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The effects of the guide field on the structures of electron density depletions in collisionless magnetic reconnection

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Two-dimensional particle-in-cell simulations are performed to investigate the formation of electron density depletions in collisionless magnetic reconnection. In anti-parallel reconnection, the quadrupole structures of the out-of-plane magnetic field are formed, and four symmetric electron density depletion layers can be found along the separatrices due to the effects of magetic mirror. With the increase of the initial guide field, the symmetry of both the out-of-plane magnetic field and electron density depletion layers is distorted. When the initial guide field is sufficiently large, the electron density depletion layers along the lower left and upper right separatrices disappear. The parallel electric field in guide field reconnection is found to play an important role in forming such structures of the electron density depletion layers. The structures of the out-of-plane magnetic field and electron depletion layers in anti-parallel and guide field reconnection are found to be related to electron flow or in-plane currents in the separatrix regions. In anti-parallel reconnection, electrons flow towards the X line along the separatrices, and are directed away from the X line along the magnetic field lines just inside the separatrices. In guide field reconnection, electrons can only flow towards the X line along the upper left and lower right separatrices due to the existence of the parallel electric field in these regions.