M39a Secondary tearing in three-dimensional reconnection

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Magnetic reconnection is one of the most important plasma fundamental processes, which explains various energy release activities, such as solar flares. It is found that the spontaneous secondary tearing instability is the key for the fast 2D reconnection. On the other hand, the three-dimensional (3D) reconnection is still not sufficiently comprehended due to its complexity. In our previous study, we examined the current sheet under random perturbation and notice that the coupling between tearing layers triggers the global fast reconnection. In order to get a clear picture of the local and global effect of the coupling, we implement a pair of rotational-symmetric tearing modes to a current sheet with weak guide field. We notice that the coupling between diffusion regions on different tearing layers grows secondary tearing on the original tearing modes, which are intrinsically stable to the secondary tearing. The partitioned diffusion regions open up a vent which ejects the plasma with magnetic fields outwardly. The outwardly going field lines collide with the inwardly coming ones, therefore build up new diffusion regions that are further away from the sheet center. Globally, the new diffusion regions form a new reconnection layer on either side of the sheet that can be explained by the 4-wave resonance in turbulence theory. With the outwardly extending reconnection layers, together with the globally existing coupling across the sheet, the overall reconnection is accelerated.