Electron Bernstein waves Driven by the Parallel Electron Crescent in the Reconnection Exhaust Region

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The recently launched NASA’s Magnetosphere Multiscale (MMS) mission enables investigations of multi-scale phenomena in the reconnection process. Especially, the MMS spacecraft revealed that high-frequency waves of electron time scales exist near the electron diffusion region (EDR) due to complex electron distributions. As such waves are generated near the EDR, they could significantly affect the environment of the EDR via wave-particle interactions.

We investigated the September 19, 2015 event when the MMS spacecraft crossed the reconnection exhaust region. The MMS spacecraft observed a parallel electron crescent, which is known to be generated by the cyclotron turning due to the normal magnetic field in the reconnection exhaust region. At the same time, highly discrete waves were observed in the power spectrum of the electric field. The wave frequency ranged between 6 ~ 14 $F_c$ (Fce: electron cyclotron frequency), and the power of perpendicular components was larger than the parallel component. Therefore, they featured electron Bernstein waves. By modeling the parallel electron crescent as a sum of 18 ring-shaped electron distributions, we calculate the linear dispersion relation using a numerical solver. The linear growth rates agreed with the power spectrum of the electric field, which means that the parallel electron crescent locally drove the electron Bernstein waves. Together with previous studies of high-frequency waves, our work could provide a diagram of high-frequency wave distributions in the reconnection geometry.