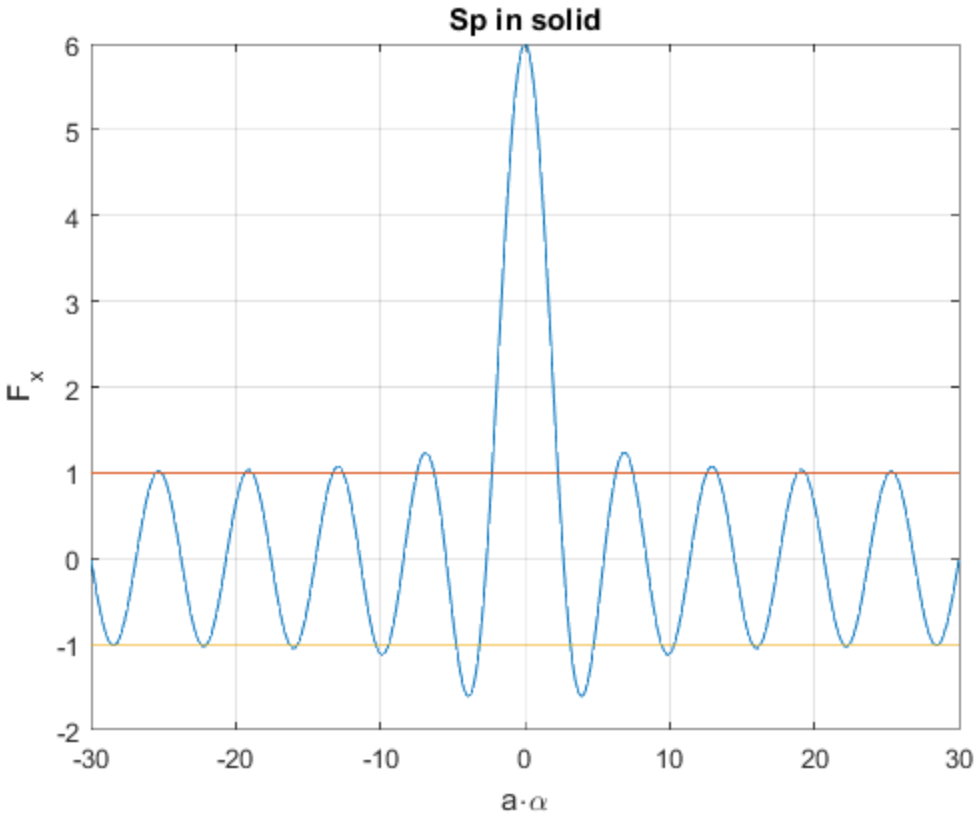
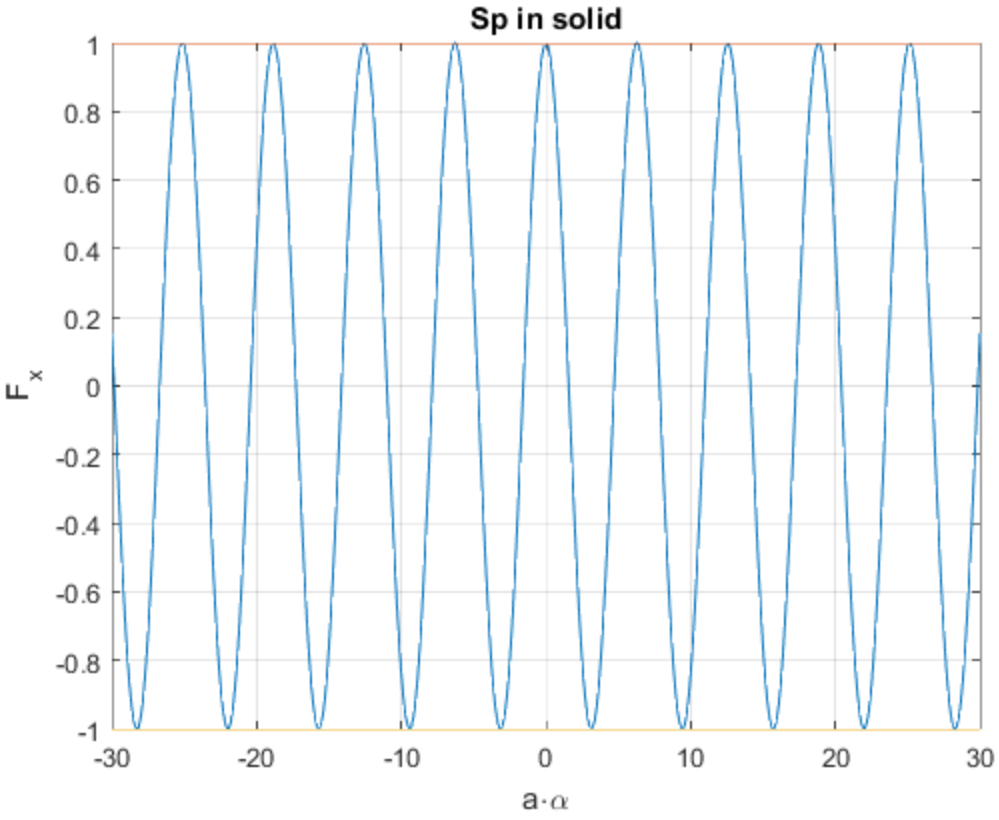
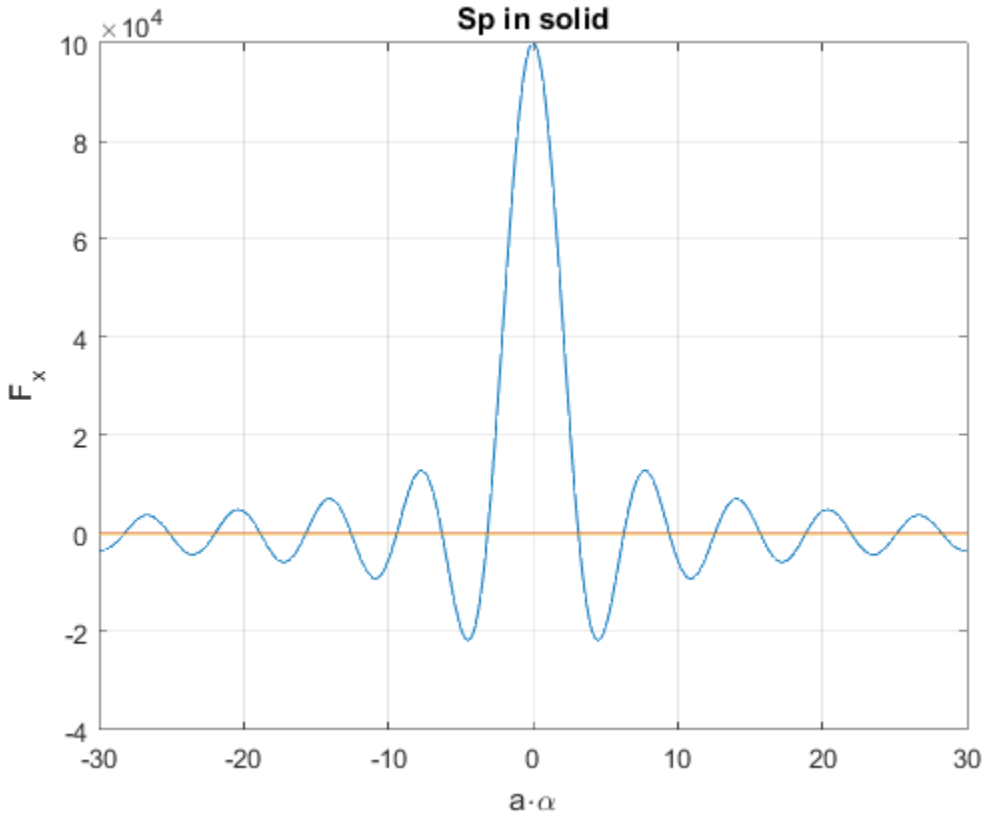
```
p =5;
t = [-30:0.1:30];
% a = size(t);
% b_1 = ones(1,a(2));
% b_2 = ones(1,a(2))*(-1);

Fx = left_kroening(p,t);
p = 0;
Fx1 = left_kroening(p,t);
p = 100000;
Fx2 = left_kroening(p,t);

% plot(t,Fx);
% hold on
% plot(t,b_1);
% plot(t,b_2);
% hold off
%
% title('Sp in solid P = 5')
% xlabel('a\cdot\alpha')
% ylabel('F_x')
% %legend('P =5')
% grid on
%
% figure
% p =0;
% Fx = left_kroening(p,t);
% plot(t,Fx);
% hold on
% plot(t,b_1);
% plot(t,b_2);
% hold off
%
% title('Sp in solid P = 0')
% xlabel('a\cdot\alpha')
% ylabel('F_x')
% %legend('P =0')
% grid on
%
% figure
% p =1000000;
% Fx = left_kroening(p,t);
% plot(t,Fx);
% hold on
% plot(t,b_1);
% plot(t,b_2);
% hold off
%
% title('Sp in solid P \rightarrow \infty')
% xlabel('a\cdot\alpha')
% ylabel('F_x')
% %legend('P \rightarrow \infty')
```

```
% grid on
```

