

ANSWER TO REVIEWERS

Report #1

Submitted on 04 Sep 2026

Anonymous referee #2

Answer: We thank the reviewer for this very profound second review and address all comments in the revision.

1/ JEI observations vs SIMION simulations

The new clarification that the SIMION calculations are intended only as an illustration of the principle is helpful, and I agree that the simulation convincingly demonstrates the qualitative effect that ions of different masses are deflected differently by the spacecraft potential. I therefore consider my original concern largely addressed. Nevertheless, I still see some limitations in the quantitative comparison between the JEI observations and the simplified potential model used in the subsequent analysis. The manuscript adopts a linear potential extending over 50 cm, whereas the Debye length inferred for the actual observation is about 8 cm. Although the authors now explain that SIMION cannot reproduce an exponentially screened potential, it remains unclear why this particular 50 cm scale was chosen and how sensitive the predicted arrival angles are to this assumption. This is relevant because the subsequent discussion makes quantitative comparisons between the expected and observed polar angles for individual ion species. I do not consider this a major issue preventing publication, but I would encourage the authors to make this limitation somewhat more explicit. In particular, it would be useful to distinguish more clearly between the robust qualitative conclusion - that the spacecraft potential provides mass-dependent angular filtering - and the quantitative prediction of the arrival angles, which depends on the assumed potential structure. A more realistic treatment using the actual spacecraft potential distribution and Debye-scale sheath structure would be a valuable future improvement of the method.

Answer: Thank you for this comment. The Debye length gives only an order of magnitude for the range of the potential. The essential assumption for the SIMION simulation is that ions start at 0 potential and that the scale height of the potential allows to treat the global geometry as planar. We added to the text: The important assumptions are that the electric field is mainly vertical and ions are launched from a field-free point. In this case the ion acceleration is mainly in vertical direction such that the distance from which ions are launched has no influence on the arrival angle. A more realistic simulation could be done using the SPIS model, cited above.

2/ Appendix B

I appreciate the substantial extension of Appendix B, which now explicitly includes the effect of the spacecraft potential on a drifting Maxwellian distribution. This addresses my previous concern about interpreting/fitting the spectra without accounting for the potential and provides a useful theoretical basis for the analysis. I have, however, noticed technical points in the new derivation that should be checked:

Definition of Delta sigma (Eq. B3) - The manuscript defines theta as the polar angle measured from the Z-axis, which is also consistent with the subsequently used spherical volume element $dV = v^2 \sin(\theta) dv d\theta d\phi$. With this convention, the angular separation between the viewing and flow directions should be

$$\cos(\Delta\sigma) = \cos(\theta) \cos(\theta_f) + \sin(\theta) \sin(\theta_f) \cos(\phi - \phi_f),$$

whereas Eq. B3 appears to correspond to an elevation angle measured from the XY-plane. As the subsequent equations use Delta sigma directly, this seems to require only a correction of its definition. Please check this carefully.

Answer: Thank you for spotting this. We corrected eqn. B3, but it has no impact on the following deduction, because we assume $\phi = \phi_f$.

Sign convention for Vp in Eq. B6 and the main text - In Eq. B6, Vp appears to be used as the positive magnitude of the potential drop, so that an incoming positive ion gains the energy $q V_p$. Elsewhere in the manuscript, however, Vp denotes the signed spacecraft potential and is correctly given as negative (e.g. -5 V). If Vp is retained as the signed spacecraft potential, the energy gain of an incoming positive ion should be $-q V_p > 0$. The notation/sign convention should therefore be made consistent.

Answer: Thank you for spotting this. We corrected eqn. B6 and noted that V_p is negative.

Finally, in connection with the statement in the authors' response that, to their knowledge, this is the first explicit calculation of the potential effect for a drifting Maxwellian velocity distribution apart from Mott-Smith (1926), I would like to point out the closely related derivation in Stverak et al. (2026):

https://www.aanda.org/articles/aa/full_html/2026/05/aa58881-26/aa58881-26.html

including some references therein. There, the spacecraft-potential transformation is explicitly derived for a drifting Maxwellian in a spherical potential geometry with the drift direction chosen along the polar axis. The present treatment considers a more general drift direction through $\Delta\sigma$ and a different, locally planar potential geometry. I therefore suggest citing this work and briefly clarifying the relation between the two treatments.

Answer: We were actually aware of the paper by Stverak et al. (2026) but we did not want to cite it because their derivation is not correct or at least incomplete. Specifically their assumption in equation A.11 is generally wrong because it assumes that all ions are initially moving towards the sensor. Ions of the Maxwellian distribution which are initially moving away from the sensor are not gaining energy but losing energy. This differentiation we have corrected in our analysis. We have added a respective sentence in Appendix B.

Minor/editorial comments

Line 164 / Figure 9: The SC potential is not overplotted in red (as stated in the text), but in black (correctly stated in the caption).

Answer: Thanks, corrected.

Line 204: An example of a missing space before the left bracket, which also occurs elsewhere in the manuscript.

Answer: corrected.

Appendix: For readability, I suggest enclosing the arguments of the exponential functions in parentheses, particularly in Eqs. B1, B2, and B4.

Answer: corrected.

Report #2

Submitted on 21 Sep 2026

Anonymous referee #1

Accept as is.

Answer: Thank you considering our manuscript again.