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C 会場 ：11/5　PM1 （13:45-15:30）
15:15〜15:30

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Observational evidence of nonlinear growth of whistler-mode waves around quasi-perpendicular bow shocks

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In this presentation, we show observational results of nongyrotropic electrons close to the cyclotron resonance velocity, which is a key feature of nonlinear growth of whistler-mode waves, using data obtained by the Magnetospheric Multiscale (MMS) spacecraft around quasi-perpendicular bow shocks. Interaction between the electromagnetic field and charged particles is central for the collisionless plasma dynamics in space. Whistler-mode waves are one of the electromagnetic plasma waves, which play important roles in efficient pitch-angle scattering and acceleration of electrons in solar wind, collisionless shock waves as well as planetary magnetospheres. The nonlinear wave-particle interaction theory for coherent large amplitude waves predicts that resonant electrons exhibit nongyrotropy due to phase trapping motion around resonance velocities in the presence of an appropriate inhomogeneity. The nongyrotropic electrons exchange energy and momentum with waves efficiently. While the nonlinear wave growth has been discussed mainly for wave growth in the magnetosphere, it has rarely been discussed for whistler-mode waves in other regions. Here we show examples of nongyrotropic electrons close to the cyclotron resonance velocity during whistler-mode wave events around three quasi-perpendicular bow shock crossings as the observational evidence of nonlinear wave growth. Using measurements by the Fast Plasma Investigation Dual Electron Spectrometer (FPI-DES) and the search-coil magnetometer (SCM), we identified electron flux hole events that induce wave growth; a hole at an appropriate relative phase angle to the whistler-mode wave magnetic field appeared only close to the cyclotron resonance velocity. The magnitudes of the gradient of the magnetic field intensity along the magnetic field line during such time intervals are consistent with an appropriate magnitude to cause phase trapping of resonant electrons. This result provides strong evidence of nonlinear growth of whistler-mode waves around quasi-perpendicular bow shocks. The nonlinear wave growth of whistler-mode waves due to phase trapping, which has been discussed mainly for wave growth in the magnetosphere, probably plays a role in broader applications in space if the appropriate condition is satisfied.