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Kinetic Alfvén waves in the magnetosphere during substorms

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The thickness of near-Earth plasma sheet is in a wide range during substorms. When ion inertial length or gyro-radius is close to the plasma sheet thickness, kinetic Alfvén waves (KAWs) can be excited in the high-β ($\beta = 2\mu_0\ nT/B^2$, the ratio of plasma thermal pressure to magnetic pressure) plasma sheet during substorms in the near-Earth magnetotail[1]. The distinct property of KAWs is that the ratio of the electric field to the magnetic fields almost equals the local Alfvén speed. The parallel electric field accompanied by KAWs accelerates charged particles along the magnetic field. KAWs play a significant role in the formation of the substorm current wedge. The field-aligned current and Poynting flux carried by KAWs have been considered to power the aurora.

The KAW eigenmode (KAWE) was accompanied by short timescale (1 min) dipolarizations likely generated by transient magnetotail reconnection. The observed polarity of the KAW field/current is consistent with that of the Hall field/current in magnetic reconnection, supporting the scenario that the Hall fields/current propagates out from reconnection site as KAWEs [2]. Aurora images on the footprint of THEMIS spacecraft suggest that KAWEs may power aurora brightening during the substorm expansion phase. During intense substorms, the KAWE with the large perpendicular unipolar electric field significantly accelerates O^+ ions in the direction perpendicular to the background magnetic field [3]. KAWE can play a significant role in O^+ ion transfer process from the lobe into the plasma sheet during intense substorms.

References
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[2]S.P.Duan et al,J. Geophys. Res.**121**, JA022431 (2016)
[3]S.P.Duan et al,J. Geophys. Res.**122**, JA024418 (2017)

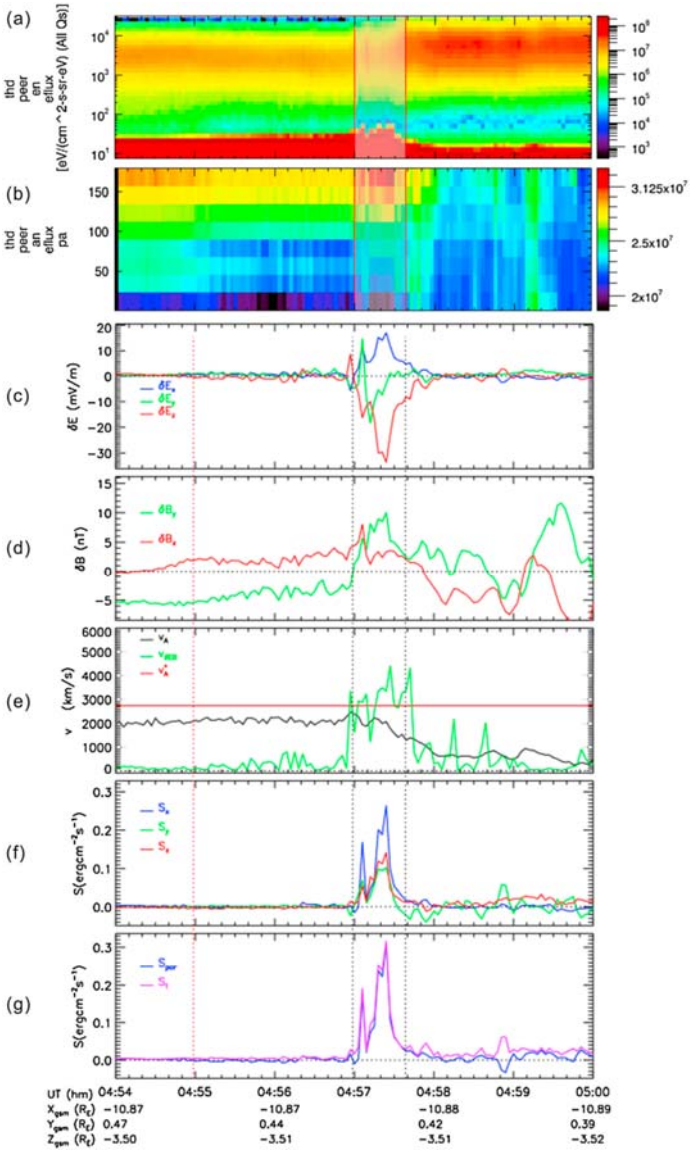

Figure 1 Electron energetic particle flux, pitch angle distribution, and electromagnetic field fluctuations during substorm expansion phase are observed by THD during the period of 0454–0500 UT on 3 February 2008 in the near-Earth plasma sheet. (a) Electron energetic particle flux; (b) energetic electron pitch angle distribution; (c) the perturbations of three components of the electric field, δE_x(blue), δE_y(green), and δE_z(red); (d) two components of the perturbation magnetic field, B_y and B_z; (e) local Alfvén speed, V_A(black), predicted propagation speed of KAW eigenmode, V_A*(red), and the ratio of the perturbation electric (δE_z) to magnetic (δBy) fields, $V_{\delta EB}$(green); (f) three components of Poynting flux, S_x, S_y, and S_z, and (g) the parallel and total Poynting flux, S_{par}(blue) and S_t(pink), respectively.