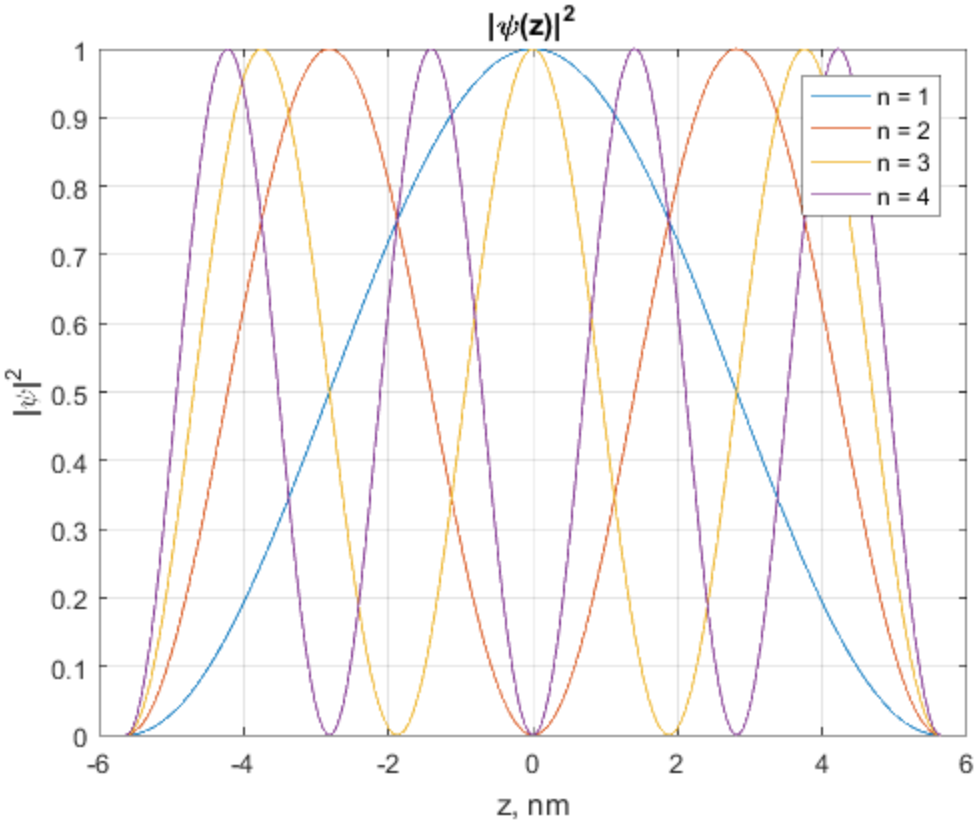


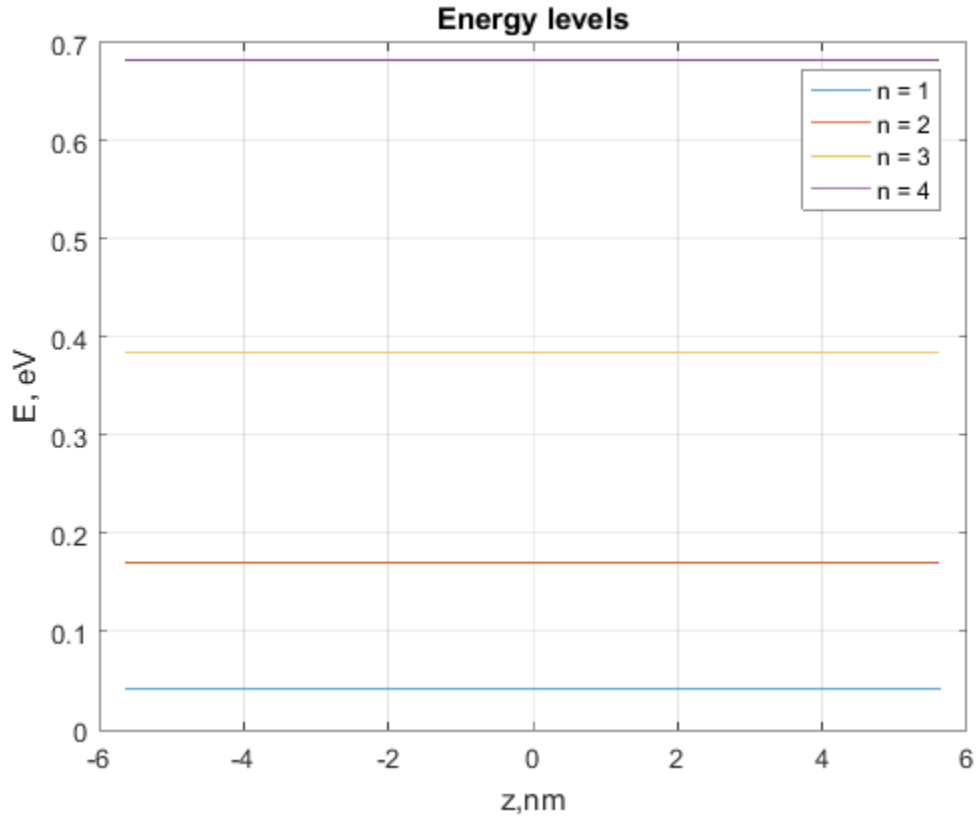

Sp in solid
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
F_x
-30
-20
-10
0
10
20
30
a·α


