Session 7: Auroral and subauroral phenomena

Chair: Kirsti Kauristie
Time: Tuesday July 29, ~13:30-14:30

The Session included four presentations:

Björn Gustavsson: Black aurora and pulsating aurora, "misunderstood" phenomena in diffuse aurora?

This presentation discussed the generation mechanisms of black aurora. So called black auroras appear as narrow stripes or curls of decreased auroral emission intensities embedded within diffuse auroras. Earlier work (e.g. Marklund et al., JGR, 1997) shows that these dark structures can be associated with field-aligned potential drops with downward pointing electric field and appearing in the lower part of auroral acceleration region (altitudes 800-1700 km). On the other hand, combined data from an aircraft campaign and FAST satellite analysed by Peticolas et al. (JGR, 2002) suggest that dark auroras can be a consequence of quenching in the pitch-angel scattering processes. The quenching takes place only for electrons with energies above a certain threshold energy.

Gustavsson presented a study of a black aurora event observed with optical instrumentation and EISCAT Incoherent Scatter Radar (ISR, EISCAT). The data was used as input for a modeling work to resolve the appearance of an intensity drop in 427.8 and 844.6 nm auroras due to the two competing scenarios. It appeared that in the analysed case the theory of quenching in the pitch-angle scattering was more consistent with the observations than the potential drop theory. Consequently, the widely accepted picture relating black auroras with acceleration region processes is not valid in all conditions, also magnetospheric processes at higher altitudes should be kept in mind. Gustavsson reminded that recent studies by Sato et al. (GRL 2005) have revealed that the situation with pulsating auroras is quite much the opposite: Previous theories suppose magnetospheric processes to cause the pulsation while newest observations suggest that also acceleration region phenomena should be taken into account.

Details of Björn's presentation are available in a recently published JGR-article: Combined EISCAT radar and optical multispectral and tomographic observations of black aurora, JGR, 113, A06308, doi:10.1029/2007JA012999, 2008.

Alexander Kozlovsky: Double structure of auroral arcs

The presentation discussed the appearance of high-latitude auroral arcs in the dawn and dusk sectors of the auroral oval. Alex has analysed field-aligned current systems related with high-latitude arcs by using data from the EISCAT Svalbard radar and all-sky cameras. It has appeared that both in the morning and dusk sectors the current systems tend to have a double sheet structure

where the upward current at the main arc is accompanied by another upward current sheet equatorward of the main arc.

The magnetospheric processes causing high-latitude arcs are anticipated to occur at the boundary layers of the magnetosphere: the afternoon arcs have their origin in the fingerlike intrusions of magnetosheet plasma into LLBL (Lundin and Evans, 1985) while the morning sector arcs are related with similar structures occurring at the boundary between LLBL and plasma sheet (Kozlovsky et al., 2007). If the effects of the field-aligned currents to the ionospheric conductivities are taken into account the ionospheric processes can control (as a feed-back process) the dynamics and structure of the magnetospheric fingers. In a linear assumption the intrusion speed of the fingers can get affected and in the non-linear assumption the fingers may split into narrower structures. The non-linear behavior would thus explain the observations of secondary weaker arcs besides the main arcs. The theory assumes, however, that this kind of splitting can take place only in the cases of (i) poleward moving arcs which originate in the west and propagate eastward and (ii) of equatorward moving arcs which originate in the east and propagate westward. While the previous scenario has already been investigated in the paper by Kozlovsky et al (2007) the latter one is still waiting for observational confirmation.

More information:
Kozlovsky et al.,: Dynamics and electric currents of morningside Sun-aligned auroral arcs, JGR, 112, A06306, doi:10.1029/2006JA012244, 2007.

Masatoshi Yamauchi: Cold, keV and MeV ion signatures of westward moving auroral bulge at L~4 in equatorial plane

This presentation discussed Cluster particle and field observations in the context of a dusk sector brightening as observed by the IMAGE satellite on May 19 2005 around ~0643 UT. The Cluster satellites resided at ~19 MLT with a geocentric distance of ~4Re (and near the magnetospheric equator). The constellation moved from south to north with sc1 (the first satellite) leading with roughly one minute sc3 (the last satellite). Inter-spacecraft distances were <300 km. The brightenings observed by IMAGE during the event included a finger-like structure at the poleward boundary of the oval followed by a westward moving bright blob in the main oval (at ~60 MLAT). According to ground-based magnetograms a small substorm was going on and the bright blob was associated with a further intensification of the substorm activity.

When the magnetospheric conjugate region of the auroral blob reached the Cluster satellites their instrumentation showed abrupt changes in the particle fluxes and DC-fields. The changes were almost simultaneous at all satellites (sc3 saw the effects only 1-10 sec before the others). In particle fluxes the medium energy (~10-100 keV) ion fluxes increased while more energetic (100-1000 keV) ion fluxes and electron fluxes (>30 keV) decreased. The increases in 10-100 keV ions were mass dependent. In pitch angles the ion population (O+

and H+) moved temporarily from perpendicular distributions to more field-aligned distributions. The bulk motion of He+ and H+ ions was consistent the observed ExB drift.

In the considered case the distances between the Cluster satellites were of the same order or smaller than ion (H+ He+ or O+) gyro-radii in the energy range of 10-1000 keV. Detailed inspection of the observed fluxes reveals some clear inter-space craft differences in the amplitudes of the flux enhancements. Consequently the considered event poses a new challenge for the modeling work: The assumption of gyrotropic behaviour is not valid any more.

Jaejin Lee: Can energetic electrons contribute to the Aurora emission?
More detailed description: TBD.

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Open questions or challenges for the future work:

- It is still poorly understood which specific features in auroral dynamics and morphology come from magnetospheric equator and which from the acceleration region.

- High-latitude arcs in the dawn and dusk sectors of the auroral oval have the tendency to appear as sequences of two (or more) combined arcs. More observations are needed to see if this behavior is more typical for arcs which have certain type of dynamics: Westward (eastward) intrusion combined with equatorward (poleward) drift.

- Now it is time to start analyse and simulate those Cluster observations where inter-spacecraft distances are of the same order of smaller than gyro radii of H+, He+ and O+ at the magnetospheric equator.