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Magnetohydrodynamic Modeling of a Giant Cusped-Loop and Associated X-ray Mass Ejection on Jan. 24, 1992

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It is known that coronal mass ejections (CME) are produced by the magnetic mechanism in the solar corona. In those activities, large scale arcade formations are usually associated with CMEs.

In order to investigate these events, we performed Magnetohydrodynamic (MHD) simulations on the basis of the CME model by Chen and Shibata (2000). In this model, the reconnection with an emerging flux breaks the equilibrium around the flux rope, and a CME occurs.

In our research, we treat a model of CMEs associated with large scale arcade formations, so we ignore the effects of radiative cooling, evaporation, and gravity. We calculate both cases with and without heat conduction, to examine its effect on structure of MHD shocks.

From the results of these simulations, we find followings.

1 In flares, the slow shock is dissociated into the conduction front and the isothermal slow shock by the effect of heat conduction. However, in giant arcade the slow shock is not dissociated. But it is noted that the conduction plays a role to decrease the temperature (cf. 3).

2 The fast shocks occur in front of the flux rope, and below and above the reconnection X point. The shock in front of the flux rope becomes an interplanetary CME shock.

Furthermore, we compared these results with the observations of the X-ray helmet streamer on Jan. 24, 1992, (e.g. Hiei et al. 1993) taken with the Yohkoh soft X-ray telescope(SXT), and we find following results.

3 Comparing the results of our simulations with the estimations of the observations, the case including heat conduction reproduces the observations of the maximum of temperatures and X-ray intensity distributions much better than the case without heat conduction. So this suggests that the heat conduction is important in helmet streamer events.

4 It is known that the Y-shape eruptive structure was observed in soft X-ray images just at the start of this event. We suggest that this Y-shape structure corresponds to the slow shock in the magnetic reconnection, and a little brighter part at the center of the Y-shape structure corresponds to the fast shock.

Until now, it was discussed the possibility that the slow and fast shock associated with flares were observed. But there were no detailed examination based on the comparison between theories and observations, so the identifications of those shocks remained as an important subject for Solar B. However, in this study we can reveal the slow and fast shock produced by magnetic reconnection for the first time in the world, because we succeeded in constructing of the realistic MHD model of large scale cusp-shaped structure.