Collisions with Mean Free Path(MFP)

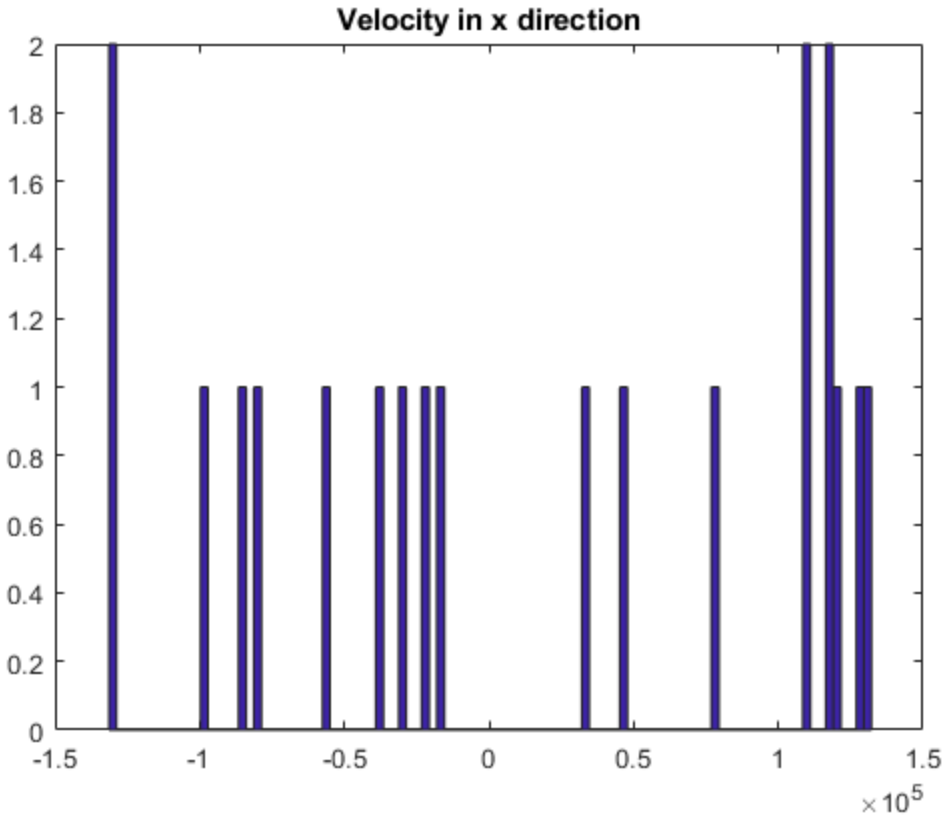
The purpose of this code is to simulate the scattering of electrons. When it scatters , the electron gets new velocities from the Maxwell-Boltzmann distributions

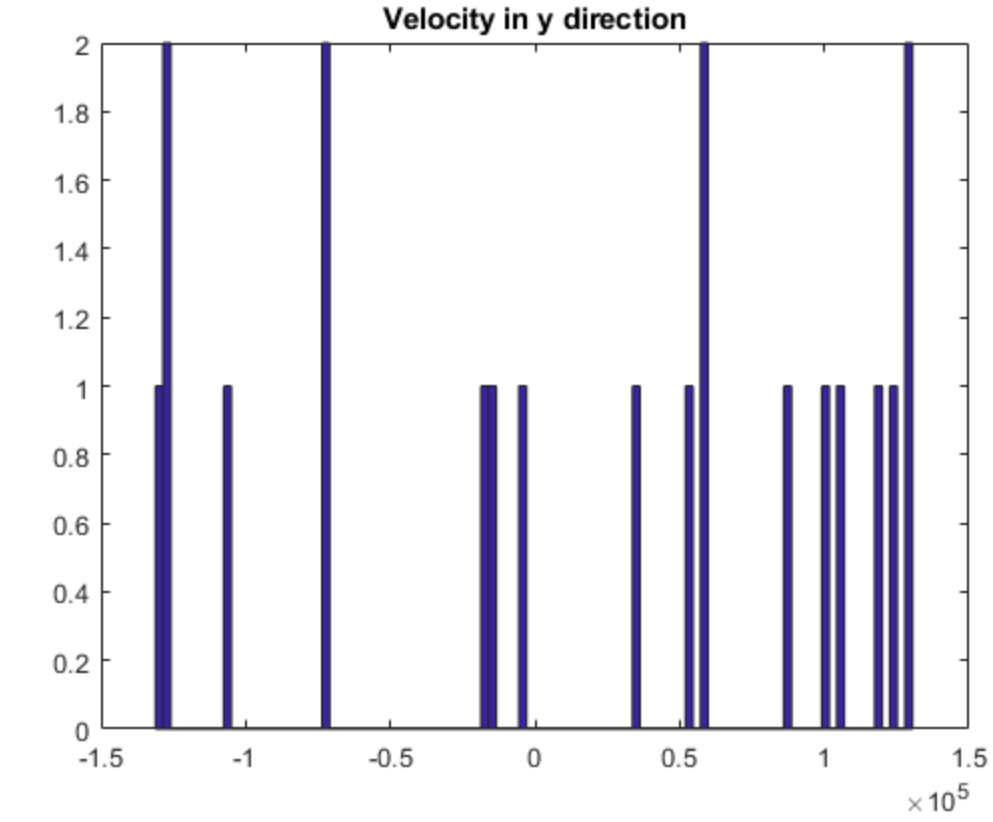
```
global C



C.q_0 = 1.60217653e-19;             % electron charge
C.hb = 1.054571596e-34;             % Dirac constant
C.h = C.hb * 2 * pi;                    % Planck constant
C.m_0 = 9.10938215e-31;             % electron mass
C.kb = 1.3806504e-23;               % Boltzmann constant
C.eps_0 = 8.854187817e-12;          % vacuum permittivity
C.mu_0 = 1.2566370614e-6;           % vacuum permeability
C.c = 299792458;                    % speed of light
C.g = 9.80665; %metres (32.1740 ft) per sÂ²


nSim = 500;
noe = 20;
r2 = randi(360,noe,1);
xbound = 200
ybound = 100
x = randi(200,noe,1);
y = randi(100,noe,1);
vth = sqrt((C.kb * 300)/(C.m_0 * 0.26));
vx = vth * cos(r2) ;
vy = vth * sin(r2);

colourArray= rand(noe,1);

MFP = vth * 0.2 * 10^-12;

figure(1);
hist(vx,100);
title("Velocity in x direction");

figure(2);
hist(vy,100);
title ("Velocity in y direction");

pScat = 1 - exp((-35 * 10^-16)/(0.2 * 10^-12));
%PscatArray = pScat * ones(noe,1)



for t = 1:nSim
    vxc = vx; % create copy of vx
    vyc = vy; % create copy of vy
    [n,m] = size(vx);
```

