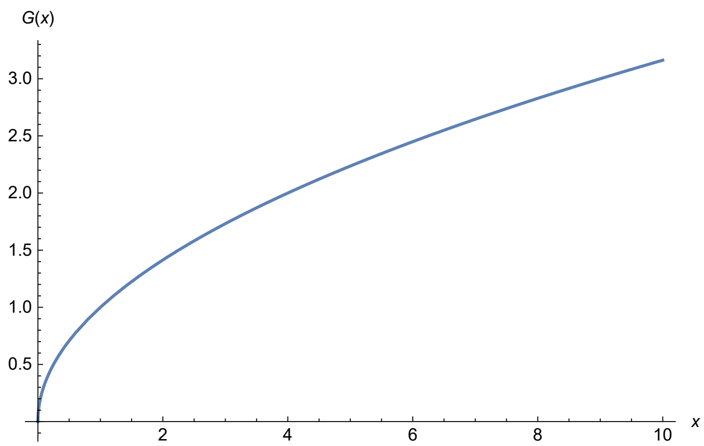
Density of States

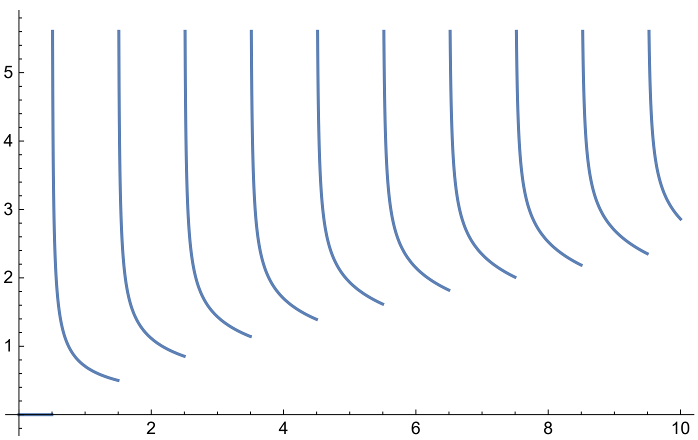
In[1]:=
```
Plot[Sqrt[x], {x, 0, 10}, AxesLabel → {x, G[x]}]
```

Out[1]=



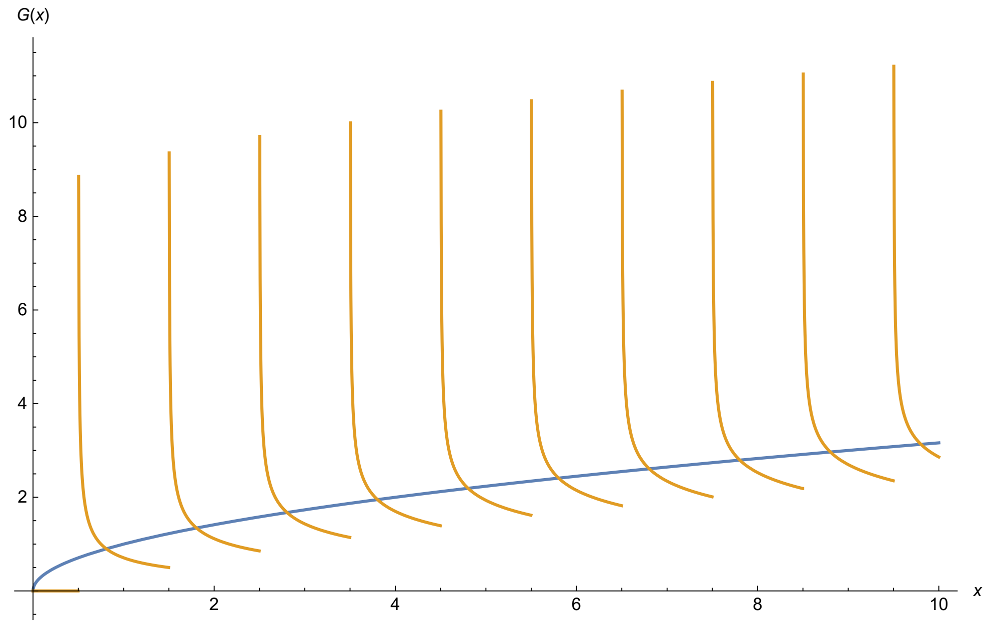
In[2]:=
```
Plot[Sum[HeavisideTheta[x - (l + 1/2)] * 1/Sqrt[x - (l + 1/2)], {l, 0, 9}]/2,
 {x, 0, 10}, PlotRange → Automatic]
```

Out[2]=



In[3]:=
```
Plot[{Sqrt[x], Sum[HeavisideTheta[x - (l + 1/2)] * 1/Sqrt[x - (l + 1/2)], {l, 0, 9}] / 2},
  {x, 0, 10}, PlotRange → All, AxesLabel → {x, G[x]}, Exclusions → True]
```

