# Outflowing Ion Ring Distributions and their Correlation with Low-Frequency Wave Spectra Observed in/near the PSBL by MMS

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We report the recent findings of the ring-type velocity distribution functions of the outflowing ions and their correlation with the low-frequency wave spectra observed in/near the plasma sheet boundary layers(PSBLs) by the NASA MMS(Magnetospheric Multiscale) spacecraft during the magnetotail crossing phase in 2016. It is most likely that the tailward-flowing ion beams in the tail lobe/mantle regions at the distance of about 10 Re would be energized in the directions perpendicular to the local magnetic fields through the wave-particle interaction in the gyro-frequency ranges due to the plasma wave activities enhanced in the PSBL before these ion components are injected into the plasma sheet. The ion composition measurements discriminating the ions species have been done by the HPCA (Hot Plasma Composition Analyzer), which could provide us with the 3-dimensional velocity distribution functions about every 30 seconds at the slowest. The fluxgate magnetometer data of three magnetic field components are also available with 128 Hz based on the observations by the FGM on an extended mast. The gyro-frequencies of the ions in the PSBL are less than 1 Hz even for protons, and the fluxgate magnetometer data indicate that the spectra of lower-frequency waves are more intensified particularly in the PSBL probably because of the two-beam instability caused by high-speed counter streams of proton in the PSBL. In this presentation, we exhibit some events based on the HPCA and FGM observations in the mid-distance magnetotail in the MMS dataset for discussing the wave-particle interaction mechanisms acting on the outflowing ion beams in/near the PSBL. These observational results imply that the wave-particle interaction would play an important role also in the plasma energization of the outflowing ions of ionospheric origin in the PSBL and their transport from the magnetotail lobe/mantle to the plasma sheet while the transversely accelerated ions caused by the wave-particle interaction processes have frequently been observed by a number of polar-orbiting satellites in the auroral magnetosphere. It is getting more obvious that the comprehensive research for the wave-particle interaction mechanisms in the space plasmas would be more essential and universal in the space physics and any relevant research fields.