Assignment3
Monte-Carlo/Finite Difference Method

ELEC4706A
Yuxin Wu
101037822
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Part1:

a) E

$E=V/d=0.1V/200nm=5\times10^5V/m$

b) F

$F=E\times q=5\times10^5\times1.602\times10^{-19}=8.01\times10^{-14}N$

c) Acceleration

$a=F/m=8.01\times10^{-14}/(0.26\times9.11\times10^{-31})=3.38\times10^{17}m/s^2$

2-D plot of particle trajectories is shown below.

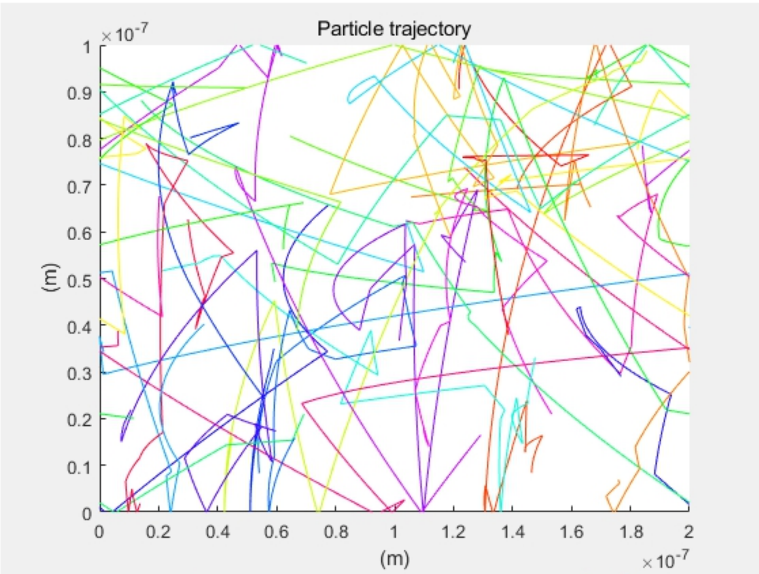

Figure1: 2-D plot of particle trajectories.

d) $J = -qnV$

Where J is the current density (A/m), q is the electron charge, n is the electron concentration, and V is the average carrier velocity.

The plot of the current density is shown below.

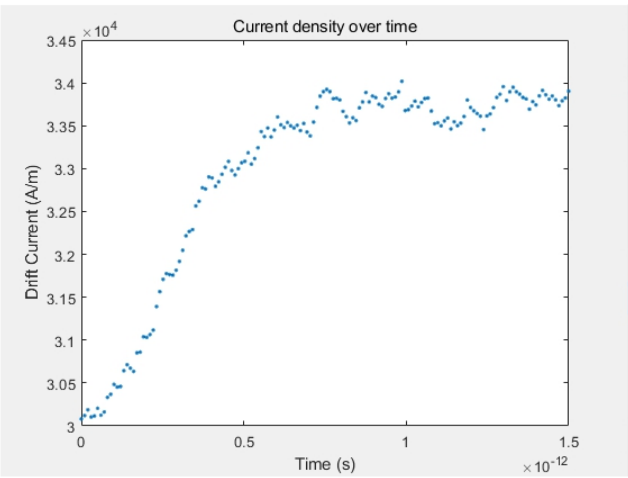

Figure2: Plot of the current density over time.

According to the figure2 above, the current density increased rapidly, but then the rising speed slowed down. Finally, the current density remains relatively constant. This is because each particle has a random velocity which created by the Maxwell Boltzmann distribution. As time goes on, the the particle is accelerated because of the electric field, which make the current density increases and remains relatively constant.

e) The density plot is shown below.

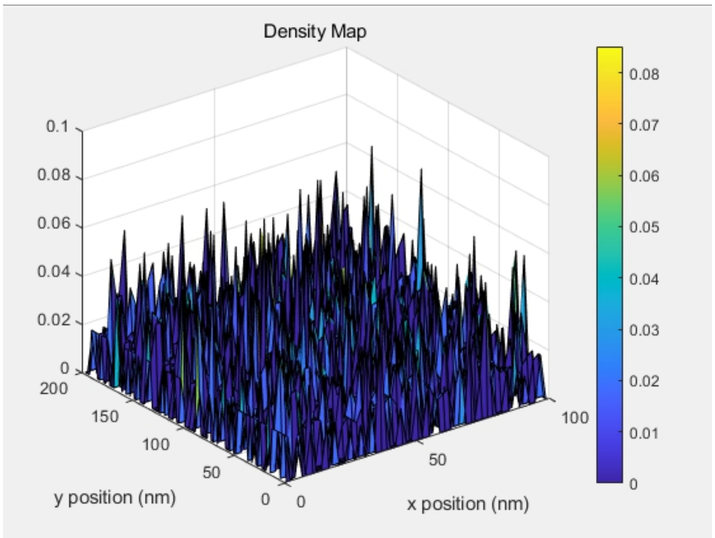

Figure3: Density map.

The temperature plot is shown below.