Sp in solid
×10^4
10
8
6
4
2
0
-2
-4
F_x
-30
-20
-10
0
10
20
30
a·α

Published with MATLAB® R2016a

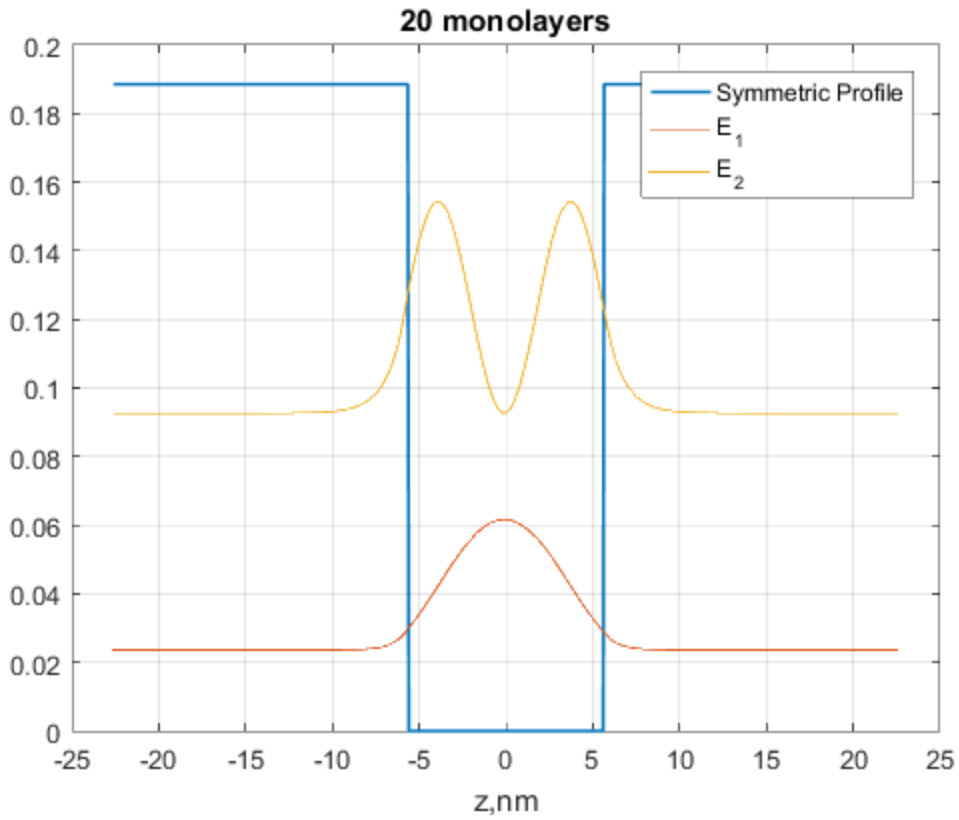
```
me = 9.1e-31;
e = 1.6e-19;
hbar = 1.034e-34;
a0 = 0.563e-9;
a = 20*a0;
z = [-a/2:.001*a:a/2];

E_an = E_analyt([1:5],me*0.067,a);
E_an_eV = E_an./e;
Psi_1 = Psi_analyt(z,1,a);
Psi_2 = Psi_analyt(z,2,a);
Psi_3 = Psi_analyt(z,3,a);
Psi_4 = Psi_analyt(z,4,a);

%Plotting
plot(z*10^9,abs(Psi_1).^2);
hold on
plot(z*10^9,abs(Psi_2).^2);
plot(z*10^9,abs(Psi_3).^2);
plot(z*10^9,abs(Psi_4).^2);
legend('n = 1','n = 2','n = 3','n = 4');
title('|\psi(z)|^{2}')
xlabel('z, nm')
ylabel('|\psi|^{2}')
grid on
hold off
figure
t = size(z);
E_1 = ones(1,t(2))*E_an_eV(1);
plot(z*10^9,E_1);
hold on
plot(z*10^9,ones(1,t(2))*E_an_eV(2));
plot(z*10^9,ones(1,t(2))*E_an_eV(3));
plot(z*10^9,ones(1,t(2))*E_an_eV(4));
hold off
title('Energy levels');
legend('n = 1','n = 2','n = 3','n = 4');
xlabel('z,nm')
ylabel('E, eV')
grid on
```


$|\psi(z)|^2$
$|\psi|^2$
z, nm
n = 1
n = 2
n = 3
n = 4


Energy levels
E, eV
z,nm
n = 1
n = 2
n = 3
n = 4

Published with MATLAB® R2016a

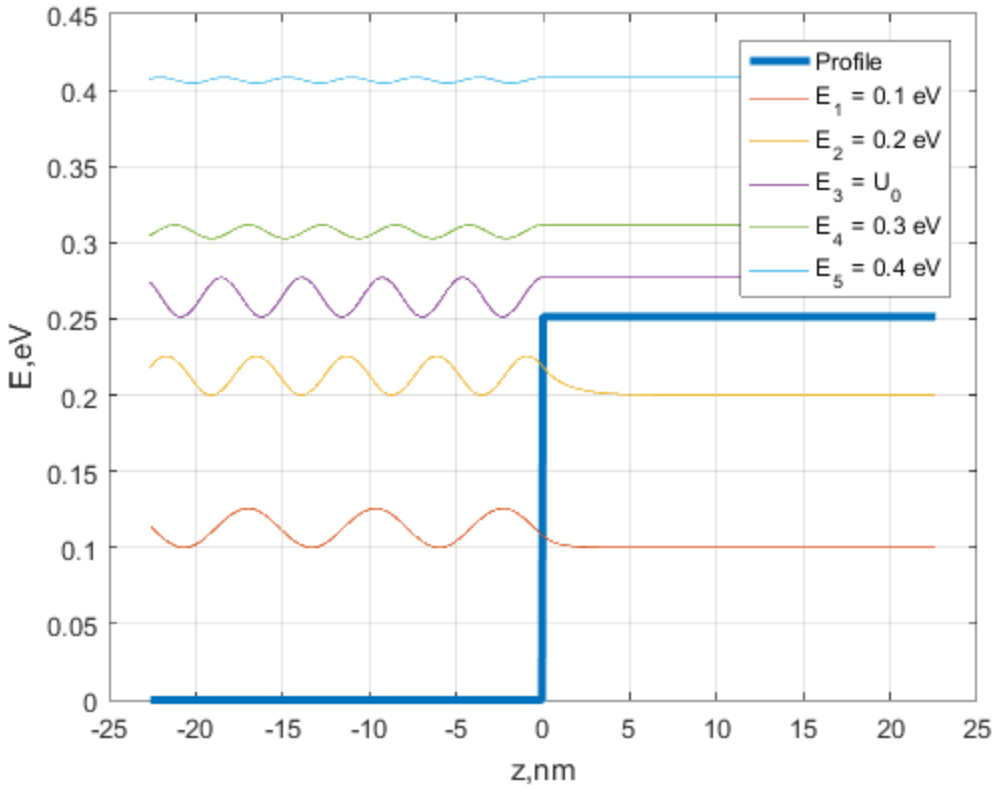
```
x_a = 0;
m_a = meff(x_a);
x_b =  0.3;
m_b = meff(x_b);
a = 20*a0_x(x_a)*10^9;
e = 1.60217e-19;
U = (Eg_x(x_b) -Eg_x(x_a))/2; %Potetial Bar Hight
z = [-2*a:0.005*a:2*a];
U_profi = Ec(a,z,U);
E = [0.0236,0.09266, 0.18521]*e;
gamma = gamma_E(m_a,E);
betta = betta_E(m_b,E,U);
[Psi_1] = Psi_E(z,betta(1),gamma(1),m_a,m_b, a);
[Psi_2] = Psi_E(z,betta(2),gamma(2),m_a,m_b, a);
[Psi_3] = Psi_E(z,betta(3),gamma(3),m_a,m_b, a);



plot(z, U_profi, 'LineWidth', 1.2);
hold on
t = size(z);
E_1 = ones(1,t(2))*E(1);
plot(z, Psi_1+max(E_1)/e)
hold on
E_2 = ones(1,t(2))*E(2);
plot(z, Psi_2+max(E_2)/e)
%E_3 = ones(1,t(2))*E(3);
%plot(z, Psi_3+max(E_3)/e)


%plot(z*10^9,abs(Psi_1).^2./(sum(abs(Psi_1).^2)) +max(E_1)/e);
%plot(z*10^9,E_1./e)
grid on
xlabel('z,nm')
title('20 monolayers')
legend('Symmetric Profile','E_1','E_2')
```