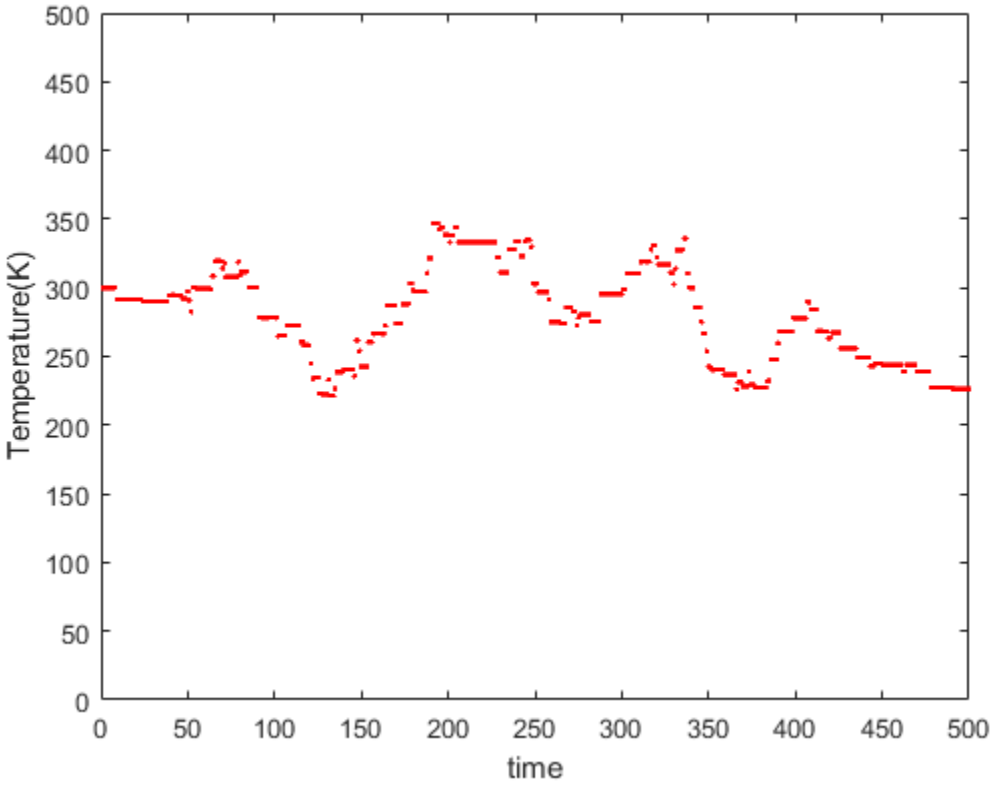
```
[n1,m1] = size(vy);

%%randomly permutation of positions in vx and vy%%%
idx = randperm(n);
randomvx = vx;
randomvx(idx,1)= vx (:,1) ;

idy = randperm(n1);
randomvy = vy;
randomvy(idy,1) = vy(:,1);


%Modelling scattering%%%%%%
rScatter= rand(noe,1);

% this gives 1s and 0s. 1 means it scatters
tempScatter = rScatter < pScat;
randomvx = tempScatter .* randomvx; % not scattered are 0s
randomvy = tempScatter .* randomvy ; % not scattered are 0s

%not scattered
notScatter = rScatter >= pScat;
%%%%%%%%%%%%%%%%%%%%%%%%%%

vx = vx .* notScatter; % the scattered vx are now 0
vy = vy .* notScatter; % scattered vy = 0

vx = vx + randomvx;
vy = vy + randomvy;



%%%%%%%%%%%%%
xc = x; % x copy
yc = y; % y copy


%Reflecting for y bounds%
temp = y >= ybound ;
temp1 = y < ybound ;


temp = temp * -1;

tempHigher = temp + temp1;


temp2 = y <= 0;
temp3 = y > 0;

temp2 = temp2 * -1;
tempLower = temp2 + temp3;

vy = vy .* tempHigher;
```

