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MMS observations of Hall system in magnetic reconnection at dayside magnetopause

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Hall systems in two asymmetric reconnection events are investigated by MMS observations. In first case, a complete Hall system is identified in the exhaust region 40 Di downstream of the X line.Calculation of the induced out-of-plane magnetic field by in-plane currents (based on Biot-Savart law) provides direct quantitative evidence for the process of Hall magnetic field generation by the Hall current system. Multipoint data analysis shows that the ion pressure gradient in the ion momentum equation produces this Hall electric field. The global pattern of the Hall system can be explained by kinetic Alfvén wave theory. In the second case, a new quadrupolar Hall field pattern different from previous observations and simulations is observed near X line for the first time: the magnetosheath Hall current cells (Hall fields) occupied the whole magnetopause region, while the magnetosphere Hall current cells (Hall fields) still exist under the highly asymmetric condition although they are much weaker than those in the magnetosheath. The dynamics of the ion-electron decoupling responsible for the observed Hall pattern is analyzed in detail. Hall electric fields display bipolar structures pointing into the midplane, while near the electron diffusion region, normal electric fields penetrate the midplane from the magnetosphere side to the magnetosheath side, forming the ‘shoulder’ as observed in the PIC simulation.