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Electron-scale quadrants of the Hall quadrupolar structure observed during asymmetric magnetic reconnection

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An in situ measurement at the magnetopause shows that the quadrupole pattern of the Hall magnetic field, which is commonly observed in a symmetric reconnection, is still evident in an asymmetric component reconnection, but the two quadrants adjacent to the magnetosphere are strongly compressed into the electron scale and the widths of the remaining two quadrants are still ion scale. The bipolar Hall electric field pattern generally created in a symmetric reconnection is replaced by a unipolar electric field within the electron-scale quadrants. Furthermore, it is concluded that the spacecraft directly passed through the inner electron diffusion region based on the violation of the electron frozen-in condition, the energy dissipation, and the slippage between the electron flow and the magnetic field. Within the inner electron diffusion region, magnetic energy was released and accumulated simultaneously, and it was accumulated in the perpendicular directions while dissipated in the parallel direction. The localized thinning of the current sheet accounts for the energy accumulation in a reconnection. In the exhaust region, the asymmetric Hall magnetic field exists still but the electron-scale quadrants has expanded to ion-scale and the bipolar Hall electric field appears again.