Observations and Theory of Mirror-Mode Structures in the Dawn-Side Magnetosphere

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There are a number of mechanisms by which ULF oscillations can be excited in the magnetosphere, both externally (i.e. solar wind) or internally (e.g. via resonance with energetic particle sources). One mechanism that is not traditionally considered/ observed is the mirror instability/mode. The mirror mode is a compressible slow mode typically excited in high-beta plasmas where there is significant pressure anisotropy and grows if the free energy of the pressure anisotropy is sufficiently large and must be dissipated. Observational evidence of these mirror modes are rare, but mainly concentrated in the dayside magnetosheath, where the necessary temperature anisotropies can develop, and increase as the magnetopause is approached. However, it is possible to generate the mirror instability inside the magnetosphere, though as yet there are few observational examples. We present an interval on the 19^{th} March 1998 when the Equator-S spacecraft is traversing the dawn-side magnetosphere above the ecliptic plane at radial distances of up to L$\sim$11, and encounters quasi-monochromatic perturbations in the magnetic field, ion number density, temperatures and velocities. The magnetic field strength and number density oscillations are anti-correlated, and the plasma and magnetic field pressure variations are in anti-phase also, which are all consistent with the mirror instability hypothesis. We calculate the classic mirror instability criterion (Hasegawa, 1969) and find that the condition for mirror-mode waves to grow is strongly met throughout the interval. We then compare this to the instability criteria when finite gyroradius effects are taken into account. Finally we discuss the solutions to the full kinetic dispersion relation with reference to the observations. We believe that this is an excellent high temporal resolution example of mirror instability ULF waves inside the Earth's magnetosphere.