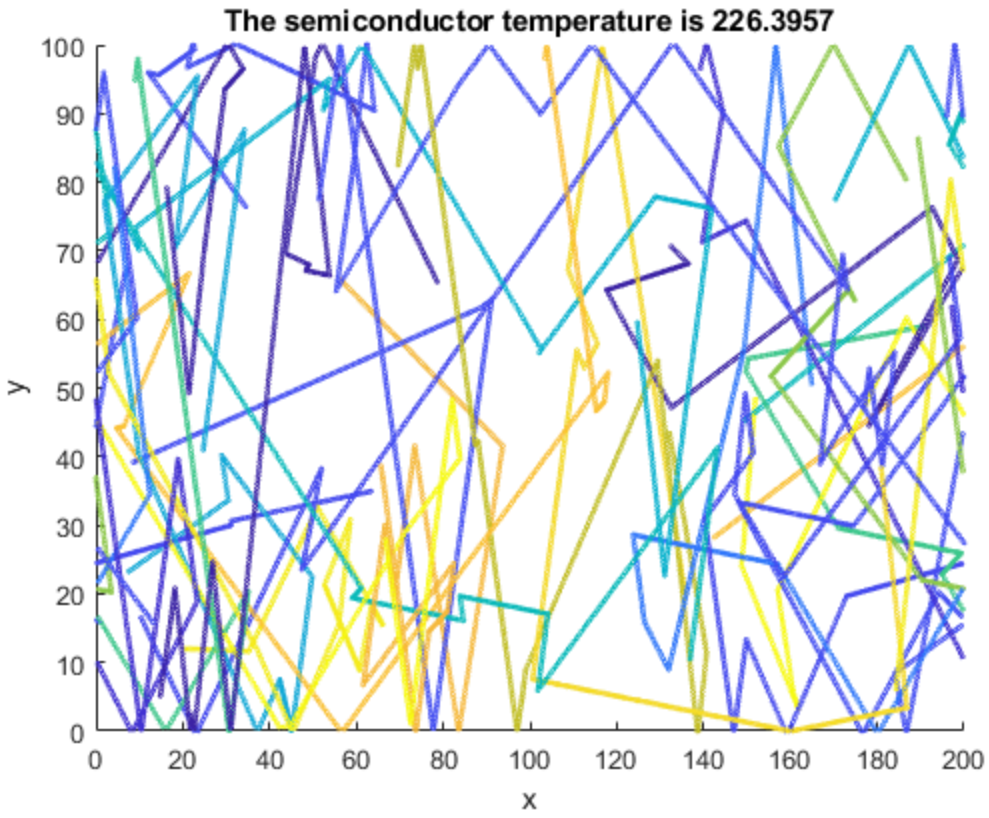
```
        vy = vy .* tempLower;

        %%%%%%%%%%%%%%%%%%%

        % when x > 200%%%%%
        tempx1 = x <= 200;

        x = x .* tempx1;
        %%%%%%%%%%%%%%%%%%%

        %%When x goes less than zero , come from 200 %%%%%

        tempx2 = x < -0.1;


        tempx2 = tempx2 * 200;
        tempxFinal = x + tempx2;

        x = tempxFinal;

        %%%%%%%%%%%%%%%%%%%
        dx = vx * (1/200000);
        dy = vy * (1/200000);

        x = x + dx;
        y = y + dy;
        vsq = (vy).^2 + (vx).^2 ;
        average = mean(vsq);

        figure (3)
        semiCTemperature = (average *(0.26)* C.m_0)/(C.kb);
        plot(t , semiCTemperature,'.r');
        xlabel("time")
        ylabel("Temperature(K)")
        axis([0 nSim 0 500]);
        hold on




        figure(4)
        scatter(x,y,3,colourArray);
        axis([0 200 0 100]);
        xlabel("x");
        ylabel("y");
        title ("The semiconductor temperature is " + semiCTemperature);


        pause(0.1);
        hold on

    end
```

```
xbound =

   200

ybound =

   100
```




Velocity in y direction
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-1.5
-1
-0.5
0
0.5
1
1.5
×10^5


Temperature(K)
500
450
400
350
300
250
200
150
100
50
0
0
50
100
150
200
250
300
350
400
450
500
time



Temperature over time

From the plot , we can see that the temperature changes, as it does not maintain the same velocity that it started with. It is also seen that the electron scatters randomly during its trajectory

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