Van Allen Probes 衛星が観測した、fast magnetosonic waves の性質

山本 和弘 [1]; 能勢 正仁 [2]
[1] 京大・理・地物・電磁気; [2] 京大・理 地磁気センター

Properties of the fast magnetosonic waves observed by Van Allen Probes

Kazuhiro Yamamoto[1]; Masahito Nose[2]
[1] Geophysics, Kyoto Univ.; [2] DACGSM, Kyoto Univ.

In this study, we report two topics: the relation between fast magnetosonic waves and thermal protons, and the radial propagation of fast magnetosonic waves.

Fast magnetosonic waves are sometimes called as equatorial noise or ion Bernstein mode waves and are frequently observed in magnetic equatorial region in the inner magnetosphere. These waves are typically compressional and have peaks in the spectra of electric and magnetic fields at the harmonics of ion cyclotron frequency.

Many theoretical studies and observations show that the energetic proton ring/shell distributions (~10keV) are the source of these waves [*Perraut et al.*, 1982; *Denton et al.*, 2010; *Gray et al.*, 2010; *Zhou et al.*, 2014, *Maldonado et al*, 2016]. The influence of thermal protons (1~100eV) is also mentioned in some theoretical studies. *Horne et al.* [2000] demonstrate the proton heating through the Doppler-shifted cyclotron resonance between thermal protons and fast magnetosonic waves by performing ray-tracings. *Min and Liu* [2015] perform linear dispersion analysis and show that the waves become electrostatic when the ratio of a Maxwellian thermal component to an isotropic shell velocity component decreases. However, there are few observations on the relation between fast magnetosonic waves and thermal protons.

The other topic is the wave propagation. *Perraut et al.* [1982] propose that we can estimate the radial propagation direction of fast magnetosonic waves from the harmonic frequency because it relates to the magnitude of the magnetic field where the waves are generated. Wave propagation may explain the harmonic structures that deviate from the local proton cyclotron frequency.

Here we investigate fast magnetosonic waves and their associated enhancements of thermal proton flux observed by Van Allen Probes. On February 6, 2014, Probe B observed two fast magnetosonic wave events in the equatorial region (L = 5.8 and 5.4, MLT = 12.8 and 13.5, and MLAT = 0.2 and 1.4) at 1700 and 1800 UT. The compressional waves appeared above 10 Hz in magnetic field. We also found electric harmonic structure below 10 Hz. Small disturbance (Dst ~-30 nT) occurred on the day. There was a sudden increase of proton density of solar wind at 1750 UT (from 2/cc to 3/cc), but around 1700 UT the condition of solar wind was stable. AE index slowly changed from 200 nT to 100 nT. At the same time, proton flux increased at the energy of 10-100 eV and had peaks around 1700 and 1800 UT. Such a simultaneous increase of thermal proton flux can be also found on March 06, 2013. We attribute the increase the flux to fast magnetosonic waves, and discuss the relation between them from the two points of view: wave-particle interaction and regime transition of fast magnetosonic waves.

In addition, we show simultaneous observation of fast magnetosonic waves by probe A and B on March 1, 2014. The radial distance between probe A and B was ~0.5 Re and probe A was nearer the earth than probe B. Probe A observed harmonics of the local proton cyclotron frequency (5 Hz, 10 Hz, ...). The harmonic structure was observed by probe B about 2 minutes after the observation of probe A. The structure had peaks at same frequency as probe A and deviated from harmonics of the local proton cyclotron frequency (4 Hz, 8 Hz, ...). We consider these spectral features as results of wave propagation in radially outward direction from the strong magnetic field region (at probe A) to the weak magnetic field region (at probe B). From the time difference between two observations, we estimate the radial component of the group velocity of the fast magnetosonic waves (v_g^{rad}) and the result is v_g^{rad} ~20 km/s.