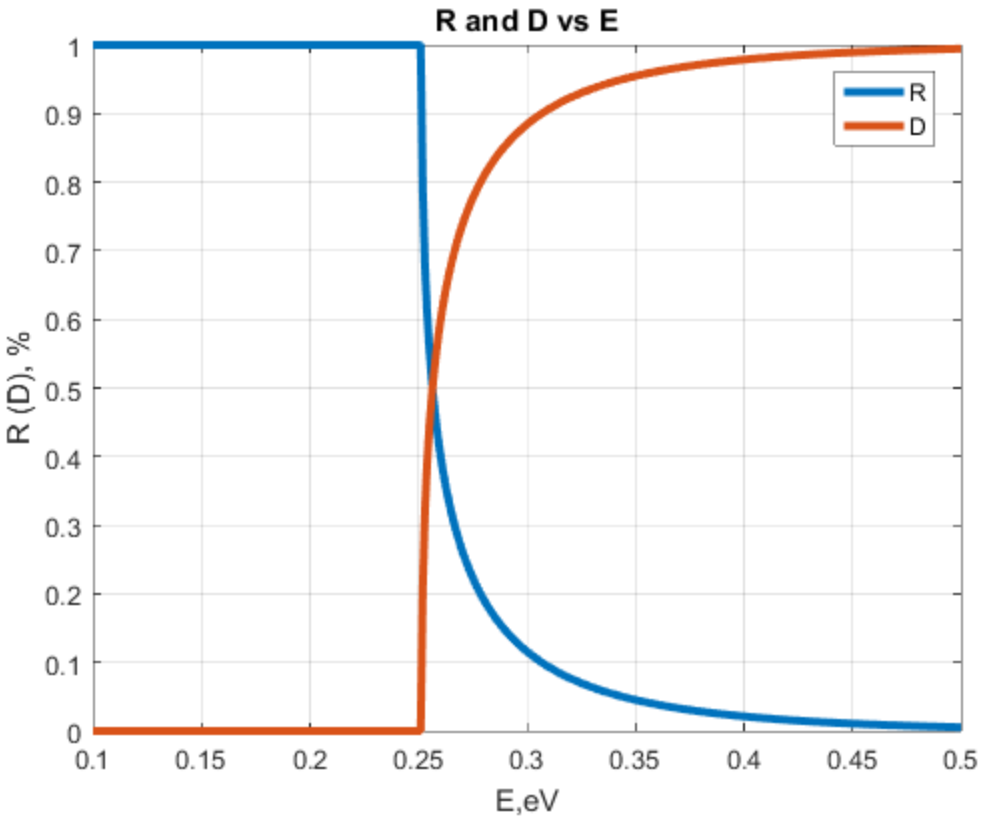


Published with MATLAB® R2016a

```
e = 1.60217e-19;
x_a = 0;
x_b = 0.4;
m_a = meff(x_a);
m_b = meff(x_b);
Eg_a = Eg_x(x_a);
Eg_b = Eg_x(x_b);
a = 20*a0_x(x_a)*10^9;
%z = [-20*a:0.01*a:20*a];
z = [-2*a:0.005*a:2*a];

V = (Eg_b - Eg_a)/2;
U = Ec_step(z,V);
E = [0.1,0.2,V/e, 0.3,0.4]*e;
%gamma1
%gamma2
gamma1 = gamma_E(m_a,E);
gamma2 = gamma_E2(m_b,E,V);

%Psi
Psi1 = Psi_E_step(gamma1(1),gamma2(1),z);
Psi2 = Psi_E_step(gamma1(2),gamma2(2),z);
Psi3 = Psi_E_step(gamma1(3),gamma2(3),z);
Psi4 = Psi_E_step(gamma1(4),gamma2(4),z);
Psi5 = Psi_E_step(gamma1(5),gamma2(5),z);


plot(z, U, 'LineWidth',3);
grid on
hold on
plot(z, Psi1 +max(E(1))/e);
plot(z, Psi2 +max(E(2))/e);
plot(z, Psi3 +max(E(3))/e);
plot(z, Psi4 +max(E(4))/e);
plot(z, Psi5 +max(E(5))/e);
xlabel('z,nm')
ylabel('E,eV')
legend('Profile','E_1 = 0.1 eV','E_2 = 0.2 eV','E_3 = U_0','E_4 = 0.3
 eV','E_5 = 0.4 eV');
hold off

%part 2
figure
E_rd = [E(1):0.01*E(1):E(end)+E(1)];
R = (gamma_E(m_a,E_rd) -gamma_E2(m_b,E_rd,V)).^2./((gamma_E(m_a,E_rd)
 +gamma_E2(m_b,E_rd,V)).^2);
plot(E_rd/e,abs(R),'LineWidth',3)
grid on
title('R and D vs E')
xlabel('E,eV')
ylabel('R (D), %')
hold on
```

```
t = size(E_rd);
D = zeros(1,t(2));
for j = [1:t(2)]
    if E_rd(j) < V
        D(j) = 0;
    else
        D(j) = (4*gamma_E(m_a,E_rd(j)).*gamma_E2(m_b,E_rd(j),V))./
((gamma_E(m_a,E_rd(j)) +gamma_E2(m_b,E_rd(j),V)).^2);
    end
end
plot(E_rd/e,abs(D),'LineWidth',3)
hold off
legend('R','D')
```