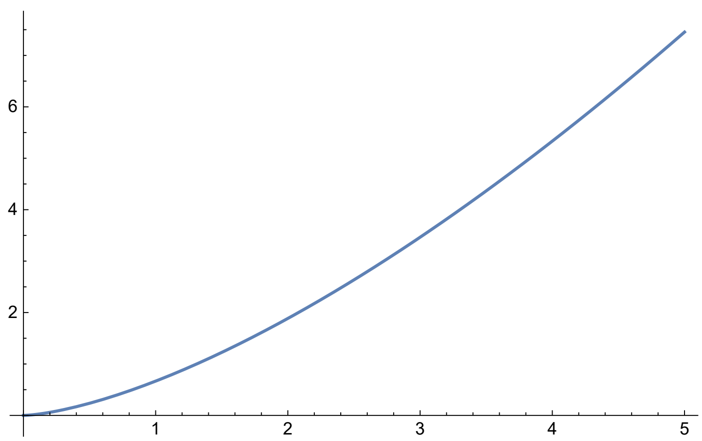
Out[3]=



Integrated Density of States

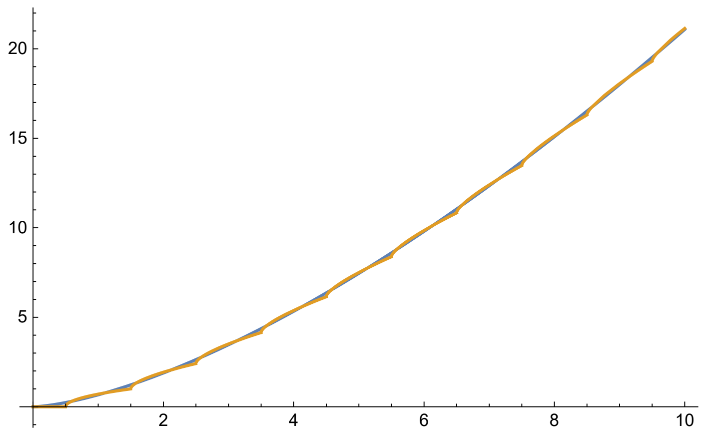
In[4]:=
```
Plot[2/3 * x^(3/2), {x, 0, 5}]
```

Out[4]=



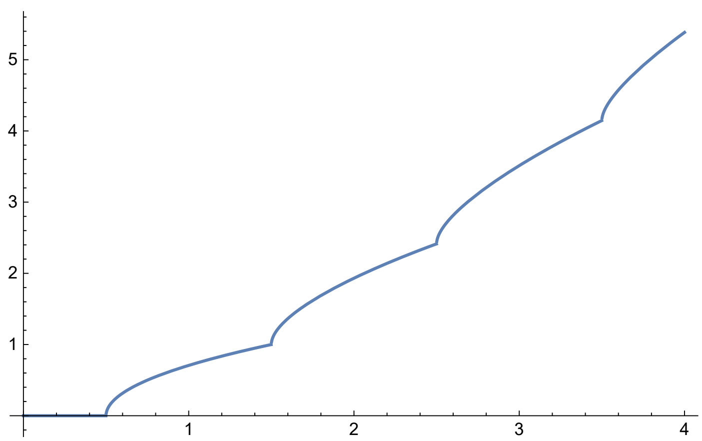
In[5]:=
```
Plot[{2/3*(x^(3/2)),
  Sum[HeavisideTheta[x - (l + 1/2)] * Sqrt[x - (l + 1/2)], {l, 0, 9}]}, {x, 0, 10}]
```

Out[5]=



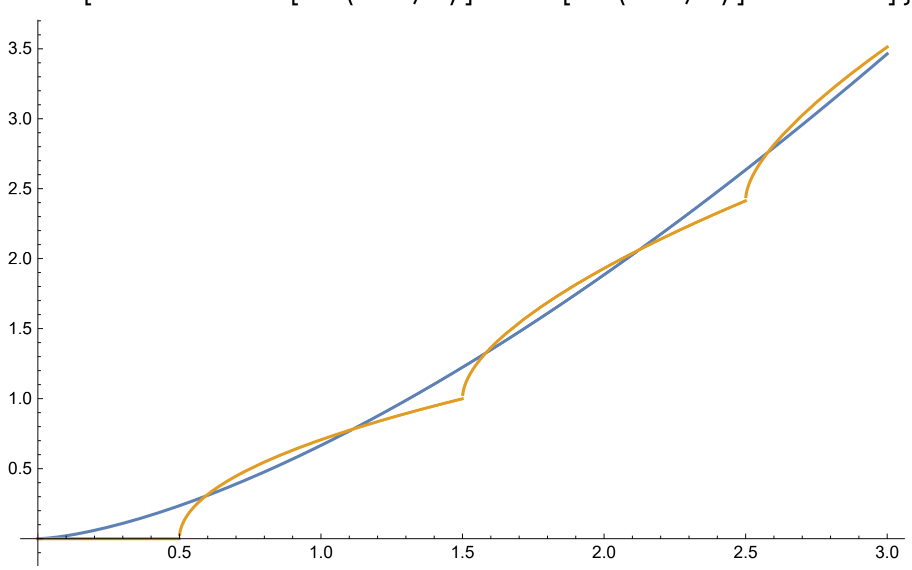
In[6]:=
```
Plot[{Sum[HeavisideTheta[x - (l + 1/2)] * Sqrt[x - (l + 1/2)], {l, 0, 9}]}, {x, 0, 4}]
```

Out[6]=



In[7]:=
```
Plot[{2/3*(x^(3/2)),
  Sum[HeavisideTheta[x - (l + 1/2)] * Sqrt[x - (l + 1/2)], {l, 0, 9}]}, {x, 0, 3}]
```

