Electron Acceleration during Magnetic Reconnection with Multiple X-lines

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Production of energetic electrons is one of the most interesting topics in space plasma physics. Magnetic reconnection has a significant role to produce highly energetic particles in any scale space plasmas. The electron acceleration mechanism during magnetic reconnection has been surveyed by numerical simulation up to today. In these simulations, the models of reconnection with only an X-line has been used. However, the in situ observations in the magnetotail and in the interplanetary space has been suggested reconnection with multiple X-lines. In this study, I focused the effect of multiple X-lines on electron accelerations and carried out two dimensional electromagnetic full particle simulations with multiple X-lines. In the reconnection with multiple X-lines, the electron accelerations corresponds to the magnetic islands coalescences. In the case of multistep coalescences, electrons were accelerated at multiple stages. These accelerated electrons spatially formed multi ring distribution due to the multiple stage accelerations. The X-lines

and the pileup regions worked as acceleration regions. I found out that electron were also accelerated at the magnetic islands coalescence regions. For the production of extremely energetic electrons, the acceleration at the X-lines was necessary at the first phase of reconnection. These electrons usually were further accelerated up to extremele energetic at the pileup regions and the coalescence region.

I carried out simulations with different numbers of initial X-lines. The electron energy spectra at the final state was almost the same in each simulation. I also carried out in different system sizes. The larger the system size was, the more electrons gained energy and the more highly energetic electrons were produced. The energy spectra depended on the scale of reconnection. In the largest simulation in this study, the acceleration at the coalescence regions evolved and substantial suprathermal electrons were produced.