Thermal Electron Population in the Earth's Magnetotail: Convective Heating and Nonlinear Resonances with kinetic Alfven Waves

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The magnetotail current sheet carries the current responsible for the largest fraction of the energy storage in the magnetotail, the magnetic energy in the lobes. It is thus inextricably linked with the dynamics and evolution of many magnetospheric phenomena, such as substorms. The magnetotail current sheet structure and stability depend mostly on the kinetic properties of the plasma populating the magnetotail. One of the most under-investigated properties of this plasma is electron temperature anisotropy, which may contribute a large fraction of the total current. The formation of the predominantly field-aligned anisotropy of thermal and subthermal electron populations is open question of the physics of Earth's magnetotail current sheets (see Figure). Although the plasma connective heating is expected to provide a transverse electron anisotropy, spacecraft observations report about strong field-aligned electron beams and field-aligned anisotropy for a wide energy range, form 100 eV to few keVs (see [1] and references therein).

The formation of such anisotropic electron populations requires a field-aligned electron acceleration, that is presumably due to transient parallel electric fields. Such fields are indeed carried by intense kinetic Alfven waves widely observed by spacecraft in the magnetotail[2]. Wave amplitudes are sufficiently strong to provide the nonlinear resonant interaction, including phase trapping effect for the Landau resonance[3,4]. In the strongly inhomogeneous background magnetic field of the magnetotail current sheet such Landau trapping may produce an effective field-aligned acceleration of electrons. In this talk we discuss main details of such acceleration, theoretical approaches for quantification of the nonlinear Landau trapping, and spacecraft observations confirming the key role of kinetic Alfven waves for electron acceleration.

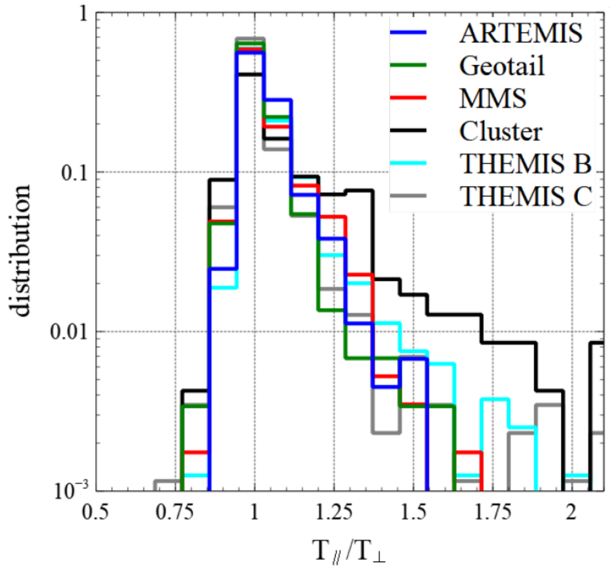
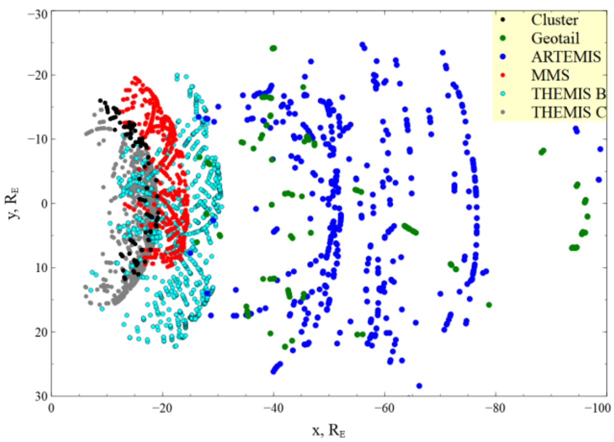


Figure. Distributions of electron thermal anisotropy for six databased of magnetotail current sheet crossings. Each dataset includes current sheets at different radial distances (see distribution of current sheets in the equatorial magnetotail plane below). For each current sheet crossing we determine electron temperatures averaged over the near-equatorial $|B_x|<10$nT region.



References

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