

Particle acceleration in magnetic reconnection: a comparative study of solar corona, magnetosphere, and interplanetary space

Hiroaki Isobe[1]; Shinsuke Imada[2]; Mitsuo Oka[3]

[1] Dept. Earth and Planetary Science, Univ. Tokyo; [2] none; [3] IGPP/UCR

Evidence for magnetic reconnection has been found in the solar corona, interplanetary solar wind and the Earth's magnetosphere. Comparative study of magnetic reconnection in these different circumstances will provide deeper insight into this important physical process. In this study we list up the typical values of physical parameters observed in the magnetic reconnection events in the solar corona, in the solar wind and in the magnetotail, and examine what are the common and different aspects.

In solar flares and magnetotail reconnection, evidence for non-thermal particles has been found, and their energy (more than a few tens of keV) and spectrum are similar. On the other hand, in-situ observations indicate that reconnection in the solar wind does not produce energetic particles. Furthermore, in the quiet region of the solar corona (i.e., away from sunspots), eruption of filament (prominence) and formation of large-scale X-ray arcade sometimes occur. Physical mechanism of such quiet sun arcades (hereafter called QS arcade) is the same as that of flares. However, their soft X-ray flux is small because of lower density, and usually they are not associated with hard X-ray and gamma-ray, i.e., signatures of energetic particles. In summary, reconnection in flares (active regions) and magnetotail produce energetic particles, but that in QS arcade and solar wind do not.

What are the parameters that seem to determine the presence of energetic particles? Obvious candidates are the magnetic field B , the inductive electric field E (reconnection rate), and the potential drop (E times length along current sheet). However, their magnitudes are in order of flares ($10^{-2}T$, $100V/m$, $10^{10}V$), QS arcade ($10^{-3}T$, $10V/m$, 10^9V), magnetotail ($30nT$, $10^{-2}V/m$, 10^6V), solar wind ($10nT$, $10^{-5}V/m$, 10^5V). Namely, these parameters are larger in QS arcade than in magnetotail, and hence cannot explain the absence in QS arcade and existence in magnetotail of energetic particles. The parameters we found that may explain the existence/absence of energetic particles are (1) ratio of cyclotron and plasma frequencies (equivalently, ratio of Alfvén velocity to speed of light) and (2) E times Larmor radius. We discuss the indications of this fact for the acceleration mechanisms.