ELECTRON HOLES IN THE AURORAL UPWARD CURRENT REGION

R. Pottelette

CETP/CNRS, 4 avenue de Neptune, 94107 Saint-Maur des Fossés, France.
e-mail :raymond.pottelette@cetp.ipsl.fr

FAST observations in the mid-altitude auroral magnetosphere [1] confirmed the existence of electron holes in the downward current region. Evidence for them to exist has also been accumulated in all regions where magnetic field-aligned currents are expected to flow: in the plasma sheet boundary layer [2, 3], at the magnetopause [4], the bow shock ramp, and even in the magnetosheath [5], though they might not always be of same nature. The importance of these holes in connection with plasma acceleration in the auroral downward current region has been stressed by numerical simulations and comparison with observation [6, 7]. In contrast, to our knowledge electron holes have so far not been reported to exist in the upward current 'inverted-V' region. This is surprising as the typical signatures of the upward current region are the fast downward electron beam (ring/shell distribution), and the cold upward ion beam, representing a typical two-stream configuration which by theory should be unstable and generate electron holes. Ion holes have, on the other hand, been observed here.

Based on high time resolution FAST data we present evidence for electron holes in the upward current auroral kilometric radiation (AKR) source region. The VLF electric field waveform parallel to the ambient magnetic field contains large numbers of isolated electric field structures of tripolar polarity which is explained in terms of a train of nested ion and electron holes such as shown in numerical simulations [6]. Such structures are created by beam plasma interaction via the kinetic two-stream instability upstream of a strong double layer and gives rise to broadband emission spectra around the ion plasma frequency. Parallel tripolar electric field amplitudes may reach about $1 Vm^{-1}$ peak-to-peak and appear to modulate both the particle energy fluxes. It is highlighted that the presence of these tripolar structures is responsible for the recorded fine structure of the electromagnetic AKR emissions. Indeed, the FAST high-resolution wave and particle instrumentation allowed associating the observation of elementary radiation sources in the AKR source region with large tripolar parallel electric field pulses, revealing the presence of a large number of electron holes. These electron holes appear to result from a kinetic Buneman instability. Their physical properties differ from those recorded in the downward current region, where they are associated with fast bipolar structures. In the upward current region the electron holes appear to be connected with slowly moving tripolar electric field structures.

REFERENCES

[1] Ergun, R. E., et al., FAST satellite observations of large amplitudesolitary structures, *Geophys. Res. Lett.*, 25, 2041-2044, 1998.
[2] Matsumoto, H., H. Kojima, T. Miyake, Y. Omura, M. Okada,and M. Tsutsui, *Geophys. Res. Lett.*, 21, 2915, 1994.
[3] Omura, Y., H. Kojima, N. Miki, and H. Matsumoto, Two-dimensional electrostatic solitary waves observed by Geotail in the magnetotail, *Adv. Space Res.*, 24, 5558, 1999.
[4] Cattell, C. et al., Comparisons of Polar satellite observations of solitary wave velocities in the plasma sheet boundary and the high altitude cusp to those in the auroral zone, *Geophys. Res. Lett.*, 26, 425-428, 1999.
[5] Pickett, J. S, et al., Solitary potential structures observed in the magnetosheath by the Cluster spacecraft, *Nonlin.Process. Geophys.*, 10, 3-11, 2003.
[6]Goldman, M. V., M. M. Oppenheim, and D. L. Newman, Nonlinear two-stream instabilities as an explanation for auroral bipolar wave structures, *Geophys. Res. Lett.*, 26, 1821-1824,1999.
[7] Goldman, M. V., D. L. Newman, and R. E. Ergun, Phase space holes due to electron and ion beams accelerated by a current-driven potential ramp, *Nonlin. Process. Geophys.*, 37-44, 2003.