

Interactive comment on “Total Reflection of the Strahl within the Foot of the Earth’s Bow Shock” by Christopher A. Gurgiolo et al.

Anonymous Referee #2

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The manuscript presents a rather detailed observational study of the terrestrial electron foreshock using full 3D electron velocity distribution functions (eVDF) acquired on board the suit of Cluster spacecraft. Based on three specific events the authors analyze the properties of reflected electrons and further investigate where the reflection may take place in the vicinity the bow shock boundary. By use of so-called phi-theta (PT) plots, showing the full 4PI maps of the eVDF at specific energy bins, the authors conclude that (i) the majority of the reflected electron population originate from the field aligned strahl electron population, and (ii) the reflection process take place already at the foot of the bow shock ramp. In general the topic and the presented results are new and of considerable scientific interest. The manuscript as is well corresponds to international standards and is worth of publication in the journal. However, for the fi-

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nal acceptance of the manuscript, I would strongly suggest to the authors to take the following comments into account.

1/ (MAJOR) While the discussion and reasoning about the "total" strahl reflection seems to be more solid and well justified by the observations and the performed analysis, the conclusions about the location of reflection are rather too strong and should be better presented as a possible hypothesis which proof will definitely require some additional analysis (like what is the justification of showing the eVDF evolution along the trajectory for event 2005-037 instead of the two other where the profile of the background magnetic field seems to be less "turbulent" and a bit more representative for a classical bow shock?; also does the missing strahl implies it was already fully reflected and not only scattered to other pitch angles?; why the reflected particles are observed even in case the strahl does not reach this location?). Therefore I strongly suggest to rewrite the conclusions accordingly and namely change the title of the manuscript.

2/ Although the "total" reflection seems to be observed the discussion should be extended like for the possible contribution of sunward propagating electrons coming from the down-stream region and accelerated eg in the bow shock. But still the observed NR/NS ratio almost equal to unity is impressive.

3/ A substantial part of the whole analysis is based on many "subjective" threshold values (limit pitch angles, density ratios, integration energy intervals) which are not well explicitly defined (eg, line 157 "the energy at which it becomes dominant" does not defines what is already dominant...). Although this fact tends to be covered in the overall discussion it is completely missing in the conclusions where it should be even emphasized!

4/ For the complete picture it could be of interest to plot not only the variation of the B-field magnitude (Figure 14) but also of the individual components to see how the magnetic background is stable or not. This is highly relevant namely when discussing the B angle to the shock normal.

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5/ The PT plots should display some color bar to give information about the scale of the color maps. In the present form it is impossible to see what is the level of variation and how the strahl/reflected electrons are significant wrt to the core-halo part. The authors could also consider to plot the eVDF PT plots in the solar wind frame (from the text it seems this is not the case now) which can very likely make the visual separation of the strahl/reflected particles more easy at lower energies.

6/ For a probability distribution function (PDF) I would expect $\text{Sum}(\text{PDF})=1$, here this is not the case as all the displayed PDF show already the maximum value for the most probable bin equal to 1... Please correct or define what is your PDF.

7/ When plotting the NR/NS ratio, consider adding a line $y=1$ so the reader can better see what is the variation around the "total" reflection. Also the y-scale on Figure 13 for this ratio can be adjusted accordingly, here the max value is too high.

line 65 - It is often... a verb is missing?

line 74 - remove "it" after mirroring

line 76 - though -> through

line 129 - What is UDF Analysis, it is generally known or should be described here (or removed)?

line 178 - (also related to comment 3) high/low density wrt what? What about to consider normalizing the NR by NT? Would it make the foreshock determination more robust?

line 212 - What is QGM? Either remove or explain a bit.

line 303 - The meaning of the last sentence is not clear even from the context.

line 308-309 - Would the return population "become more gyrotropic" (full ring) when plotting the PT plot is solar wind frame?

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line 387 - remove "eV", the energization factor has no units

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line 408 - effect -> affect ?

line 526 - are -> is

line 533-539 - This paragraph should be placed later in the Conclusions. First one should recall the MAIN results.

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