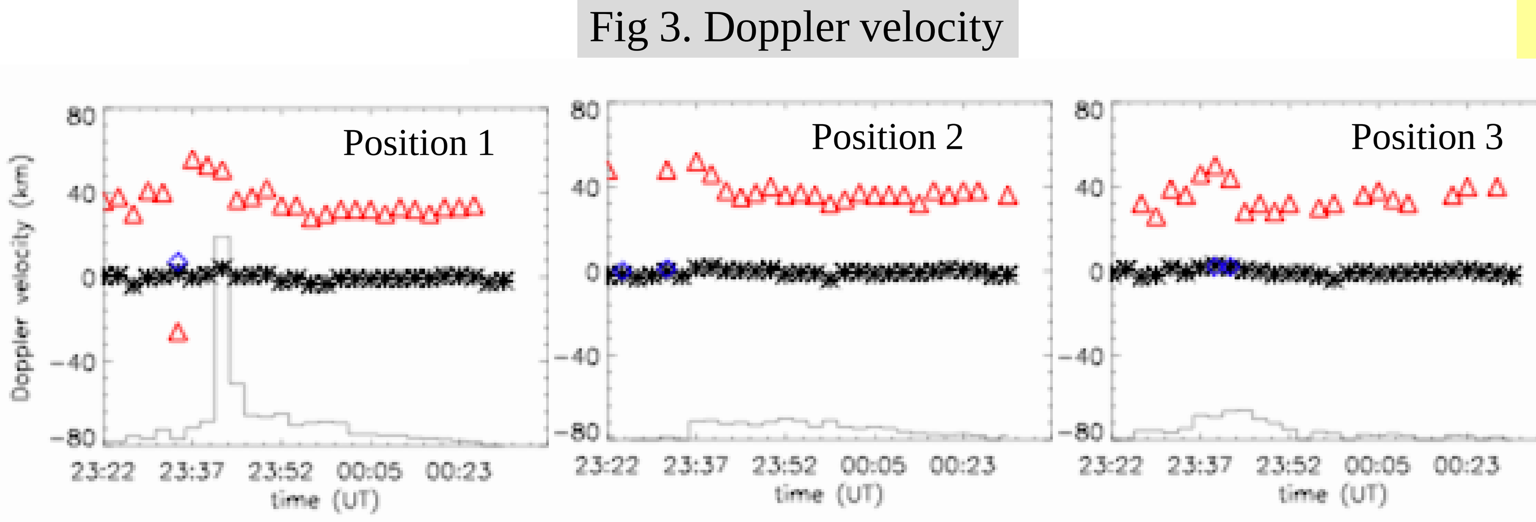
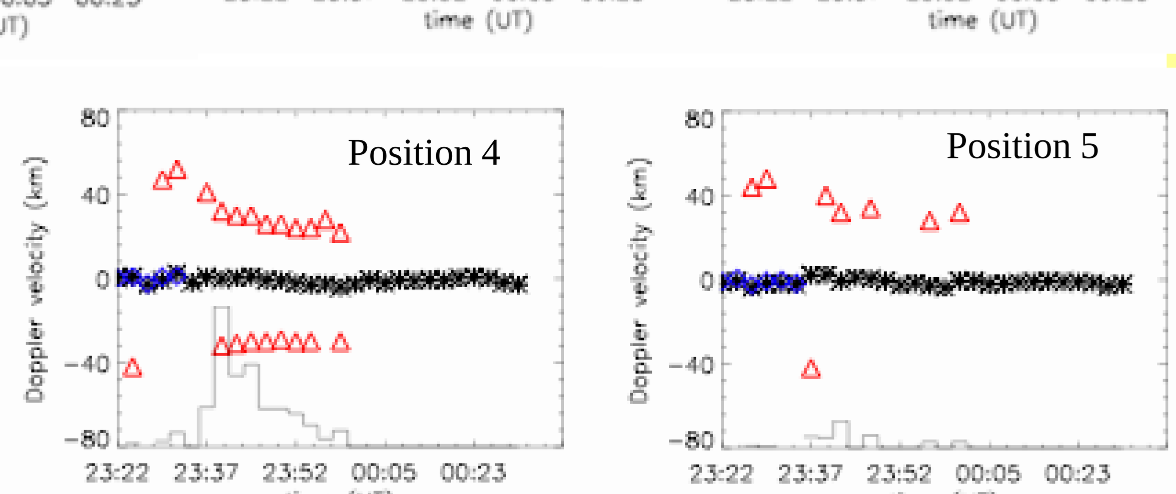