Out[7]=

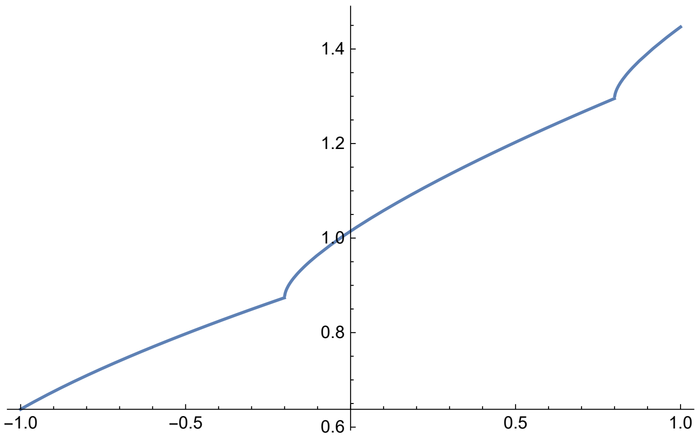


Fermi Energy

In[8]:=
```
x0 = 3.7
```
Out[8]= 3.7

In[9]:=
```
Plot[3/2/((x0)^(3/2))
  Sum[Sqrt[x0 + dx - (l + 1/2)] * HeavisideTheta[x0 + dx - (l + 1/2)], {l, 0, 9}], {dx, -1, 1}]
```

Out[9]=



In[10]:=

In[11]:=
```
xo = Table[k, {k, 0.1, 10, 0.001}];
```

In[12]:=
```
lmax = Table[0, {k, 0.1, 10, 0.001}];
```

In[13]:=
```
Length[lmax]
```
Out[13]= 9901

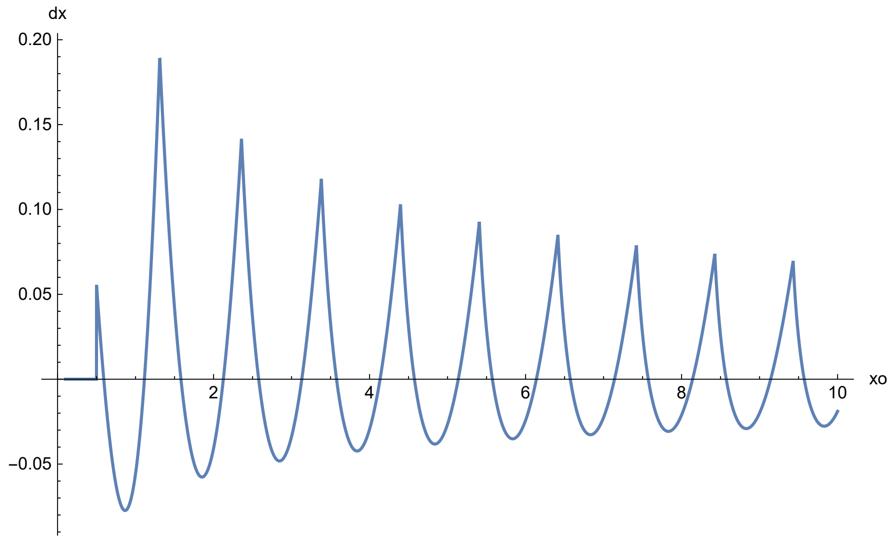
In[14]:=
```
Table[{l = 0;
   While[l < xo[[k]] + 1 - 1/2, l++], lmax[[k]] = l - 1}, {k, 1, Length[lmax]}];
```

In[15]:=
```
roots = Table[Quiet[FindRoot[3/2 * 1/(xo[[k]]^(3/2)) *
        Sum[Sqrt[xo[[k]] + dx - (l + 1/2)] * HeavisideTheta[xo[[k]] + dx - (l + 1/2)],
          {l, 0, lmax[[k]]}] - 1, {dx, 0}]], {k, 1, Length[lmax]}];
```

In[16]:=
```
xf = Table[dx /. roots[[k]], {k, 1, Length[lmax]}];
```

In[17]:=
```
ListPlot[Table[{xo[[k]], Re[xf[[k]]]}, {k, 1, Length[lmax]}],
 Joined → True, PlotRange → All, AxesLabel → {"xo", "dx"}]
```

Out[17]=



Energies

In[18]:=

In[19]:=
```
xo = Table[k, {k, 0.1, 100, 0.01}];
```

In[20]:=
```
lmax = Table[0, {k, 0.1, 10, 0.001}];
```

In[21]:=
```
Length[lmax]
```

Out[21]= 9901

In[22]:=
```
Table[{l = 0;
   While[l < xo[[k]] + 1 - 1/2, l++], lmax[[k]] = l - 1}, {k, 1, Length[lmax]}];
```

In[23]:=
```
roots = Table[Quiet[FindRoot[3/2 * 1/(xo[[k]]^(3/2)) *
       Sum[Sqrt[xo[[k]] + dx - (1 + 1/2)] * HeavisideTheta[xo[[k]] + dx - (1 + 1/2)],
        {l, 0, lmax[[k]]}] - 1, {dx, 0}]], {k, 1, Length[lmax]}];
```

