Assignment 2

Vikas Kurapati - 130010058

October 9, 2016

1 Question1:

1.1 ODE for Normalized Sheath Potential

The normalized sheath potential $V = \frac{e(\phi_{se}-\phi)}{kT_e}$ with normalized distance $\eta = \frac{x-x_{se}}{\lambda_D}$ for $M_{se} = 1$ is given by

$$\frac{d^2V}{d\eta^2} = \frac{1}{\sqrt{1+2V}} - e^{-V} \tag{1}$$

1.2 Expression for normalized sheath electric field $\frac{dV}{d\eta}$

Expression for normalized sheath electric field $\frac{dV}{d\eta}$ for $\frac{dV}{d\eta} = \epsilon$ at $\eta = 0$ is given by

$$\frac{dV}{d\eta} = \sqrt{\epsilon^2 + 2(\sqrt{1+2V} + e^{-v} - 2)} \tag{2}$$

2 Question 2

2.1 Bohm Condition

The form it takes in the Bohm ($V \ll 1$) case is:

$$\frac{dV}{d\eta} = \epsilon \Rightarrow V(\eta) = \epsilon\eta \tag{3}$$

where ϵ is $\frac{dV}{d\eta}$ at $\eta = 0$

2.2 Child-Langmuir Limits

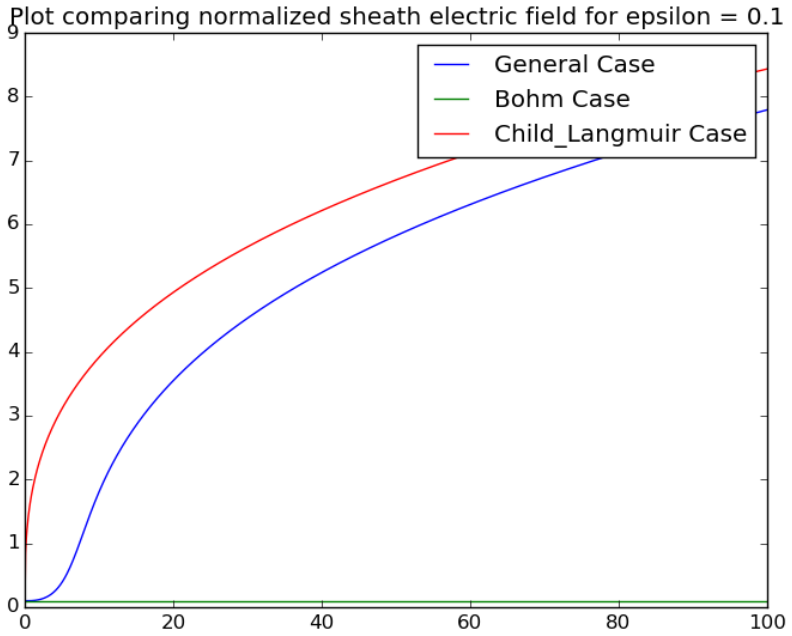
The form it takes in the Child-Langmuir ($V \gg 1$) case is:

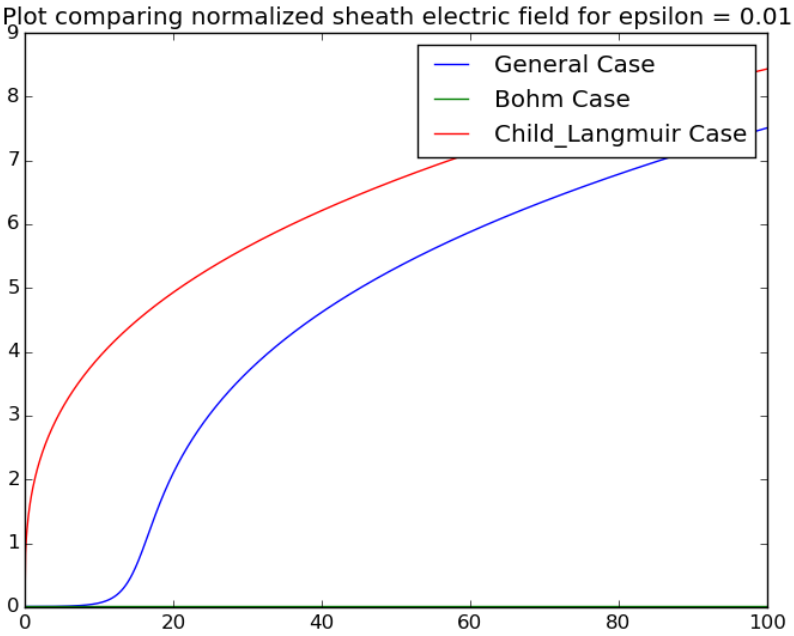
$$V(\eta) = \frac{3^{\frac{4}{3}}}{2^{\frac{5}{3}}}\eta^{\frac{4}{3}} \Rightarrow \frac{dV}{d\eta} = 6^{\frac{1}{3}}\eta^{\frac{1}{3}} \tag{4}$$