Fig 4. Profile of Position 4

Fig 3. Doppler velocity

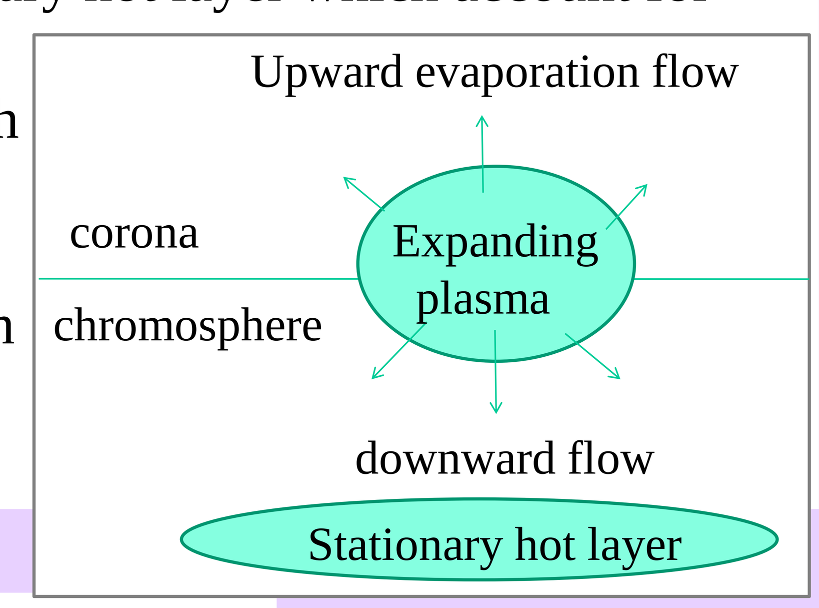




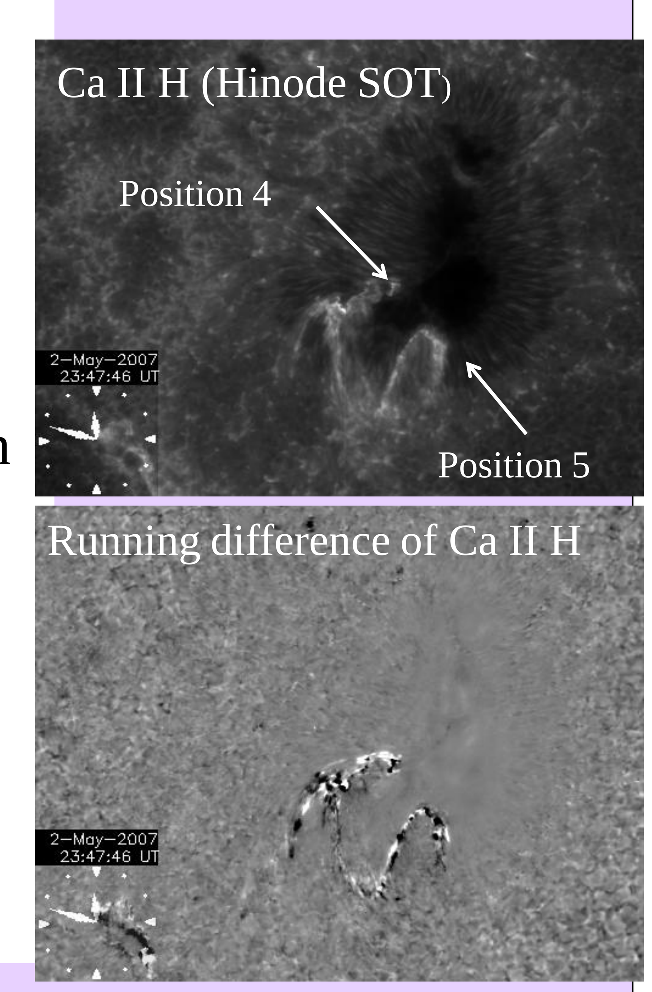
Position 1 and Position 4 show stronger asymmetric profiles than the other kernels. This may be due to the presence of highly turbulent or heated downward moving plasma (probably in upper layers).

DISCUSSION

We found that the line center of main emission components of Ca II K at flare is extremely stationary (less than 5 km/s). This leads to the conclusion that the temperature becomes high (~10000-20000K) but the heated layer does not move at all. On the other hand, there is red asymmetry both during impulsive and decay phases, and the degree of asymmetry varies according to kernel positions. We consider the two layer model to interpret this spectral character; Stationary hot layer which account for main components, and downward moving layer which account for sub components. This result is consistent with the chromospheric evaporation model (momentum balance argument).



<Asymmetry>
One kernel (position 4) had highly asymmetric profile. Both red and blue sub components were detected. In Hinode/SOT Ca II H images, complicated flows were observed near this kernel. Also, there is no response in blue continuum images, so the heating did not reach photospheric height. As the end tip of the filament related to the flare was rooted in the kernel, the blue shifted extra component may be due to mass ejection along the filament axis or to the evaporation flow itself .



In near future, we will try MULTI code profile calculations to reproduce typical characters of Ca II K spectra.