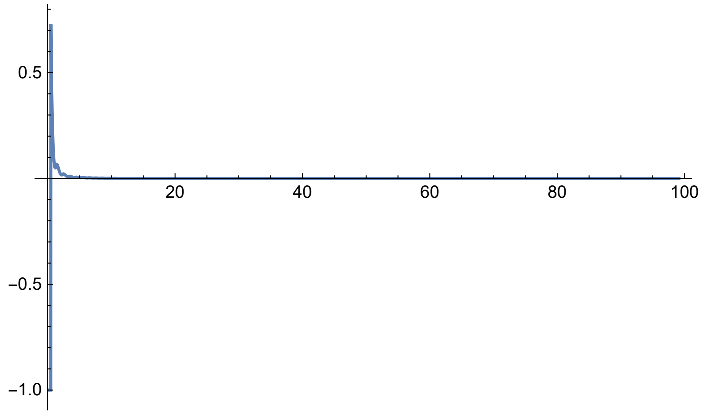
In[24]:=
```
xf = Table[dx /. roots[[k]], {k, 1, Length[lmax]}];
```

In[25]:=
```
f =
  Table[(5/6 * Sum[Chop[Sqrt[xo[[k]] + xf[[k]] - (1 + 1/2)]] * (xo[[k]] + xf[[k]] + 1 + 2 * l) *
          HeavisideTheta[xo[[k]] + xf[[k]] - (1 + 1/2)], {l, 0, lmax[[k]]}] /
        (xo[[k]]^(5/2))) - 1, {k, 1, Length[lmax]}];
```