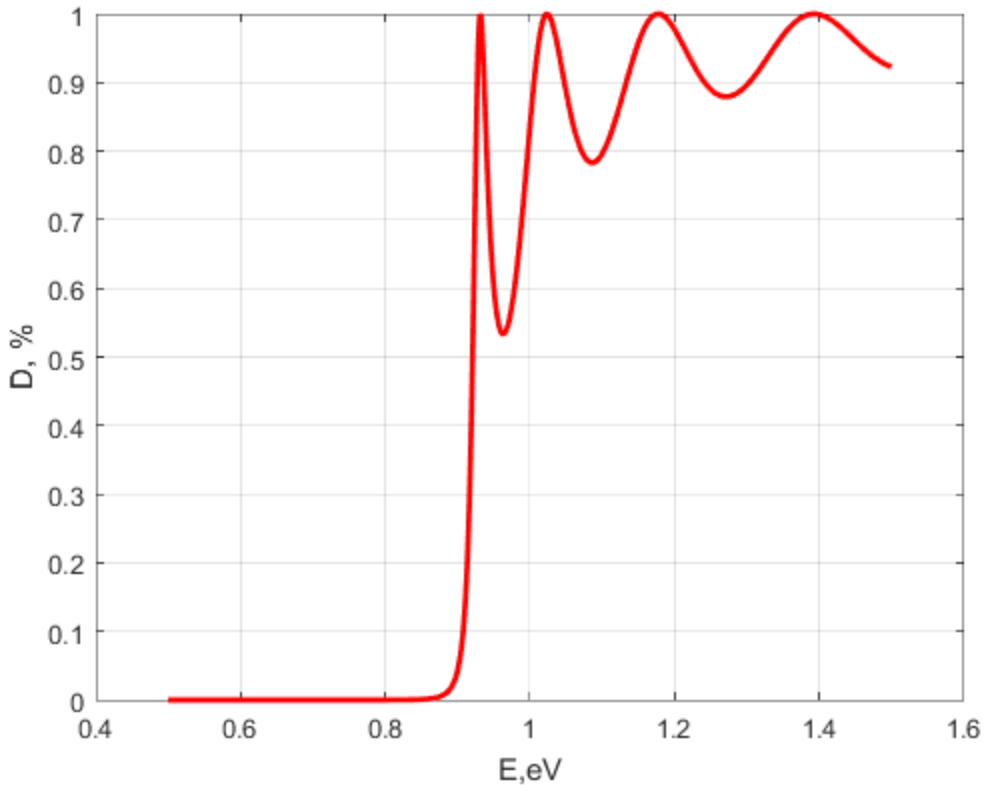


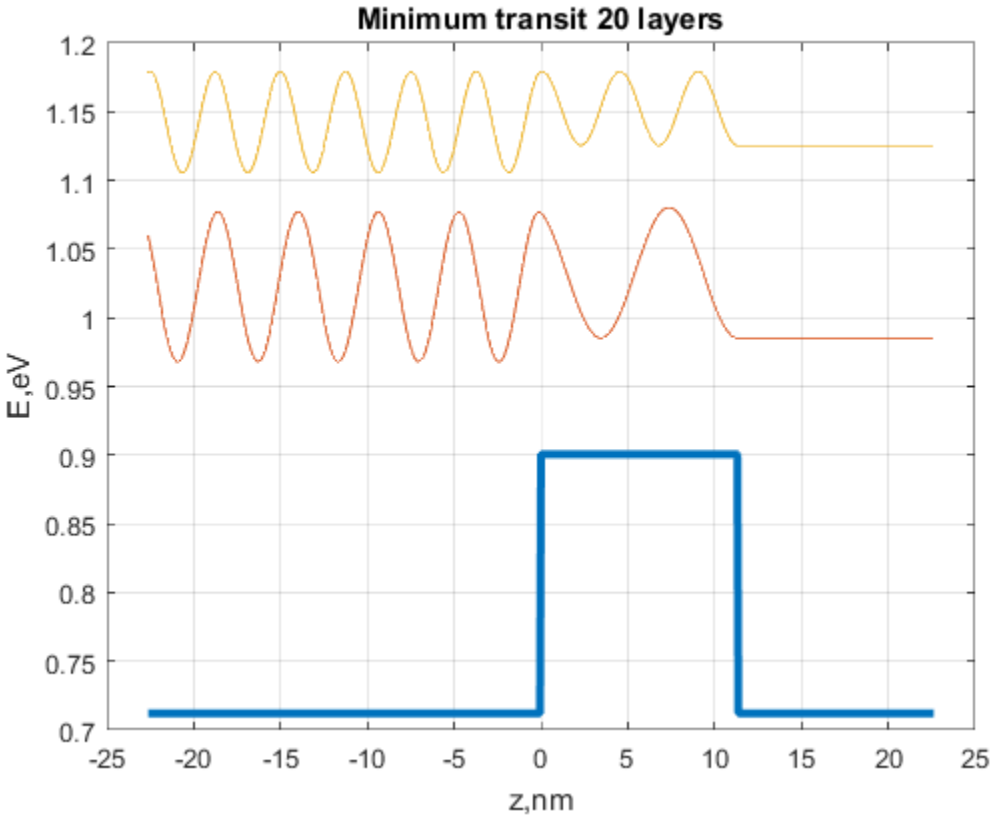


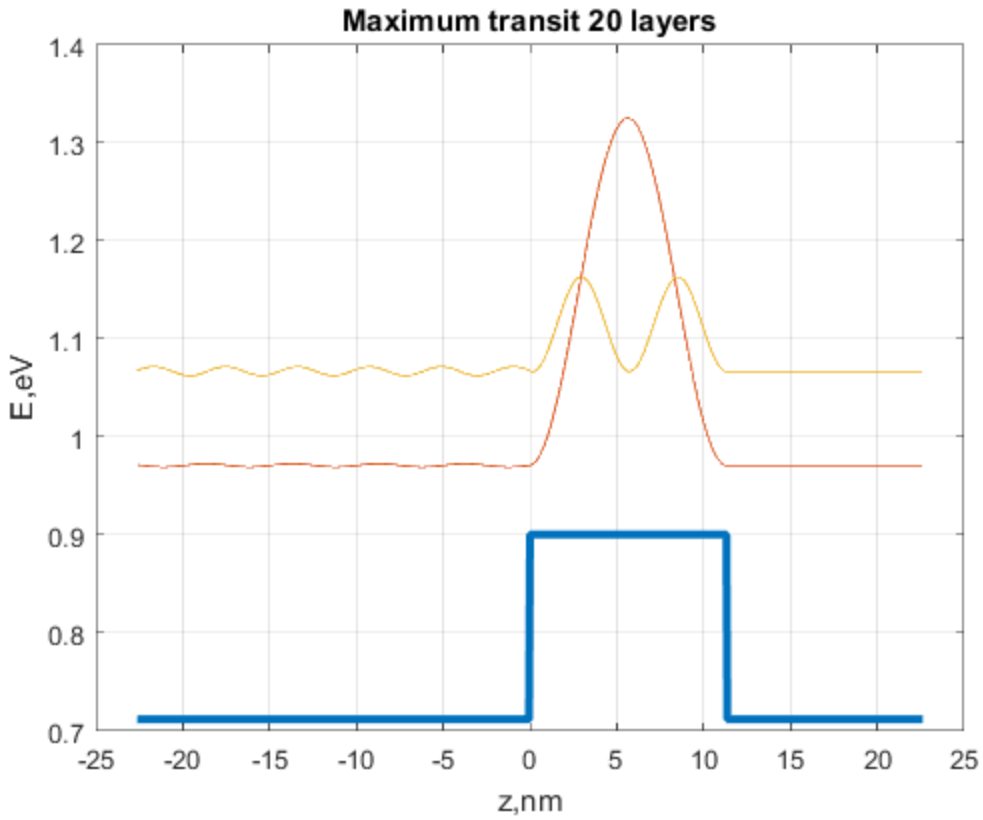
Published with MATLAB® R2016a

```
clc
clear all

me = 9.10938e-31;
e = 1.6021773e-19;
hbar = 1.034e-34;


x_1 = 0;
x_2 = 0.3;
x_3 = 0;
m1 = meff(x_1);
m2 = meff(x_2);
m3 = meff(x_3);

Eg1 = Eg_x(x_1);
Eg2 = Eg_x(x_2);
Eg3 = Eg_x(x_3);
a = a0_x(x_2)*20*10^9;
z = [-2*a:0.005*a:2*a];

E1 = 0.5*e;
E2 = 1.5*e;
dE = (E2-E1)/1000;
E = [E1:dE:E2];

gamma1 = sqrt(2*m1*(E -Eg1/2))./hbar;
gamma2 = sqrt(2*m2*(E - Eg2/2))./hbar;
gamma3 = sqrt(2*m3*(E-Eg3/2))./hbar;

[D,ksi,A3,A1] = D_E_func(gamma1,m1,gamma2,m2,gamma3,m3,a,E,Eg1);




plot(E./e,abs(D),'r', 'LineWidth',2);
grid on
xlabel('E,eV')
ylabel('D, %')

%min max in python folders
%min max result
E_max = [0.931,1.027]*e;
E_min = [0.964, 1.094]*e;

gamma1_1_max = sqrt(2*m1*(E_max -Eg1/2))./hbar;
gamma2_2_max = sqrt(2*m2*(E_max - Eg2/2))./hbar;
