Observations of Plasma Waves in the Multiple X-line Reconnection at the Magnetopause

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Plasma waves are one of the important products of the magnetic reconnection process. Plasma waves can produce particle heating, diffusion, and anomalous effects, which can potentially affect magnetic reconnection. We investigate the evolution and properties of plasma waves during a multiple X-line reconnection event at the magnetopause using measurements from the Magnetospheric Multiscale (MMS) mission. Both whistler waves and large-amplitude electrostatic waves were observed around the reconnecting current sheet. In these regions, the electron velocity distribution functions consist of a combination of a cold beam at low energies with an anisotropic population or a loss-cone at high energies. The electrostatic waves corresponded to regions where the cold beams are accelerated, while the whistlers corresponded to regions with significant anisotropies or loss cones. When the cold beams were accelerated to higher energies, the whistlers disappeared since the anisotropy or loss-cone distributions became less apparent. These results present the detailed evolution of the plasma waves reflecting the electron dynamics during magnetic reconnection.