In[26]:=
```
z = Table[{xo[[k]], Chop[f[[k]]]}, {k, 1, Length[lmax]}];
```

In[27]:=
```
ListPlot[z, Joined → True, PlotRange → All]
```

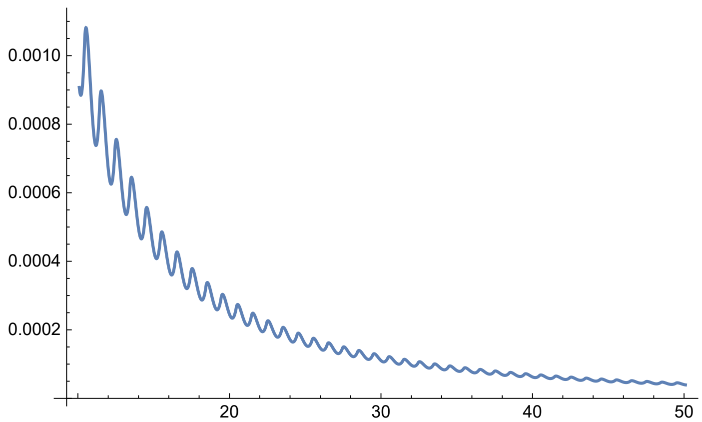
Out[27]=



In[28]:=
```
zz = Table[z[[k]], {k, 1000, 5000}];
```

In[29]:=
```
ListPlot[zz, Joined → True, PlotRange → All]
```

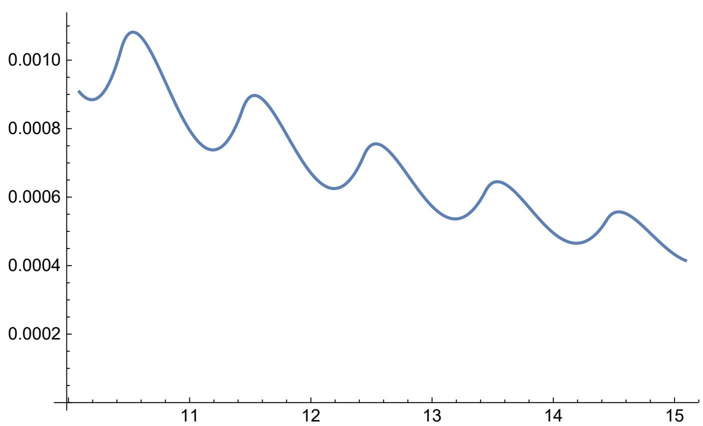
Out[29]=



In[30]:=
```
zzz = Table[z[[k]], {k, 1000, 1500}];
```

In[31]:=
```
ListPlot[zzz, Joined → True]
```

Out[31]=



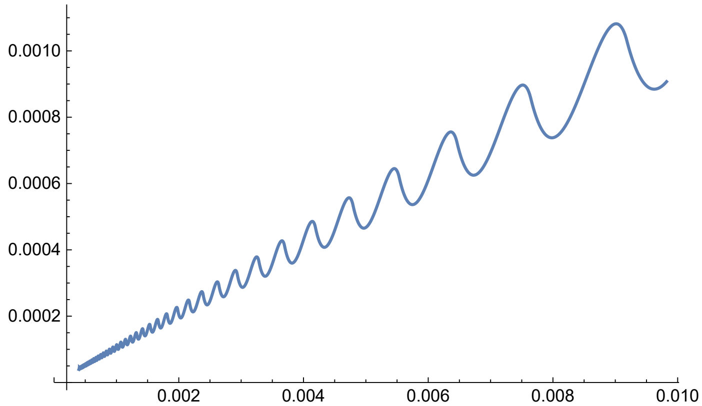
Finding the decay of the energy ratio

In[32]:=
```
y = Table[{1 / xo[[k]]^2, Chop[f[[k]]]}, {k, 1, Length[lmax]}];
```

In[33]:=
```
yy = Chop[Table[y[[k]], {k, 1000, 5000}]];
```

In[34]:=
```
ListPlot[yy, Joined → True, PlotRange → All]
```

Out[34]=



In[35]:=
```
LinearModelFit[Chop[yy], x, x]
```

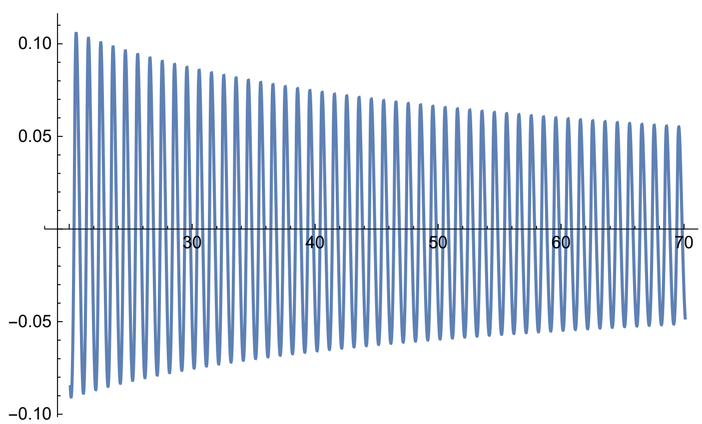
Out[35]=
FittedModel[$-6.2692\times10^{-8} + 0.104693\,x$]

Finding the decay of the envelope

In[36]:=
```
qq = Table[{xo[[k]], xo[[k]]^2 * Chop[f[[k]]] / (0.1047) - 1}, {k, 2000, 7000}];
```

In[37]:=
```
ListPlot[qq, Joined → True, PlotRange → All]
```

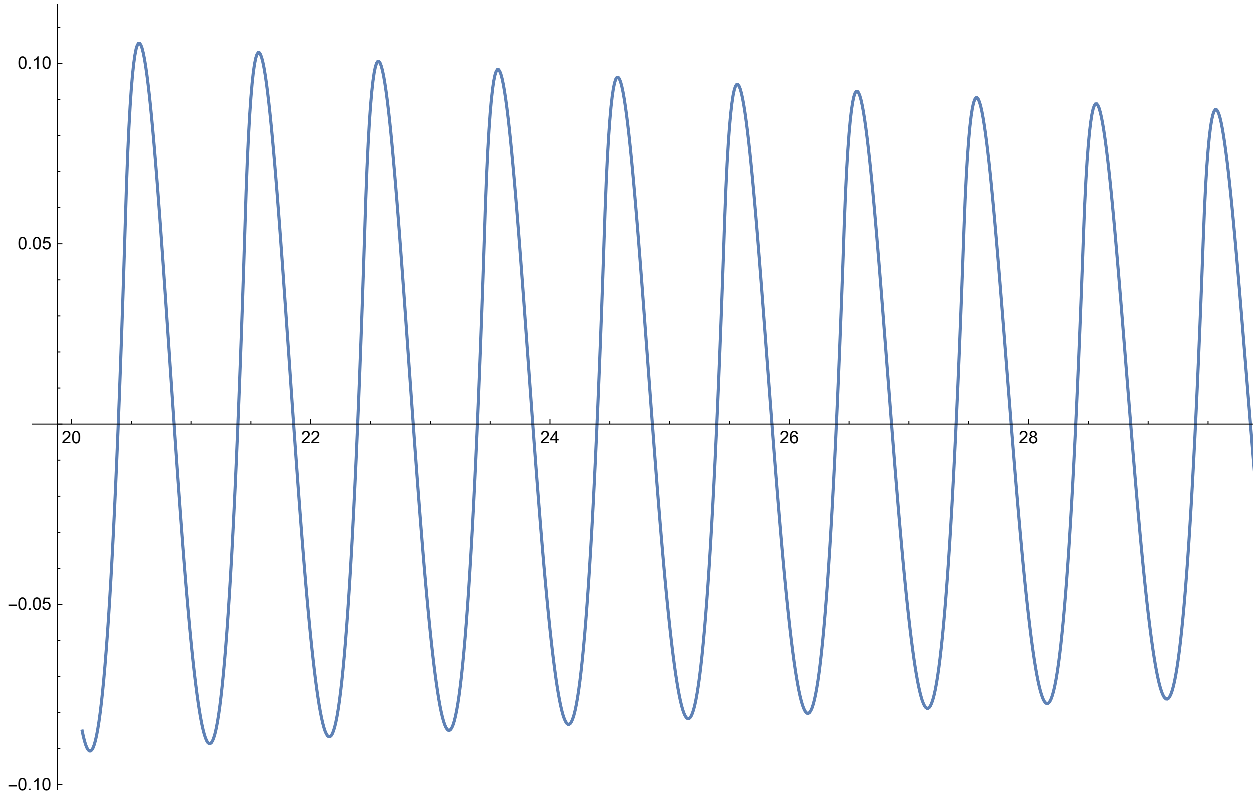
Out[37]=



In[38]:=
```
qq2 = Table[{xo[[k]], xo[[k]]^2 * Chop[f[[k]]] / (0.1047) - 1}, {k, 2000, 3000}];
```