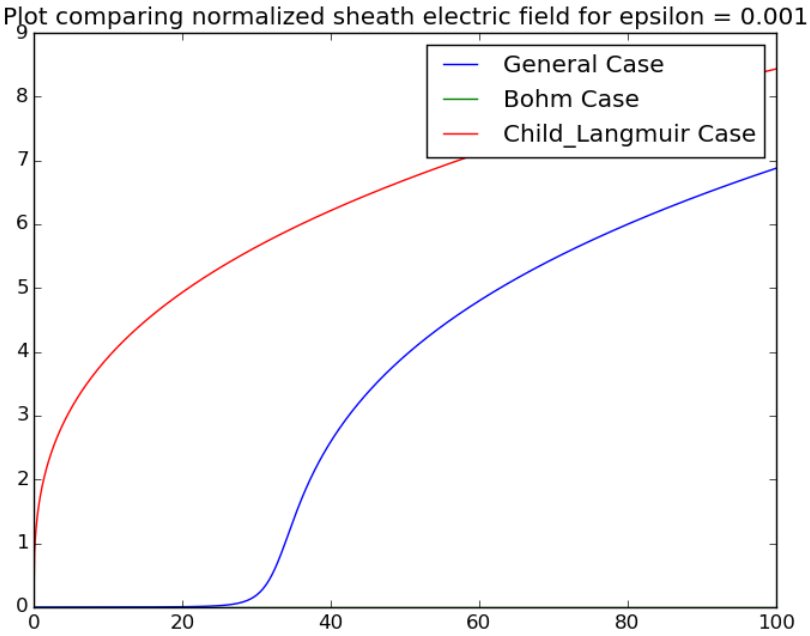
3 Question 3

3.1 Normalized electric Field

Plots comparing the RHS for normalized electric field for the three cases:

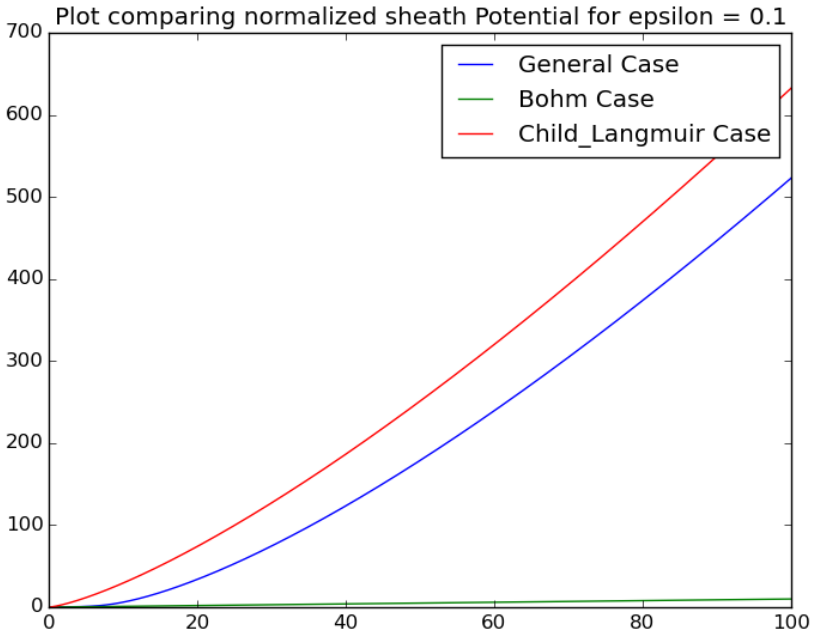

Plot comparing normalized sheath electric field for epsilon = 0.1
General Case
Bohm Case
Child_Langmuir Case
0
1
2
3
4
5
6
7
8
9
0
20
40
60
80
100

