MHD Simulations of Flares

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Two-dimensional simulation of a solar flare is performed using a newly developed magnetohydrodynamic (MHD) code including nonlinear anisotropic heat conduction effect. The numerical simulation starts with a vertical current sheet which is line-tied at one end to a dense chromosphere. The flare energy is released by the magnetic reconnection mechanism stimulated initially by the resistivity perturbation in the corona. The released thermal energy is transported into the chromosphere by heat conduction and drives chromospheric evaporation. Owing to the heat conduction effect, the adiabatic slow-mode MHD shocks emanated from the neutral point are dissociated into conduction fronts and isothermal slow-mode shocks. We discovered two new features, i.e. (1) a pair of *high density humps* on the evaporated plasma loops formed at the collision site between the reconnection flow and the evaporation flow, and (2) a *loop-top dense blob* behind the fast-mode MHD shock. We also derived a simple scaling law for the flare temperature described as

$$T_{\rm A} \approx \left(\frac{B^3 L}{2\pi\kappa_0\sqrt{4\pi\rho}} \right)^{2/7} \propto B^{6/7}$$

where $T_{\rm A}$, B, ρ, κ_0 are the temperature at the flare loop apex, the coronal magnetic field strength, the coronal density and the heat conduction coefficient, respectively. This formula is confirmed by the numerical simulations. Temperature and derived soft X-ray distributions are similar to the cusp-like structure of long-duration-event (LDE) flares observed by the soft X-ray telescope aboard Yohkoh satellite. Density and radio free-free intensity maps show a simple loop configuration which is consistent with the observation with Nobeyama Radio Heliograph.