In[39]:=
```
ListPlot[qq2, Joined → True, PlotRange → All]
```

Out[39]=



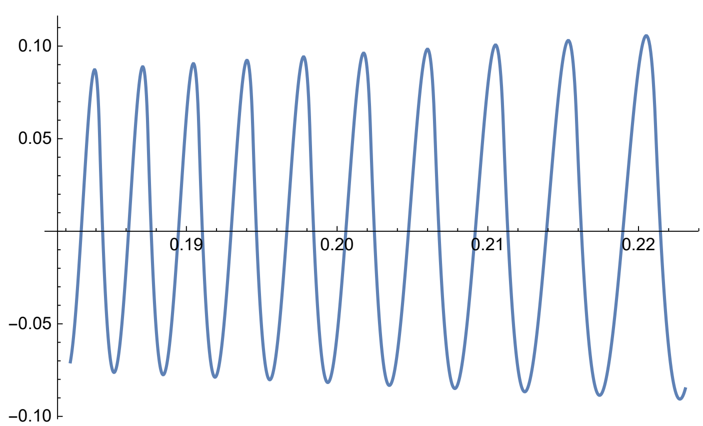
In[40]:=
```
Dimensions[qq2]
```

Out[40]= {1001, 2}

In[41]:=
```
qq3 = Table[{1 / Sqrt[xo[[k]]], xo[[k]]^2 * Chop[f[[k]]] / (0.1047) - 1}, {k, 2000, 3000}];
```

In[42]:=
```
ListPlot[qq3, Joined → True, PlotRange → All]
```

Out[42]=



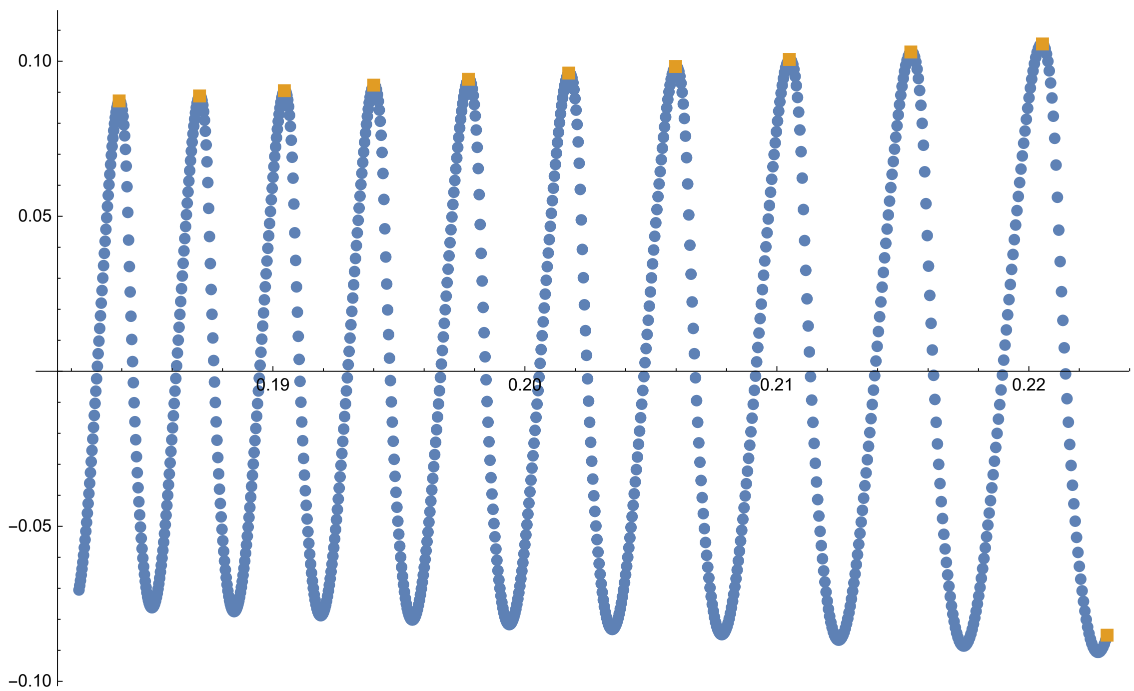
Let' s find the peaks of this oscillatory function plotted as a square root of xo

In[43]:=
```
Dimensions[qq3]
```
Out[43]= {1001, 2}

In[44]:=
```
qq3peaks = Chop[qq3[[Flatten[Position[MaxDetect[Chop[qq3[[All, 2]]]], 1]], All]]];
```

In[45]:=
```
Dimensions[qq3peaks]
```
Out[45]= {11, 2}

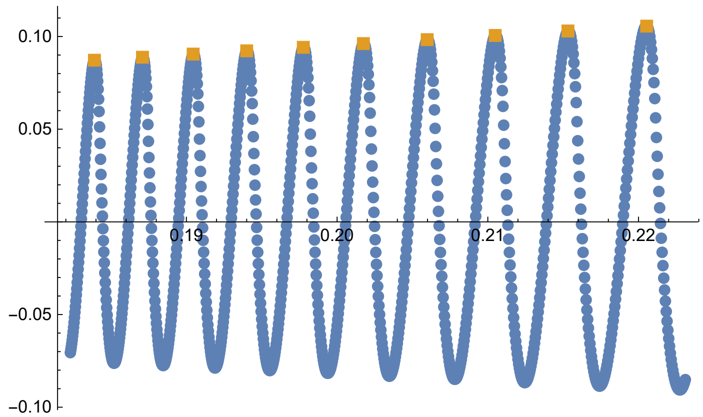
In[46]:=
```
ListPlot[{qq3, qq3peaks}, Joined → False, PlotRange → All, PlotMarkers → Automatic]
```
Out[46]=



