and timing data.

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11. THE ACTIVE CORONA OBSERVED FROM SPACE: JETS AND TRANSIENT BRIGHTENINGS

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11.1. X-RAY JETS

X-ray jets have been discovered by the soft X-ray telescope aboard *Yohkoh* as transitory X-ray enhancements with apparent collimated motion (Strong et al. 1992). They are associated with micro-flares or subflares,which occurred in X-ray bright points (XBPs), emerging flux regions, and active regions. According to statistical study of 100 jets by Shimojo et al. (1996), the length of the jets is $10^3 - 4 \times 10^5$ km (average $\simeq 1.5 \times 10^5$ km), the apparent velocity is $10 - 1000$ km/s (average $\simeq 200$ km/s), and the lifetime ranges from a few minutes to more than a few hours. The number of jets decreases as the length, the velocity, or the lifetime increases, and histograms are similar to those of flares and EUV explosive events. The temperature of jets ($\sim 3 - 6$ MK) is comparable to that of micro-flares at the footpoints of the jets, and the kinetic energy is estimated to be $10^{25} - 10^{28}$ erg. Shimojo et al. (1996) found that the width of the jets often decreases with height (i.e., *converging* shape), which is similar to the shape of Hα surges observed in emerging flux regions (Kurokawa and Kawai 1993) and EUV macrospicules (Karovska and Habbal 1994).

There are many evidences of magnetic reconnection in jets (Shibata et al. 1994a,b, 1996); i.e., change of magnetic field topology at the footpoint active regions, and so on. Shibata et al. (1994b) found two types of the interaction (reconnection) between emerging flux and coronal field; the *anemone-jet* type and the *two-sided-loops-jets* type. The former occurs when emerging flux appears in coronal holes. In this case, a jet is ejected in a vertical direction. On the other hand, the latter occurs when emerging flux appears in quiet regions, and two loop brightenings (or jets) occur in the horizontal direction at both sides of the emerging flux.

Yokoyama and Shibata (1994, 1995, 1996) successfully modeled these two types of reconnection of emerging flux with pre-existing magnetic fields, by performing 2-D MHD numerical simulations. (See Matsumoto et al. 1993 for a 3-D model of emerging flux.) In these models, the reconnection produces not only hot jets (X-ray jets) but also hot loops ($\sim$ *transient brightenings*; Shimizu et al. 1992) and even cool jets. The cool jets possibly correspond to Hα surges that are often associated with X-ray jets (Canfield et al. 1996). Priest et al. (1994) and Parnel et al. (1994) presented a slightly different reconnection model (i.e., "converging flux" model) for X-ray bright points and jets. Though these reconnection models are successful as energy release mechanism, the specific acceleration mechanism of each jet remains to be identified; in fact, there is a possibility that some of jets are evaporation flow accelerated by thermal pressure force (e.g., Sterling et al. 1993) even if reconnection is the energy release mechanism.

Canfield et al. (1996) found several examples of simultaneous ejection of X-ray jets and Hα surges in the same direction. These surges are known to spin around their axis. (Note that there are also many Hα surges which are not associated with X-ray jets; e.g., Schmieder et al. 1995). Kundu et al. (1995) found that a type III burst was associated with an X-ray jet (see also Auras et al. 1995, Raulin et al. 1996). This implies the existence of high energy electrons in these small flares and jets, and supports the view that the generation mechanism of X-ray jets and micro-flares may be physically similar to that for larger flares.

It is interesting to note that Shibata et al. (1995) discovered X-ray plasma ejections (some are similar to jets) even from the impulsive compact loop flares, e.g., the Masuda (1994) flare, which have been considered to be *confined.* Based on this finding, Shibata (1996) presented a unified model to explain LDE flares, impulsive flares, and micro-flares/jets with a single physical mechanism, magnetic reconnection triggered by plasmoid ejection.

