A route to explosive large-scale magnetic reconnection in a super-ion-scale current sheet

Kentaro Tanaka[1]; Koji Haijima[2]; Masaki Fujimoto[3]; Iku Shinohara[4]
[1] JAXA; [2] DEPT,TITECH; [3] ISAS, JAXA; [4] ISAS/JAXA

How to trigger magnetic reconnection is an interesting and important problem in space plasma physics. Recently, the electron temperature anisotropy (alpha$_{eo}$ = T$_{e,perp}$/T$_{e,para}$) at the center of a current sheet has attracted attention in this context. In contrast, here we focus on the effect of additional ion temperature anisotropy (alpha$_{io}$ = T$_{i,perp}$/T$_{i,para}$) on reconnection triggering process. Using three-dimensional full-particle simulations, we investigate whether introduction of ion and electron temperature anisotropies in the initial stage can accelerate the triggering of and boost-up the non-linear stage of magnetic reconnection in a current sheet that has a super-ion-scale initial thickness. At this thickness, when ion and electron temperatures are isotropic, small (10%) increase in the initial current sheet half thickness (from D = 1 to 1.125, D: initial half-thickness in the ion-inertial scale) slows the triggering significantly. When alpha$_{io}$ = alpha$_{eo}$ = 2 is introduced, the thicker (D = 1.125) case obtains triggering as quick as in the D=1 isotropic case and a saturation level that surpasses the D = 1 isotropic level. Detailed analyses show the scenario as follows: (1) The electron temperature anisotropy is exhausted upon very quick formation of a number of minuscule magnetic islands which do not coalesce into a large-scale reconnection. (2) The ion temperature anisotropy, which remains after the small island formation, eventually leads to explosive growth of large scale reconnection. (3) The development to large-scale reconnection is earlier than in the two-dimensional counterpart case implying that the lower-hybrid wave activity at the current sheet edges are effective in this aspect. The results of this study imply that explosive large-scale magnetic reconnection can be triggered rather quickly even in a super-ion-scale current sheet if both ion and electron anisotropies are present.