gamma3_3_max = sqrt(2*m3*(E_max-Eg3/2))./hbar;

gamma1_1_min = sqrt(2*m1*(E_min -Eg1/2))./hbar;
gamma2_2_min = sqrt(2*m2*(E_min - Eg2/2))./hbar;
```

```
gamma3_3_min = sqrt(2*m3*(E_min-Eg3/2))./hbar;

Psi = Psi_T(gamma1_1_min(1),
 gamma2_2_min(1),gamma3_3_min(1),m1,m2,m3,z,a);


%Psi drawing
figure
U = Profil_func(Eg1/2,Eg2/2,Eg3/2,z,a);
plot(z,U./e,'LineWidth',3);
grid on
hold on
plot(z, Psi +E_min(1)/e);
Psi2 = Psi_T(gamma1_1_min(2),
 gamma2_2_min(2),gamma3_3_min(2),m1,m2,m3,z,a);
plot(z,Psi2+E_min(2)/e);
xlabel('z,nm')
ylabel('E,eV')
title('Minimum transit 20 layers')
hold off


figure
U = Profil_func(Eg1/2,Eg2/2,Eg3/2,z,a);
plot(z,U./e,'LineWidth',3);
grid on
hold on
Psi1 = Psi_T(gamma1_1_max(1),
 gamma2_2_max(1),gamma3_3_max(1),m1,m2,m3,z,a);
plot(z, Psi1 +E_max(1)/e);
Psi2 = Psi_T(gamma1_1_max(2),
 gamma2_2_max(2),gamma3_3_max(2),m1,m2,m3,z,a);
plot(z,Psi2+E_max(2)/e);
xlabel('z,nm')
ylabel('E,eV')
title('Maximum transit 20 layers')
hold off
```

