Investigation of Energy Conversion and Transfer in the Auroral Magnetosphere by Multi-Point Observations

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A comprehensive network of satellites and ground observatories allows nowadays a close investigation of the energy flow in the auroral magnetosphere:

- Satellite formations like Cluster, or the upcoming MMS and (hopefully) Cross-Scale, provide both estimates of the spatial and temporal derivatives of the physical fields, and the increased redundancy needed when the fields are weak. This enables the local examination of the power density, and thus of the energy conversion between its basic mechanical and electromagnetic forms. It also enables the evaluation of the quantities relevant for the local energy transfer – bulk flow energy flux, heat flux, and Poynting flux – together with their derivatives.
- Conjugate observations between high and low altitude / ground platforms can offer a global view over the energy transfer. In-situ measurements by e.g. Cluster, FAST, Polar, Geotail, Double Star, as well as optical and radar data, have been used to relate energy conversion and transfer between different regions of the magnetosphere, or between the magnetosphere and ionosphere. A systematic effort in this direction is now ongoing through the THEMIS mission.

A wide variety of simulation and modelling tools complement the observations on both local and global scale.

Given the preliminaries above, it may be worthwhile to address the energy conversion and transfer systematically, as a goal in itself. A number of possible questions (biased towards energy conversion) are listed below.

- Are the energy conversion regions rather structured or rather flat?
- Where is the energy conversion located? More in the plasma volume or near / within boundary layers? Like PSBL? LLBL? Neutral sheet?
- What influences the magnitude of the energy conversion? Plasma beta? Other parameters?
- What is the lifetime of the energy conversion regions? Should stable auroral arcs necessarily be associated with steady generators?
- How important are the parallel electric fields for energy conversion? Are they often important, or most of the time the Lorentz force is enough?
- Energy conversion is quite often associated with bulk flow. What are the implications for load versus generator regions?
- Loads are sometimes observed together with temperature anisotropy, with $T_{\parallel} > T_{\perp}$. Is this related to faster thermalization of the plasma in parallel direction?
- Is it possible to identify / quantify irreversible processes associated with energy conversion? Could entropy calculation help in this respect?
- How well can we check the coupling to aurora of magnetospheric generator regions? What about the coupling of load regions?
- What are the dominant energy transfer vehicles in the magnetospheric regions coupled to aurora? How do they depend on the substorm cycle?
- Is it possible to extend (some of) the Cluster techniques to other missions, starting with the three THEMIS satellites in the current disruption region?