Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM09-20 Room:211 Time:April 28 15:30-15:45

Particle acceleration in a 3D current sheet of a Solar flare and comparison with solar radio observations

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Solar flares show intermittent time variability in nonthermal emissions, because particles are impulsively accelerated in small acceleration regions, i.e. multiple X-points, reconnection outflows, colliding plasmoids and internal shocks in a fragmented current sheet. We performed 3D MHD simulation of a solar flare, in which a horizontal flux rope in an unstable but equilibrium state are triggered by small amplitude of perturbation to be flown upward. The eruption of a flux rope forms a current sheet just below the flux rope, and when the width of a current sheet becomes enough thin, it becomes unstable for the tearing instability and generate small scale plasmoid inside. The formation and interaction of the plasmoids make the current sheet complex and turbulent structure. When a small scale plasmoid is ejected out or when two plasmoids collide with each other, the electric field in a current sheet is locally and intermittently enhanced.

In this 3D MHD simulation result, we inserted test particles, which are forced by electromagnetic field varying in time. Particles are trapped in the turbulent current sheet, or more exactly between multiple plasmoids, and accelerated by locally enhanced electric field along the current sheet. At that time, particles are intermittently accelerated at several heights and repeat multistep acceleration moving to other X-points. Sometimes, particles escape upward into the erupting flux rope and propagate along the field line of the flux rope. Particles are slightly accelerated by the curvature drift acceleration in the erupting flux rope and finally precipitate to another X-point connected to the different pair of loop-foot points. We also compared this simulation result with radio spectrograph data observed in Ondrejov observatory in Czech Republic. The radio spectrograph data shows similar intermittent time variability of type III bursts, i.e. electron beams, and sometimes slowly drifting pulsating structures, i.e. trapped electron beams in a plasmoid.

In this talk, we mainly talk about the test particle acceleration in 3D MHD simulation of an erupting solar flare and the comparison with the radio observation data. We are also aiming at simulating the propagation of a flux rope eruption into the interplanetary space, i.e. coronal mass ejection, forming a shock at the propagation front and reconnecting with open field in the interplanetary space. We welcome discussion and collaboration in VarSITI.

Keywords: Solar Flare, Coronal Mass Ejection, Particle Acceleration, Space Weather, Numerical Simulation, Radio Observation