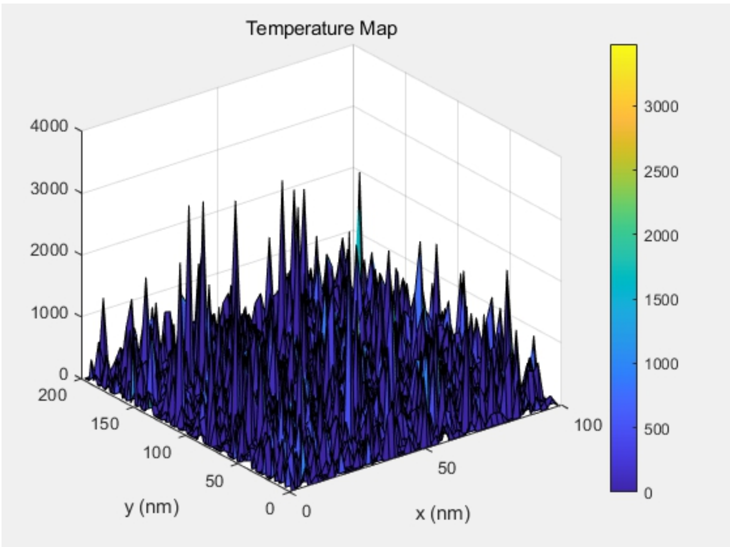

Figure4: Temperature map.

Part2:

a) Surface plot of V(x,y) is shown below.

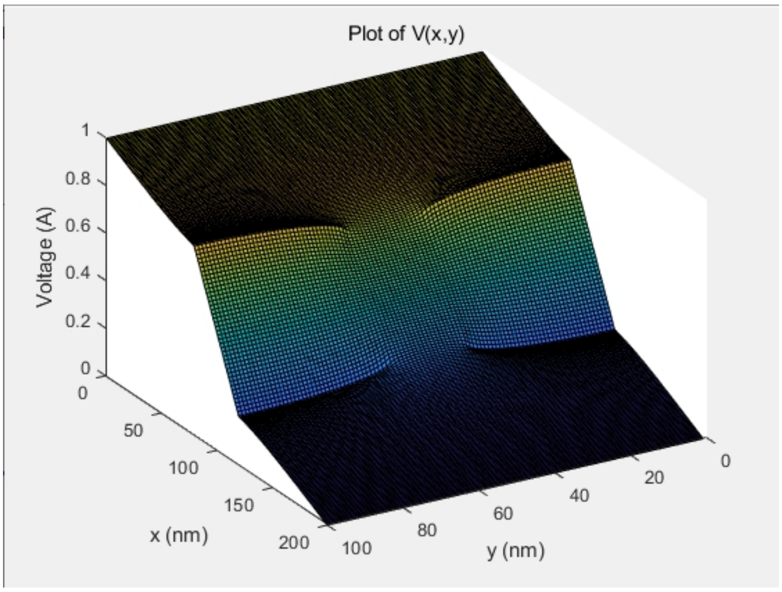

Figure5:Surface plot of V(x,y).

b) 2-D electric field vector plot is shown below.

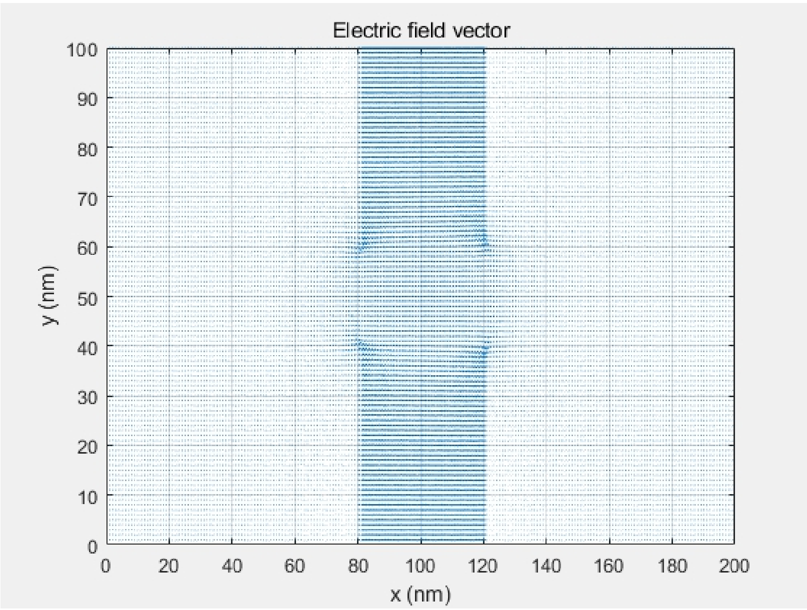

Figure6: 2-D electric field vector plot.

c) 2-D plot of particle trajectories with 1000 electrons and 1000 time steps is shown below.

