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Interactive comment on "Thermal electron anisotropy driven by kinetic Alfven waves in the Earth's magnetotail" *by* Alexander Lukin et al.

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1 Referee 2

1. I am a little surprised at the large size of the parallel electric fields (Figure 4). It has been demonstrated from observations by authors on this manuscript that phase space holes are prevalent in filamentary currents carried by KAWs in the magnetotail. It might be worthwhile to provide a description of how these fields (which will not follow the KAW relations given) were removed from the measurements.

   It is a good point! Strictly speaking we cannot fully exclude the impact of electrostatic structures on our results. We don't perform analysis of such structures

   in our observations and don't apply any special procedure of their removing. But we remove all electric field perturbations with frequencies $\omega_{sc} > \omega_{LH}$, because above the lower-hybrid frequency observed $E_\perp/B_\perp$ spectra ratios strongly deviate from theoretical prediction for KAWs. At the same time for electrostatic solitary waves we expect (based on previous publications, e.g., Malaspina et al. (2015); Malaspina et al. (2018)) higher frequencies. And we also can't assume that all perturbations with large parallel electric fields have non-KAW nature, because it has been shown in previous works (e.g. (Chaston et al., 2012; Ergun et al., 2015)) that KAW electric fields can reach magnitudes up to 100 mV/m.

2. In the neutral sheet, where the background magnetic field is weak, and the Alfven speed is small, I am a little concerned about the use of a fixed scale background magnetic field applied across all scales or spacecraft frame frequencies. This may be a contributing factor mixing field-aligned and transverse variations if the wave field amplitudes are a significant fraction of the background. Just an idea, but it might be worth checking given the deviations in the statistics from the local wave model in Figure 9.

   We have used several different cutoff frequencies to filter background fields and didn't find any strong effect on our conclusions. The strongest deviation we got for cutoff frequency of 0.05 Hz and the results for this case shown on Figs. 3 and 4 in supplement (Figs. 1 and 2 show results for cutoff frequency of 0.01 Hz). At the same time, since we try to find KAW's we didn't use cuttor frequency higher that 0.1 Hz because in this case we can lose some part of KAW spectral energy.

3. Line 112, Is omega here the plasma frame wave frequency or the spacecraft frame frequency? I think in Equation 4 omega is the plasma frame wave frequency which I am not sure can be measured. Please explain. Reviewer is right, it is a plasma frame frequency. We have revised the procedure of $k_\parallel$ estimation and provide more details there:

knowing the transverse component $k_\perp$ as function of wave frequency in the spacecraft frame ω_{sc}, we estimate the parallel $k_\parallel$ from equation (Stasiewicz et al., 2000):

$$k_\parallel = \frac{\omega_{pf}}{v_A\sqrt{1+k_\perp^2(\rho_i^2+\rho_s^2)-\frac{\omega_{pf}^2}{\omega_{ci}^2}(1+k_\perp^2\rho_i^2)}} \quad (1)$$

where ω_{pf} is a wave frequency in the plasma rest frame and ω_{ci} is a local ion cyclotron frequency. Because we can't estimate ω_{pf} we choose two typical values: $\omega_{pf} = 0.05\omega_{ci}$ and $\omega_{pf} = 0.5\omega_{ci}$ and define $\phi_{\parallel 05} = \phi_\parallel(0.5\omega_{ci})$ and $\phi_{\parallel 005} = \phi_\parallel(0.05\omega_{ci})$.

4. Figure 1 - no date. Might also be good to make the grey lines showing the averaged field a bit darker to improved visibility.

   Averaged field lines have been modified. Regarding Fig.1, we have include a table with all event listed.

5. There is a recent study by Hull et al. GRL 2020 in the inner edge of the plasma sheet that also links electron anisotropy to KAWs. This work is sufficiently close in topic and method that perhaps it should be cited in this work.

   Thanks, we have cited this work (see line 55 in the revised version).

6. Can I suggest that one of the native English speaking authors edit the text to improve the expression. It is understandable, but a little rough in places, and could be improved without too much effort.

   - line 24 'what' should be 'that'
   - line 115 'zeros' should be 'zero'
   - line 221 - 'perspective' should perhaps be 'likely' or 'probable'

   Done!

References

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