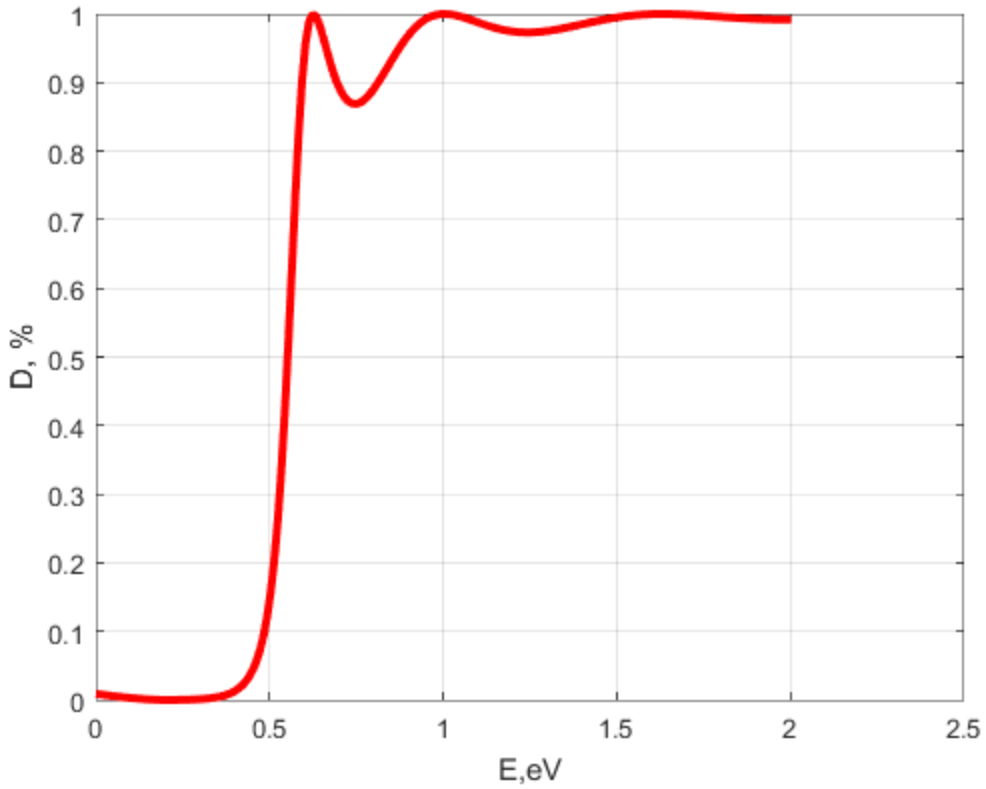

D, %
E,eV
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.4
0.6
0.8
1
1.2
1.4
1.6


Minimum transit 20 layers
E,eV
z,nm
0.7
0.75
0.8
0.85
0.9
0.95
1
1.05
1.1
1.15
1.2
-25
-20
-15
-10
-5
0
5
10
15
20
25



Published with MATLAB® R2016a

```
clc
clear all

m0 = 9.10938e-31;
e = 1.6021773e-19;
hbar = 1.034e-34;
delta_z = 0.5e-11;


x_1=0;
m_eff = meff(x_1);
a = a0_x(x_1);
e = 1.6e-19;



U=[0.2 0.5 0.2]*e;
t = size(U);
N = t(2);
E = 0.45*e;



[D,E] = D_matrix_transp(ones(1,N)*m0,N,E,U,a,ones(1,N)*3,delta_z);
plot(E./e,D,'r','LineWidth', 3)
grid on
xlabel('E,eV')
ylabel('D, %')
```



Published with MATLAB® R2016a