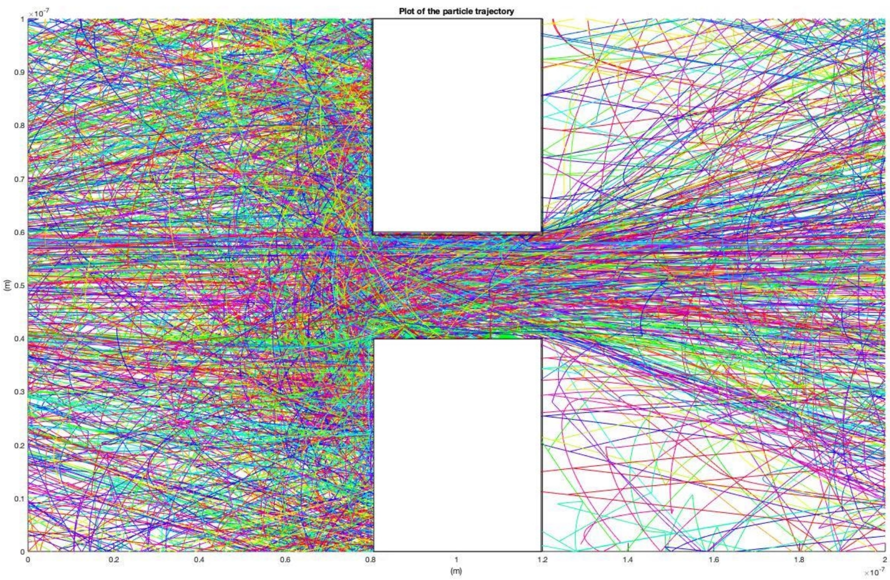

Figure7: 2-D plot of particle trajectories (1000 electrons & 1000 time step).

Part3:

a) The density map of 1000 electrons and 1000 time steps is shown below.

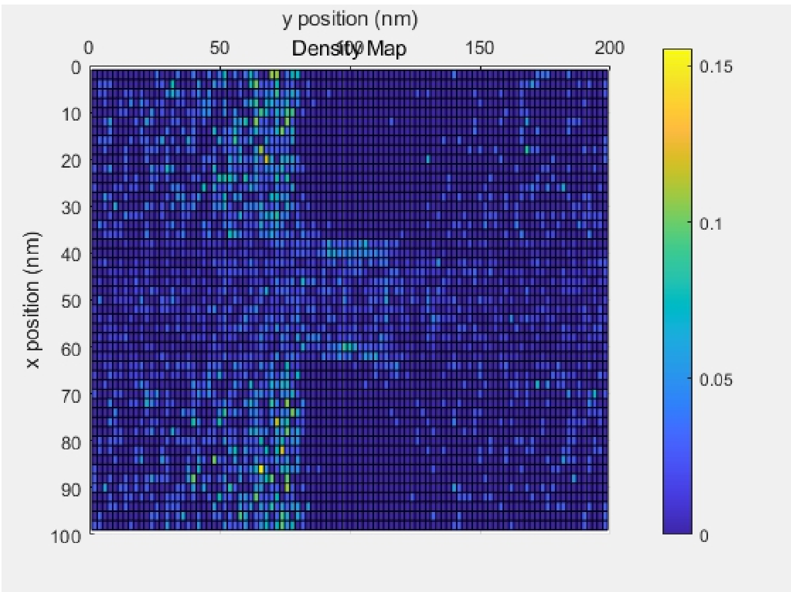

Figure8: Density map (1000 electrons & 1000 time step).

According to the figure8, because if the bottleneck, the density in the left side is much higher than that of the right side.

b) Plot of current vs bottleneck is shown below.

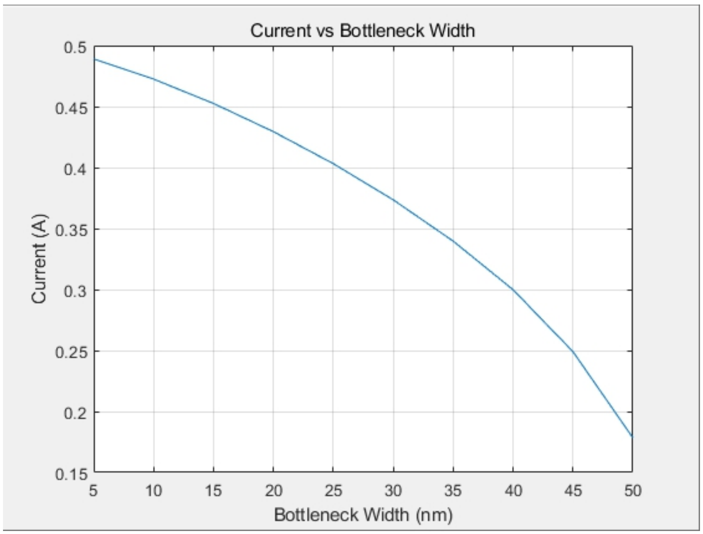

Figure9: current vs bottleneck.

c) To make the more accurate simulation, we can decrease the mesh size, decrease the time step, increase the number of electrons and the number of steps.