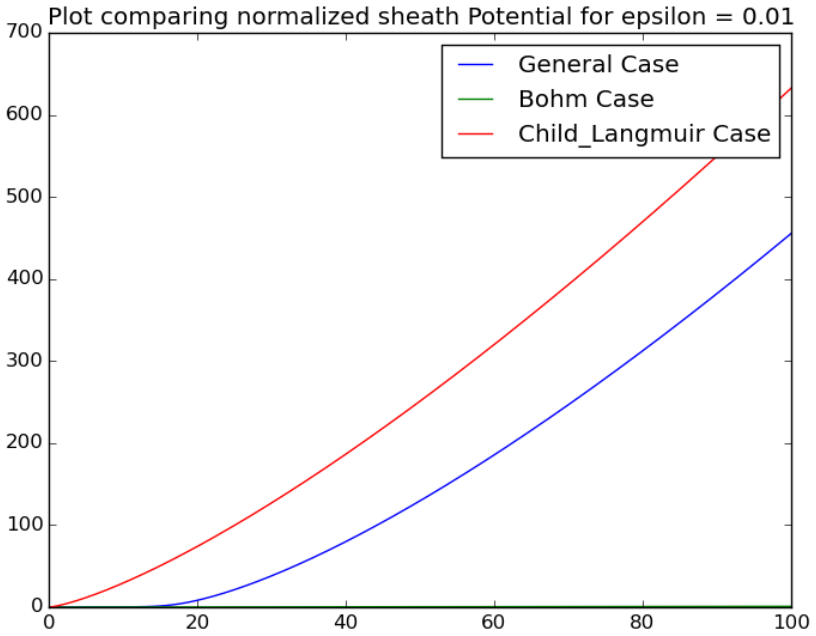

Plot comparing normalized sheath electric field for epsilon = 0.01
General Case
Bohm Case
Child_Langmuir Case
0
1
2
3
4
5
6
7
8
9
0
20
40
60
80
100

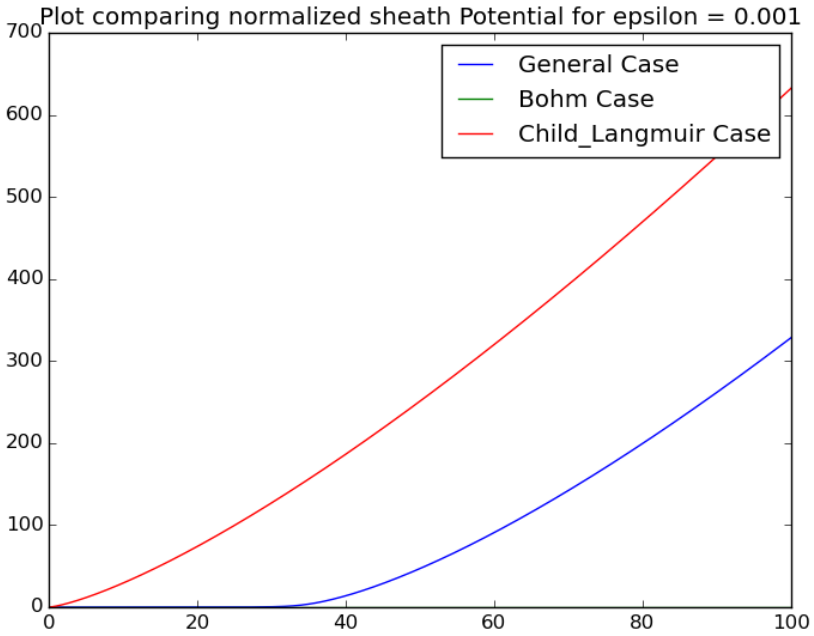


3.2 Normalized Potential

Plots comparing the RHS for normalized Potential for the three cases:


Plot comparing normalized sheath Potential for epsilon = 0.1
General Case
Bohm Case
Child_Langmuir Case
700
600
500
400
300
200
100
0
0
20
40
60
80
100


Plot comparing normalized sheath Potential for epsilon = 0.01
General Case
Bohm Case
Child_Langmuir Case
700
600
500
400
300
200
100
0
0
20
40
60
80
100


Plot comparing normalized sheath Potential for epsilon = 0.001
General Case
Bohm Case
Child_Langmuir Case
700
600
500
400
300
200
100
0
0
20
40
60
80
100