In[47]:=
```
Take[qq3peaks, 10]
```
Out[47]= {{0.223105, -0.0851228}, {0.220541, 0.105596}, {0.215315, 0.102996}, {0.210491, 0.100574}, {0.205978, 0.098307}, {0.201743, 0.0961801}, {0.197758, 0.0941793}, {0.194001, 0.0922926}, {0.19045, 0.0905096}, {0.187088, 0.0888211}}

In[48]:=
```
ListPlot[{qq3, Take[qq3peaks, -10]},
 Joined → False, PlotRange → All, PlotMarkers → Automatic]
```

Out[48]=



In[49]:=
```
LinearModelFit[Chop[Take[qq3peaks, -10]], x, x]
```

Out[49]= FittedModel[−0.0050602 + 0.501816 x]

Ratio of number densities

In[50]:=
```
Dimensions[lmax]
```

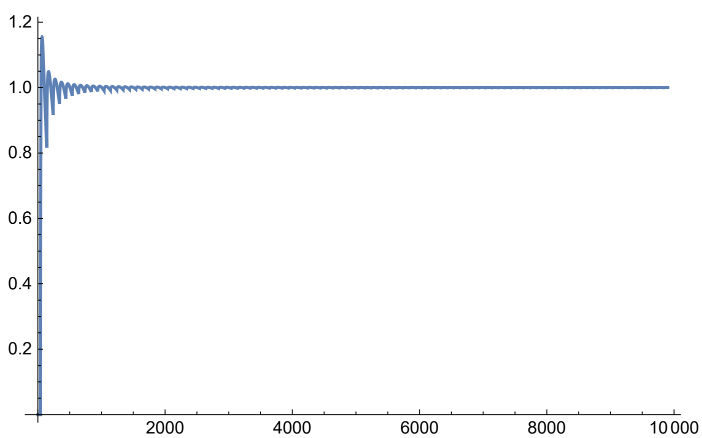
Out[50]= {9901}

In[51]:=
```
nratio =
  Table[(3/2 * Sum[Chop[Sqrt[xo[[k]] - (l + 1/2)]] * HeavisideTheta[xo[[k]] - (l + 1/2)],
      {l, 0, lmax[[k]]}] / (xo[[k]]^(3/2))), {k, 1, Length[lmax]}];
```

In[57]:=
```
nratioreduced = Table[Chop[nratio[[k]]], {k, 100, 500}];
```

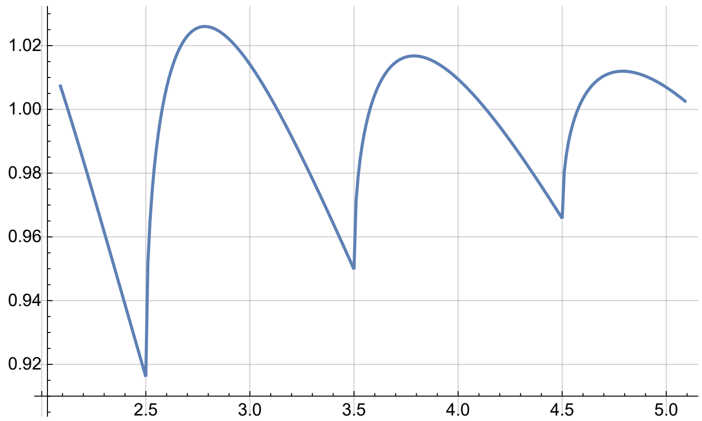
In[58]:=
```
ListPlot[nratio, Joined → True, PlotRange → All]
```

Out[58]=



In[63]:=
```
l1 = ListPlot[Table[{xo[[k]], nratio[[k]]}, {k, 200, 500}],
  Joined → True, PlotRange → All, GridLines → Automatic]
```

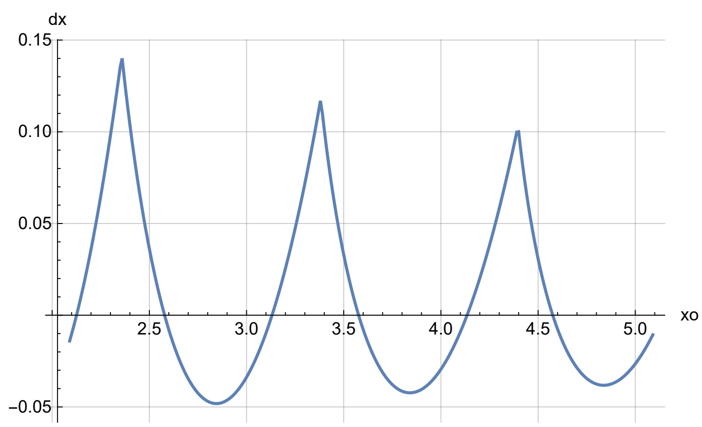
Out[63]=



In[140]:=
```
t1 = Chop[Table[{xo[[k]], nratio[[k]]}, {k, 200, 500}]];
```

In[87]:=
```
l2 = ListPlot[Table[{xo[[k]], Re[xf[[k]]]}, {k, 200, 500}],
  Joined → True, PlotRange → All, AxesLabel → {"xo", "dx"}, GridLines → Automatic]
```

