

Test particle simulation of high energy electrons during solar flare

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Solar energetic particles are generated by flares in the solar atmosphere and coronal mass ejections propagating in the interplanetary space. During solar flares, energetic electrons with an energy of 100 eV to 100 keV are commonly observed. The high energy electrons reaching 1 MeV or higher are also occasionally observed. The reconnection model of solar flare has been established by both numerous observations and MHD simulations. However, major electron acceleration processes have not been incorporated in the standard flare model yet. In MHD models, we can find multiple candidate sources of particle acceleration such as plasmoids, shocks, and turbulence. The remained issue is to specify the major acceleration site. In this study, we investigate possible sites of particle acceleration in a flare reconnection model using MHD simulations and test particle simulations for electrons based on the guiding center approximation. We quantitatively evaluated the electron energies in different locations in the framework of the standard flare model. We performed a MHD simulation of a solar flare including the thermal conduction and the gravitational stratification. We conducted test particle simulations using the numerical solution of the MHD simulation as the background field for the particles. As a result, high energy electrons with an energy of 10 keV to 1 MeV were reproduced. Our simulations show that the loop-top region is a strong accelerator: the particles around the termination shock were accelerated up to 1 MeV. In the other areas, the particles were accelerated up to 100 keV, consistent with observations. We found that electron energies around shock regions are larger than those in plasmoids. We discuss the link between MHD structures and major electron acceleration processes.

Keywords: solar flare, particle acceleration