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Electron acceleration and flat-tops in asymmetric reconnection: 3D Particle-in-Cell simulations

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We present results of kinetic three-dimensional simulations of asymmetric magnetic reconnection aiming at in-depth investigation of electron acceleration and thermalization in the X-line vicinity. Initial condition for our simulation mimics the MMS observations of the reconnection diffusion region crossing on 6 December 2015, 23:38:30 UT which was studied by Khotyaintsev et. al., GRL, 2016. In order to disentangle paths of electron beams in the X-line vicinity, we mark electrons according to their origin (magnetosheath or magnetospheric electrons) and construct partial velocity distribution functions for each component. Electron flow null (in-plane electron flow X-point) is pushed into the low-density region, but in fact the flow null is formed by superposition of electron streams of magnetosheath and magnetospheric origin. Accelerated beam of colder magnetosheath electrons turns nearly 180 degrees inside the EDR and streams along the separatrices mixing with hotter magnetospheric population. Resulting distribution functions are susceptible to electron-electron streaming instabilities resulting in formation of flat-tops in reconnection electron exhaust. Simulation results show good agreement with observations and emphasise the role of electrostatic instabilities in the EDR vicinity.