Assignment 2: Comparison of sheath conditions using interpolation

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1 Overview

In this assignment you are going to build on the first assignment in order to explore how the sheath solution depends upon the speed at which ions enter the sheath, v_s. You are welcome to write a new code or to build on either your submission or the example solution to the first assignment.

In order to compare the results for different v_s values it is necessary to align the solution that you get so that $\hat{x}$ means something comparable in each case. Here we will be interested in finding the location of the material surface (i.e. the wall) in each case and shifting our results so that the surface is always at the same location. To do this it is helpful to note that in steady state (i.e. when things are not evolving in time) the current into the wall must be zero[1].

Tasks: The assignment is split into three tasks, with a total of 10 marks.

2 Generalising for multiple $\hat{v}_s$ values

✓ 1

Task [3 marks]: The first step is to generalise your code to solve for multiple $\hat{v}_s$ values, specifically $\hat{v}_s = 1, 1.5$ and 2. You should avoid using copy-paste and/or hard-coding these values.

3 Finding the wall location for multiple $\hat{v}_s$ values

✓ 2

Task [4 marks]: For each $\hat{v}_s$ you will need to find the location of the wall, i.e. the $\hat{x}$ where $\hat{j} = 0$. You should **not** specify the value by hand (e.g. by reading off from a figure). Instead you must use interpolation (for example see either numpy.interp or scipy.interpolate.interp1d) to identify the wall location $\hat{x}_w$ such that $\hat{j}\left(\hat{x}_w\right) = 0$ for each value of $\hat{v}_s$. Print these wall locations for each $\hat{v}_s$.

4 Plotting the solution for multiple $\hat{v}_s$ values as a function of distance from the wall

✓ 3

Task [3 marks]: Plot the normalised current against the distance from the wall, $\hat{x} - \hat{x}_w$, for each $\hat{v}_s$ on the same figure. What do the regions to the left and the right of the wall represent here?

5 Example plots

To help you check your implementation the following figure shows an example result. It should be noted that whilst the figure shows "correct" data the presentation would need to be improved for full marks (so don't just copy this!).

Points to consider: Please pay attention to how you present your figures, part of the marks available are for the quality of the presentation. Code quality influences the marks in this assignment (e.g. see the hint about not using copy-paste/duplication). This also includes ensuring that you provide sufficient comments in the code to explain what you are doing and why.

[1] This is required as if there is a non-zero current into the wall then there is a net flow of charge into the wall and hence the charge (and potential) at the wall would be changing in time.

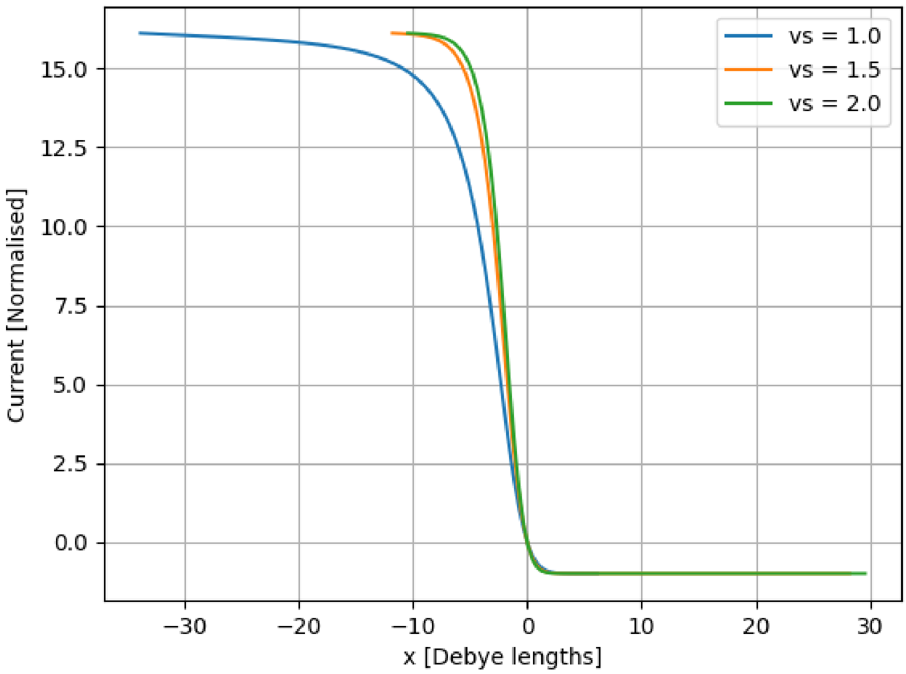

Figure 1: Figure showing plot of normalised current as a function of the normalised distance from the wall $\bar{x}$ for $\hat{v}_s = 1, 1.5, 2$. Shows current drops from around 17 down to -1 and the rate this happens depends on $\hat{v}_s$.