§24. Evolution of Eruptive Flares
I. Plasmoid Dynamics in Eruptive Flares

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We investigate the resistive processes of plasmoid dynamics in eruptive flares by performing 2.5-D resistive MHD numerical simulations. We start with a linear force-free field arcade and impose the localized resistive perturbation on the symmetry axis of the arcade. Then the magnetic fields begin to dissipate, producing inflows toward this region. These inflow make the magnetic fields convex to the symmetry axis and hence a neutral point is formed on this axis, leading to a formation of a magnetic island around the symmetry axis. Typical case of the temperature time-variation is in Figure 1. In this figure contours and arrows indicate magnetic field lines and fluid velocity fields, respectively.

The evolution is characterized by three distinct stages, which is shown in Figure 2. At the first stage, the magnetic island slowly rises by the upflow produced by the initial resistive perturbation. Then, once the anomalous resistivity sets in, the magnetic island begins to be accelerated. This acceleration stops after the fast MHD shock is formed at the bottom of the magnetic island, which implies that the upflow around the central part of the magnetic island is no longer strong. These three stages in the evolution of the plasmoid are confirmed to exist in the observational results (Ohyama & Shibata[1]). Moreover, a time-lag between the start time when the magnetic island begins to be accelerated and the peak time of the neutral-point electric field can be explained by the inhibition of magnetic reconnection by the perpendicular magnetic field.

We also study the difference of the initial rise motion of the plasmoid between the simulation results and the observational ones, and we conclude that in actual situations, the initial resistive perturbation proceeds very weakly and at many positions inside the arcade.

This work will be reported in ApJ[2].

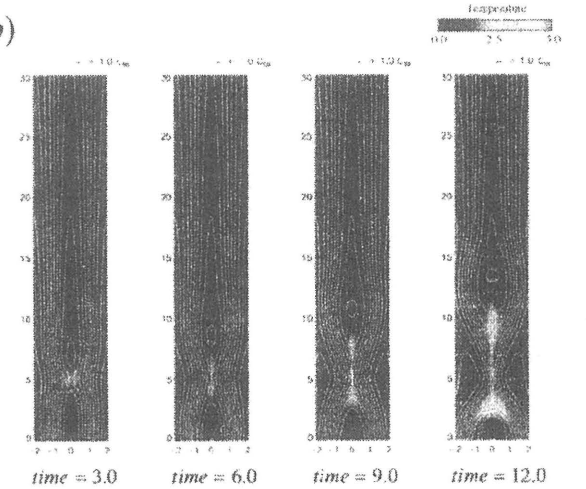

Fig. 1. Time-variation of temperature. Contours and arrows indicate magnetic field lines projected onto the (x, z) plane and fluid velocity fields on the same planes, respectively.

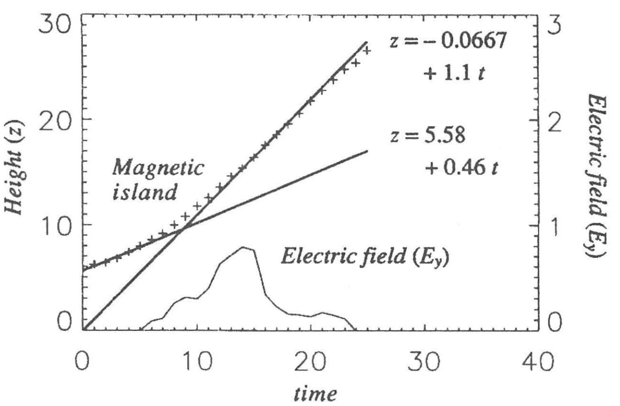

Fig. 2. Time-variations of both perpendicular component of electric field (E_y) at the neutral point (X-point) and height of magnetic island which are represented by thin solid line and crosses (+), respectively. Thick solid lines represent the results of line-fitting for this temporal variation of height of magnetic island. (Each time range for the line-fitting is $0 \le t \le 5$ for the first and $15 \le t \le 17$ for the second, respectively.)

References

1) Ohyama, M., and Shibata, K. : PASJ, 49, 249.
2) Magara, T., Shibata, K., and Yokoyama, T. : ApJ, in press