

Evidence of Electron Acceleration around the Reconnection X-point in a Solar Flare

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Particle acceleration is one of the most significant features that are ubiquitous among space and cosmic plasmas. It is most prominent during flares in the case of the Sun, with which huge amount of electromagnetic radiation and high-energy particles are expelled into the interplanetary space through acceleration of plasma particles in the corona. Though it has been well understood that energies of flares are supplied by the mechanism called magnetic reconnection based on the observations in X-rays and EUV with space telescopes, where and how in the flaring magnetic field plasmas are accelerated has remained unknown due to the low plasma density in the flaring corona.

We report the first observational identification of the energetic non-thermal electrons around the point of the ongoing magnetic reconnection (X-point) [1]. The location of the X-point is identified by soft X-ray imagery (Figure 1 (b)–(d)). There is microwave emission from non-thermal electrons (negative alpha index) most clearly seen around the X-point (Figure 1 (k)–(m)). This indicates that there are energetic electrons present around the X-point during the course of the magnetic reconnection. Meanwhile, the soft X-ray observations of the flare were in good agreement, in a morphological sense, with the canonical reconnection picture (Figure 1 (a)) from which we expect, in addition to the inflow, bi-directional outflow of plasma particles and magnetic fields away from the X-point towards the bright soft X-ray loop and in the opposite direction. Assuming the presence of the expected reconnection outflow, it would be reasonable to conclude that the energetic non-thermal electrons are supplied from, namely, accelerated at, the region around the X-point rather than assuming that they travel from a region lower in altitude than the X-point against the counter-streaming downward outflow, or that they come from a region higher in altitude beyond the X-point against the counter-streaming upward outflow from the X-point.

Reference

[1] Narukage, N., Shimojo, M., Sakao, T.: 2014, *ApJ*, **787**, 125.

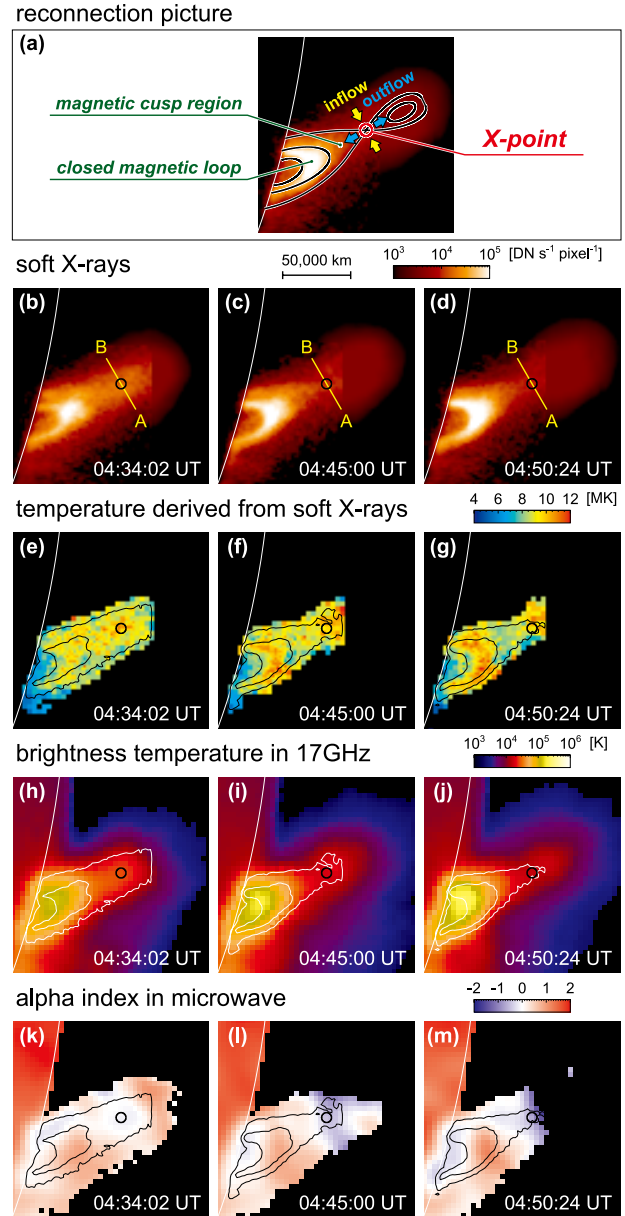


Figure 1: Soft X-ray and microwave observations of the 6 August 1999 flare. **(a)** Schematic illustration of the reconnection picture for the flare. **(b)–(d)** Soft X-ray images taken with the AIMg filter of *Yohkoh*/SXT. The location of the reconnection X-point is indicated by a black circle in each panel. **(e)–(g)** Electron temperature distribution derived with the filter ratio method from pairs of soft X-ray images obtained with the AIMg and Be119 filters of *Yohkoh*/SXT. **(h)–(j)** 17 GHz microwave brightness temperature maps from Nobeyama Radioheliograph (NoRH). **(k)–(m)** Spatial distribution of power-law index of microwave flux density spectra (alpha index) derived from NoRH 17 GHz and 34 GHz data.