Various patterns of the Hall magnetic field in magnetic islands: Two-fluid simulations and full particle simulations

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The formation of Hall magnetic field structure is a key factor in understanding the development of magnetic reconnection. It is well-known that the quadrupole Hall magnetic field is formed in the vicinity of the electron diffusion region, where electrons flow faster than ions. In this study, using two-fluid simulations and full particle simulations we investigate other patterns of the Hall magnetic field, which are formed in developed magnetic islands. Ion and electron jets that are accelerated at X-lines conflict in a magnetic island and therefore strong convection of plasmas is produced in the magnetic island. This convection results in various patterns of the Hall magnetic field different from normal pattern of quadrupole Hall magnetic field as mentioned above. In this study, we classify these patterns of the Hall magnetic field into two types as 'the electron type' that are formed by the electron flow and 'the ion type' that are formed by the ion flow. Since electrons tend to convect faster than ions in magnetic islands, most patterns of the Hall magnetic field are formed by electron flow and are classified into the electron type. However, it is noteworthy that there is the region at some point distant from X-lines where the Hall magnetic field is formed by the ion flow. In this region, since electrons accelerated at the end X-lines conflict and diffuse faster than ions, ions can flow faster than electrons. In addition, recent study using two-fluid simulations in an open system suggests that the ion type of Hall magnetic filed largely affects the electron flow in magnetic islands and controls the coalescence process of magnetic islands.

We will show detailed structure of these two types of the Hall magnetic filed formed in magnetic islands.