ELEC 4700

Assignment 1

Monte-Carlo Modeling of Electron Transport

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1 Electron Modeling

Thermal velocity was calculated using an effective particle mass of 0.26 times the electron rest mass. This resulted in a thermal velocity of 1.8702 x 10^5 m/s.

$$v_{th} = \sqrt{\frac{2kT}{0.26m_0}} = 1.8702 * 10^5 \mathrm{m/s}$$

Mean Free Path (MFP) is calculated as follows using a time step of 0.2 picoseconds:

$$\mathrm{MFP} = v_{th} * \Gamma_{mn} = 0.374\mathrm{ns}$$

Figure 1 below is a snapshot of the mid-animation simulation of electrons in silicon.

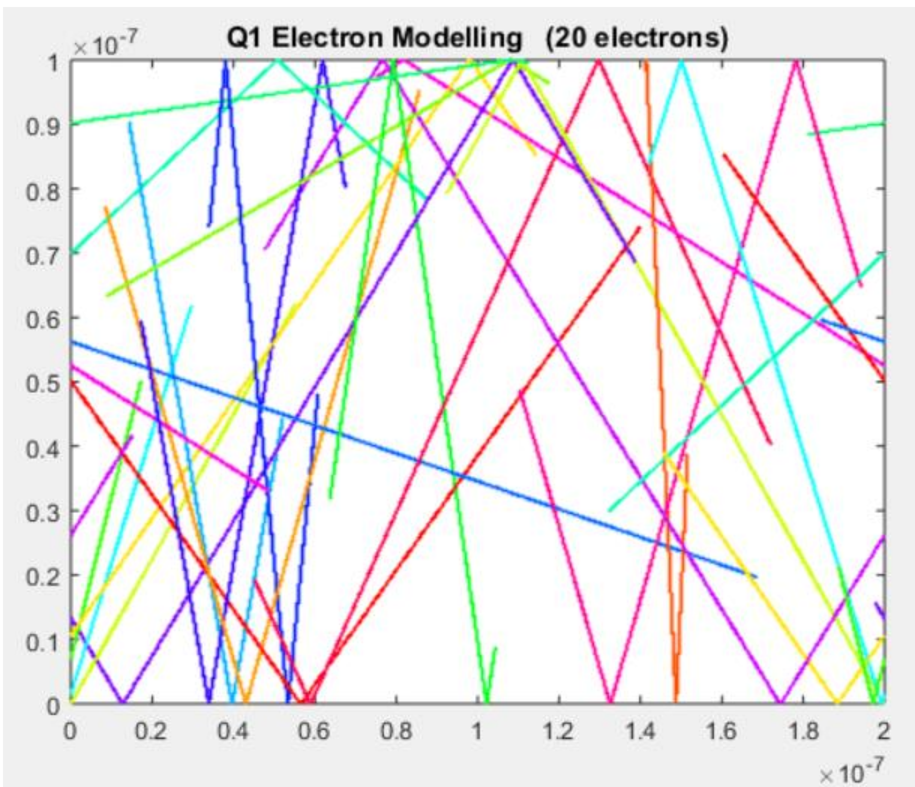

Figure 1 Electron Modelling

The electrons behaved as expected, bouncing off of the top and bottom barriers with angular reflection and continuing to the opposite side when colliding with the left and right barriers.

The following code shows my unsuccessful attempt to implement a temperature plot:

```
%figure(2);
%axis([0 1000 0 500]);
%temp = (vth^2)*Mass/(2*k)
%for i=1:timestep
    %plot(i,temp);
%end
%hold on;
%pause(0.01);
```

2 Collision with Mean Free Path (MFP)

I was unable to work out the Maxwell-Boltzmann distribution for velocities but was able to successfully implement the scattering.

Figure 2 below is a snapshot of the mid-animation simulation with scattering.