11.2. TRANSIENT BRIGHTENINGS

The soft X-ray telescope aboard *Yohkoh* found another interesting phenomenon, i.e., *transient brightenings*, which frequently occur in "active" active regions (Shimizu et al. 1992). According to Shimizu et al. (1992), the *active region transient brightenings* (ARTBs) usually show a single or multiple loops, the total thermal energy content in one transient brightening is $10^{25} - 10^{29}$ erg, time scale $1 - 10$ min, and the loop length is $0.5 - 4 \times 10^4$ km. They further found that ARTBs correlate well with GOES C-class or sub-C-class flares so that ARTBs are considered to be a spatially resolved soft X-ray counterpart of hard X-ray micro-flares. Morphology of ARTBs, such as multiple loop structures (e.g. Hanaoka 1996), is suggestive of *loop-loop interaction* or *two current loop interaction* (e.g., Fushiki and Sakai 1995), though clear evidence of *interaction* between *two current loops* has not yet been found.

From simultaneous observations by VLA and *Yohkoh*, Gopalswamy et al. (1994) found microwave counterparts of ARTBs. White et al. (1995) reported that no impulsive radio emission at 17 GHz was detected from ARTBs, using the Nobeyama Radioheliograph. This negative result leaves open the possibility that there is a difference between ARTBs and large flares. On the other hand, Kundu et al. (1994) observed type III bursts in association with an XBP flare, which means that XBP flares are similar to normal flares and can accelerate non-thermal electrons.

Shimizu (1995) found that the number of ARTBs, N, as a function of their total thermal energy content, W, scales as a single power law; $dN/dW \propto W^{-(1.55\pm0.05)}$, where W ranges from 10^{27} to 10^{29} erg. Since this relation is essentially the same as that of larger flares, it is likely that the same physical mechanism causes ARTBs as in larger flares. On the other hand, this means that the coronal heating cannot be explained by X-ray micro-flares, since the power law index is less than the critical value 2. However, Porter et al. (1994) claimed that EUV micro-flares show the power law index larger than 2. Yokoyama and Shibata (1995) pointed out that the jets are often associated with micro-flares, while the kinetic energy of the jets has not been considered in the estimate of energy. The inclusion of the kinetic energy would change the power law index significantly.

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12. THE ACTIVE CORONA OBSERVED FROM SPACE: LARGE-SCALE EVOLVING STRUCTURES

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12.1. INTRODUCTION

Series of new discoveries on large-scale coronal structures have been made so far with *Yohkoh* since its launch in August, 1991: the global structural changes of soft X-ray structures, especially the formation of spectacular arcades, X-ray jets (Shibata et al. 1994), and interacting active regions (Tsuneta 1996a) in static large-scale X-ray corona outside active regions. Although the transient nature of the solar corona was noticed earlier by *Skylab* observers the extent of its time variability has been fully appreciated with the advent of *Yohkoh*. One is also beginning to realize that all these transient phenomena are due to magnetic reconnection. Here, "transient" means that the observed time-scale roughly ranges between 10 and 100 Alfvén transit times of the system. The time-scale of the transient events tends to be shorter in active regions, and longer for large-scale events in the quiet Sun. However, if one normalizes the time-scale with Alfvén transit time, the time-scale is almost invariant (Tsuneta 1996c).

12.2. FORMATION OF LARGE SCALE ARCADE

Yohkoh X-ray movies show that even the quiet Sun often has large-scale structural changes as well as brightenings (heating). The number of these transient events appears to decrease from the solar maximum to the minimum. One type of transient events are the large-scale arcades (Hanaoka et al. 1994, Hiei, Hundhausen, & Sime 1993), which appear to be associated with the global eruption of coronal magnetic structures in X-rays together with prominence eruption. The eruptive structures are also observed as coronal mass ejection (CME; McAllister et al 1996, McAllister, & Hundhausen 1996). As a result of the eruption, the neutral sheet structure is dynamically formed, and magnetic reconnection takes place (Magara et al. 1996, Yokoyama & Shibata 1996). The reconnected field lines are heated, and resultant chromospheric evaporation increases a plasma density of the flux tubes. This makes the reconnected loop structure highly visible in soft X-rays. When an arcade is formed near the limb, a distint triangular structure, which we call "cusp" structure, is seen (Tsuneta et al. 1992a). The cusp structure suggests the X-point structure located above the arcade (reconnected loops).

These cusp structures are seen also in flares, especially in the Long Duration Events (LDE;Tsuneta 1996), as well as in active regions (Yoshida & Tsuneta 1996). The cusps seen in active regions are as small as 10^4 km. The giant cusps with size as large as solar radius in the quiet Sun, the cusps seen in LDE flares, and the mini-cusps in active regions are apparently governed by the same physical process; magnetic reconnection.