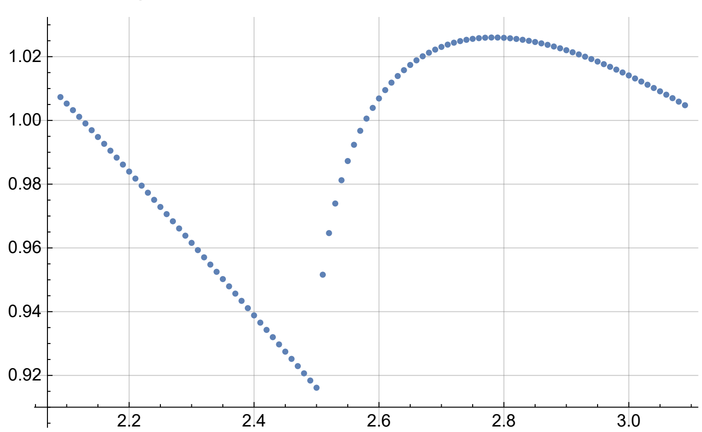
Out[87]=



In[141]:=
```
t2 = Table[{xo[[k]], Re[xf[[k]]]}, {k, 200, 500}];
```

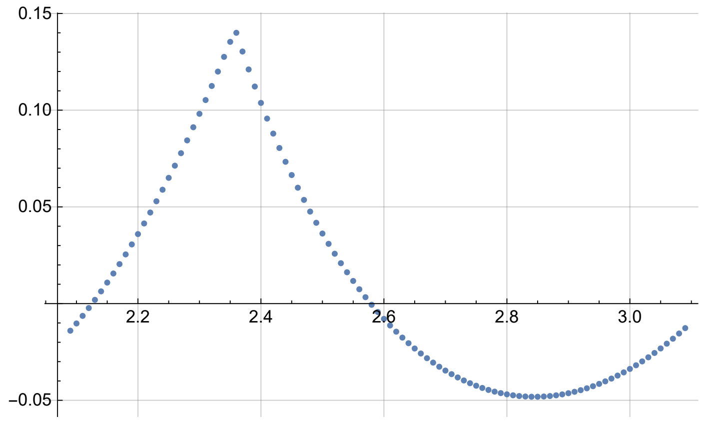
In[118]:=
```
g1 = ListPlot[Table[{Re[xo[[k]]], Re[nratio[[k]]]}, {k, 200, 300}],
  PlotRange → All, GridLines → Automatic]
```

Out[118]=



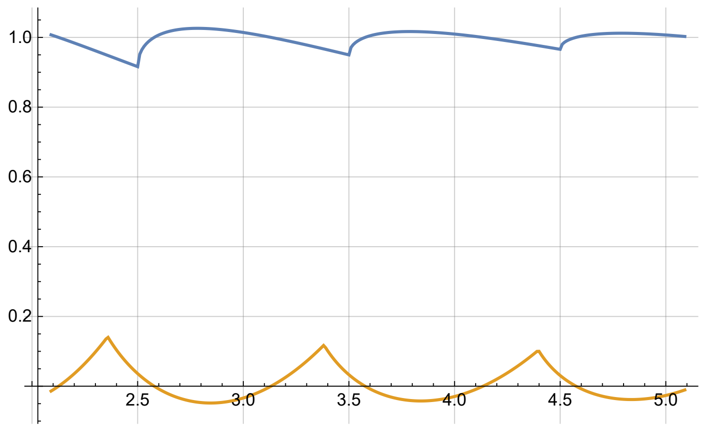
In[119]:=
```
g2 = ListPlot[Table[{Re[xo[[k]]], Re[xf[[k]]]}, {k, 200, 300}],
  PlotRange → All, GridLines → Automatic]
```

Out[119]=



In[145]:=
```
ListPlot[{t1, t2}, Joined → True, GridLines → Automatic]
```

Out[145]=

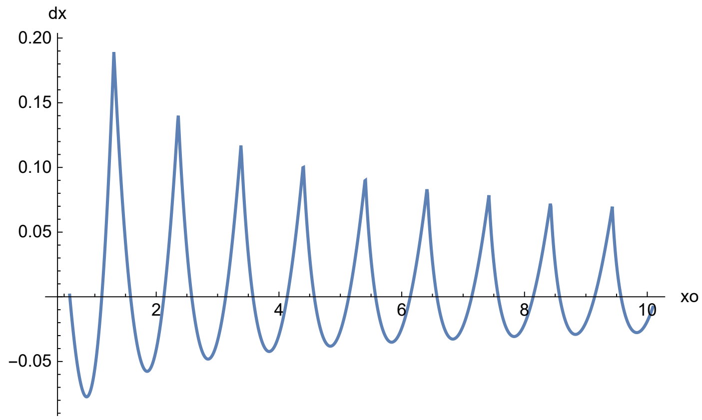


Plotting Fermi Energy versus magnetic field

In[146]:=
```
Dimensions[xf]
```

Out[146]= {9901}

In[151]:=
```
ListPlot[Table[{xo[[k]], Re[xf[[k]]]}, {k, 50, 1000}],
 Joined → True, PlotRange → All, AxesLabel → {"xo", "dx"}]
```

Out[151]=


In[152]:=
```
B = Table[k, {k, 0.1, 10, 0.1}];

xo[[k]]
```

Out[154]= {9991}

In[199]:=
```
ListPlot[Table[{1/xo[[k]], Re[xf[[k]]]}, {k, 45, 500}],
 Joined → True, PlotRange → {-0.5, 0.2}, AxesLabel → {"1/xo", "dx"},
 GridLines → Automatic, Ticks → {Automatic,  Automatic}]
```

Out[199]=