Production of High Temperature Plasmas During the Early Phases of a C9.7 Flare

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The early phases of a C9.7 flare on 2007 June 6 were observed by the EIS instrument on board the *Hinode* mission with an EIS study that enabled a high-cadence raster observation over an area of 240 arcsec × 240 arcsec, by rastering of the 1 arcsec slit utilizing scan jumps of 10 arcsecs in the heliocentric E-W direction. The time cadence of rastering was about 160 seconds[1].

Sections of raster images obtained between 17:20:09 and 17:20:29 (UT) show a few bright patches of emission from Fe XXIII/Fe XXXIV lines at the footpoints of flaring loops and these footpoints show dominating blue-shifted components of −(300–400) km s^{-1} while Fe XV/XIV lines are nearly stationary, Fe XII lines and/or lowertemperature lines show slightly red-shifted features, and Fe VIII, Si VII to He II lines show ~ + 50 km s^{-1} redshifted components. The density of the 1.5–2 MK plasma at these footpoints is estimated to to be 3×10^{10} cm^{-3} by Fe XIII/XIV line pairs around the maximum of the flare.

High-temperature loops connecting the footpoints appear in the Fe XXIII/XXIV images taken over 17:22:49–17:23:08 (UT) which is near the flare peak. Line profiles of these high-temperature lines at this flare peak time show only slowly-moving components. The concurrent cooler Fe XVII line at 254.8 Å is relatively weak, indicating the predominance of high-temperature plasma (> 10^7 K) in these loops.

The rapid appearance of flaring loops in the flareline raster images can be explained by high-speed chromospheric evaporation of ~400 km s^{-1}. However, this plasma might not be in ionization equilibrium, because the relaxation time scale to reach ionization equilibrium is estimated to require more than 300 seconds, if the density is assumed to be that in preflare; $(3–4) \times 10^9$ cm^{-3} which is the situation expected in the scenario of explosive evaporation[2].

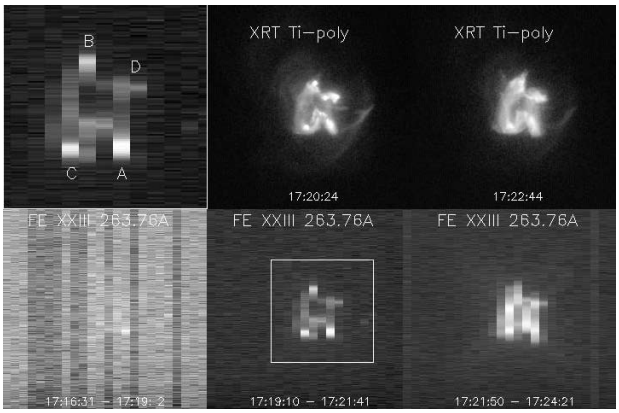

Figure 1: Monochromatic raster images of EIS emission lines of Fe XXIII λ263.76 (bottom panels). The EIS raster images are constructed by using 10 arcsec jumps in the E-W direction. The top-left panel shows a twice-expanded image of white-square area in the Fe XXIII image (middle panel) obtained over 17:19:10–17:21:41 (UT), in which prominent flaring loop footpoints are denoted as A, B, C, and D. The X-Ray Telescope (XRT) observed the flare with Ti-poly filter at the times of 17:20:24 and 17:22:44 (UT).

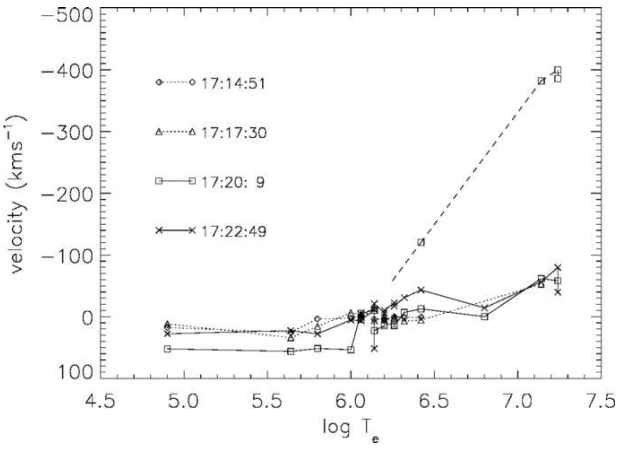

Figure 2: Temperature dependence of plasma motions in the initial phases of the flare at Footpoint A of Figure 1: Negative (positive) velocities represent blue (red) line shifts in the ordinate, and they are plotted against their line formation temperatures. Line-center positions of high-speed components are connected by dashed line.

References

[1] Watanabe, T., Hara, H., Sterling, A. C., Harra, L. K.: 2010, *ApJ*, **719**, 213.
[2] Fisher, G. H. Canfield, C. C., McClymont, A. N.: 1985, *ApJ*, **289**, 434.