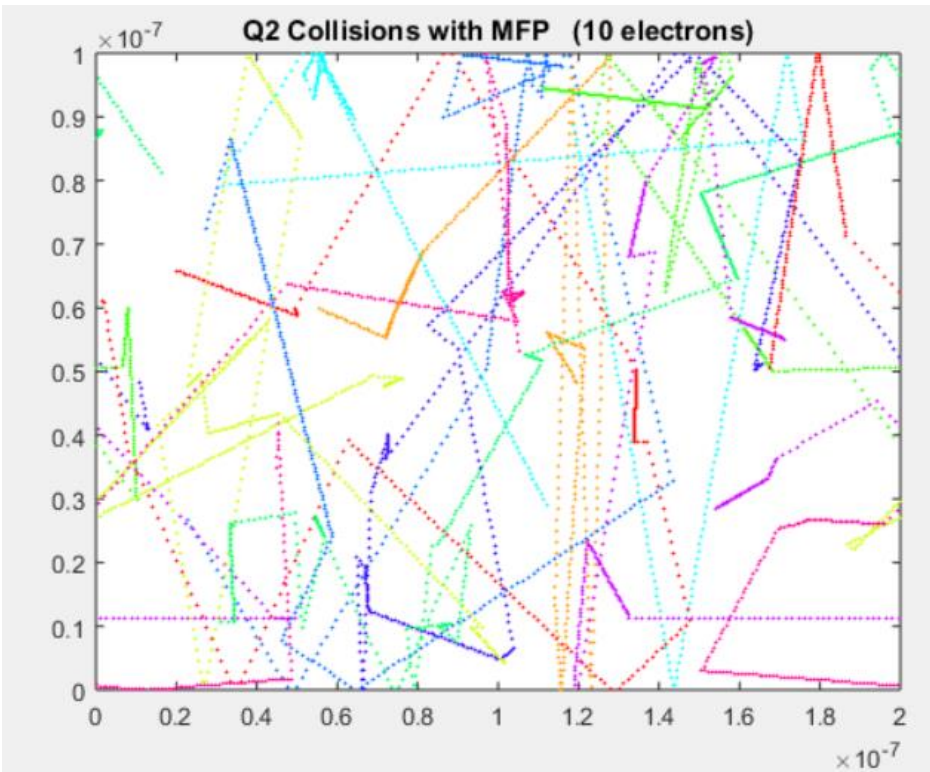

Figure 2 Collisions with MFP

Although I was unable to obtain Maxwell-Boltzmann distribution, it is understood that the temperature would not remain at 300 K but would instead fluctuate around 300 K. MFP and Γ_{mn} would be expected to remain the same.

3 Enhancements

Figure 3 below shows the mid-animation simulation with the “bottleneck” spatial limitations.

I was able to get the side collisions for the top box and the bottom box working but for some reason the lower edge of the top box and the higher edge of the lower box kept sending the electrons on a vertical upward and vertical downward path respectively.

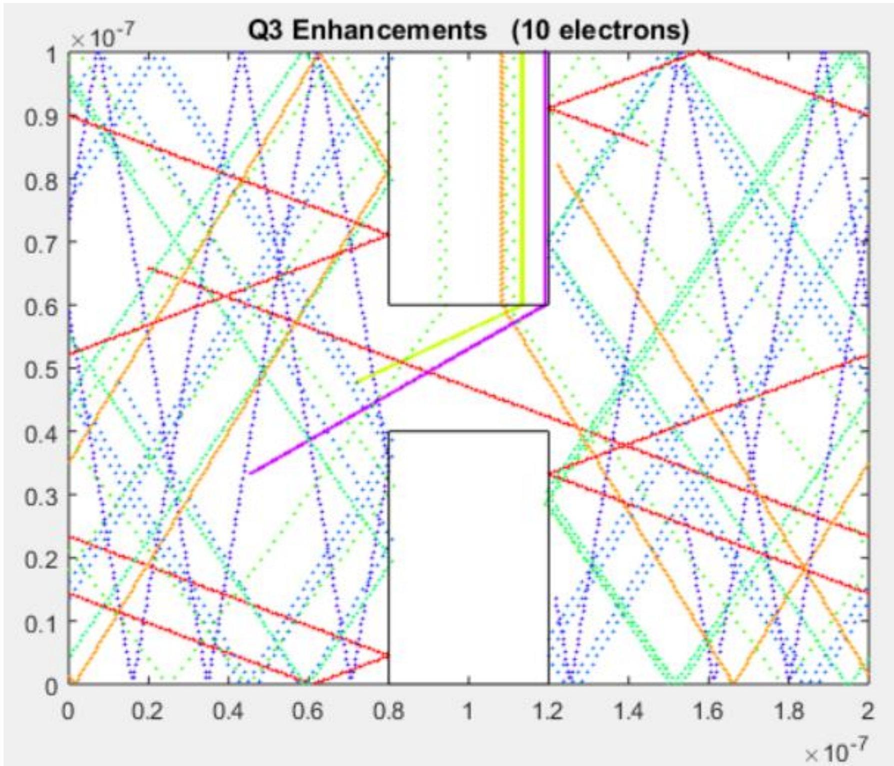

Figure 3 Enhancements