dielectric

September 4, 2020

0.1 # Dielectric

In the small frequency limit we can write the dielectric function as

$$\epsilon(i\omega, q) = X(q) + \omega^2 Y(q)$$

where $X(q)$ and $Y(q)$ can be calculated numerically (see the code).

[1]:
```
using JLD
using PyPlot
```

[2]:
```
using PyCall
```

[3]:
```
dielectric,dielectric2= load("correction.jld","dielectric","dielectric2");
```

[4]:
```
X = dielectric[:,1];
Y = dielectric2[:,1];
```

Pole correction approximation:

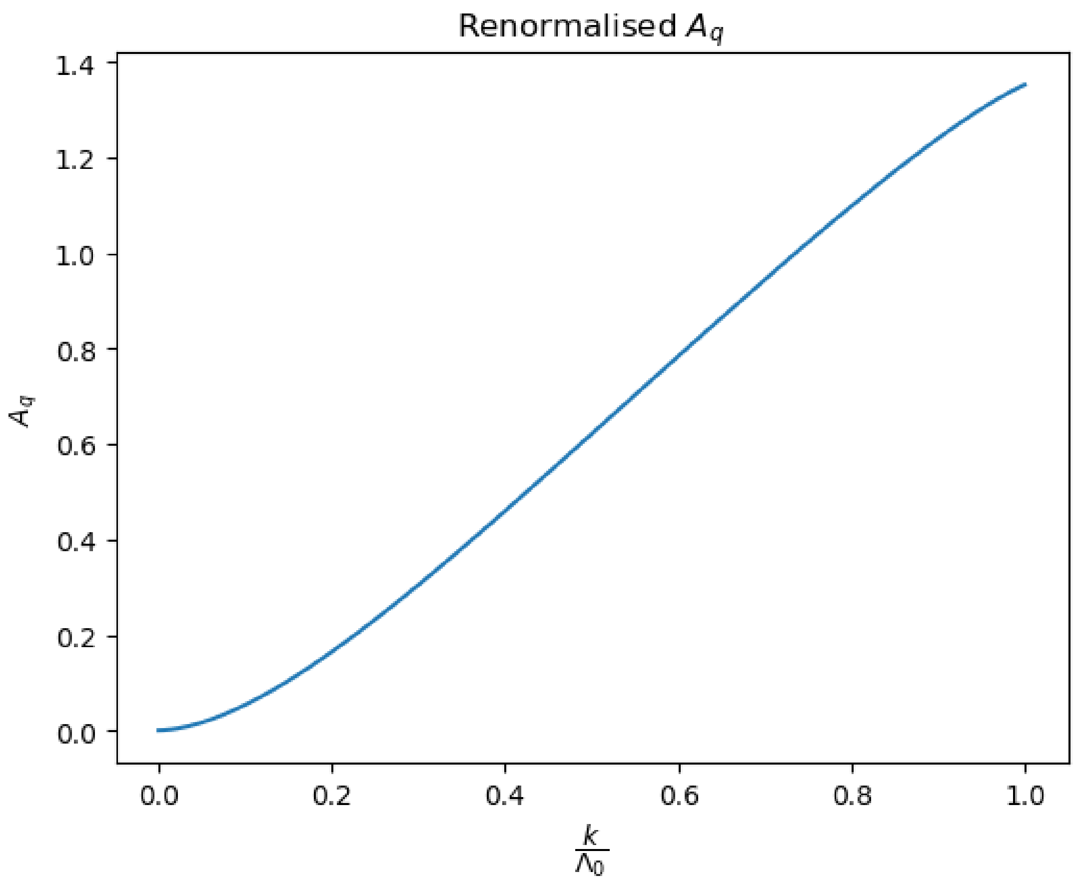
$$\frac{1}{\epsilon(\omega, q)} = 1 + \frac{A_q}{\omega^2 - \omega_q^2}$$

Equating this with the previous equation in the small frequency limit we get

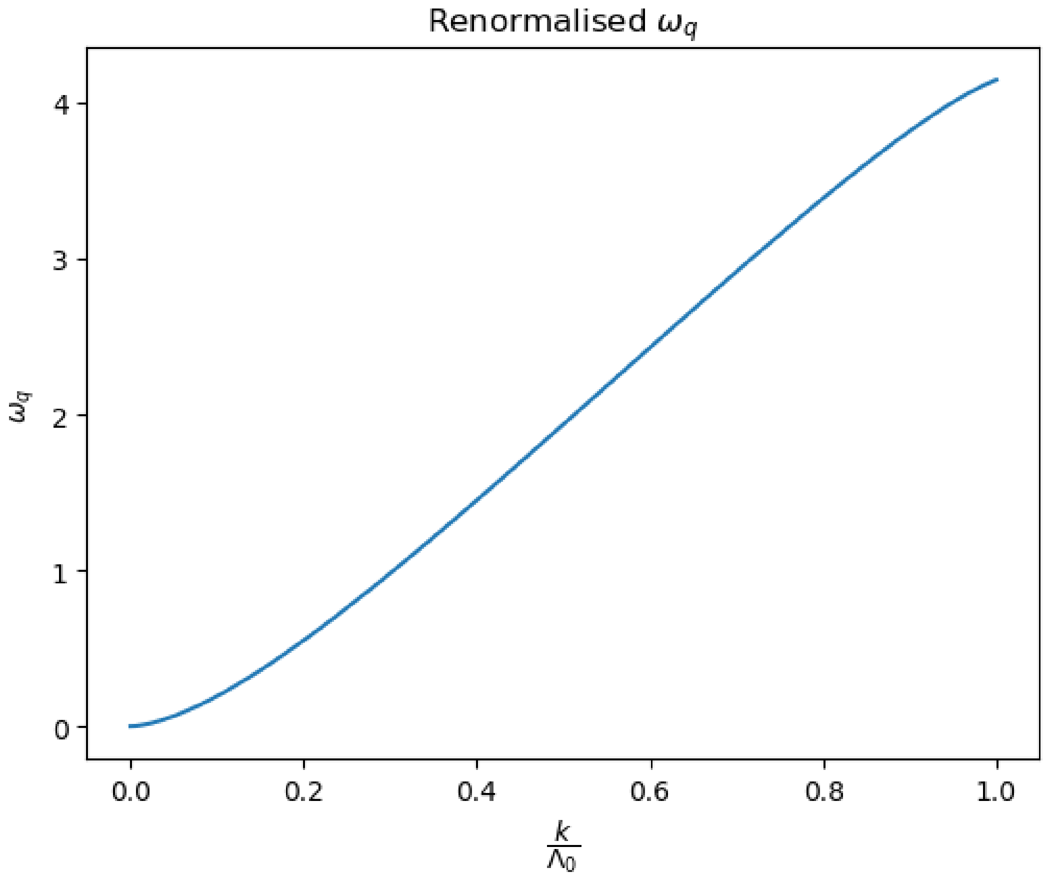
$$A_q = -\frac{(X(q) - 1)^2}{Y(q)} \quad \omega_q^2 = -\frac{X(q)(X(q) - 1)}{Y(q)}$$

[5]:
```
Aq = -(X .- 1.0).^2 ./Y;
 q = -(X .* (X .- 1.0)) ./Y;
```

[6]:
```
plot(range(0,stop=1,length=length(Aq)),Aq)
title(L"Renormalised $A_q$");
xlabel(L"$\dfrac{k}{\Lambda_0}$");
ylabel(L"$A_q$");
```



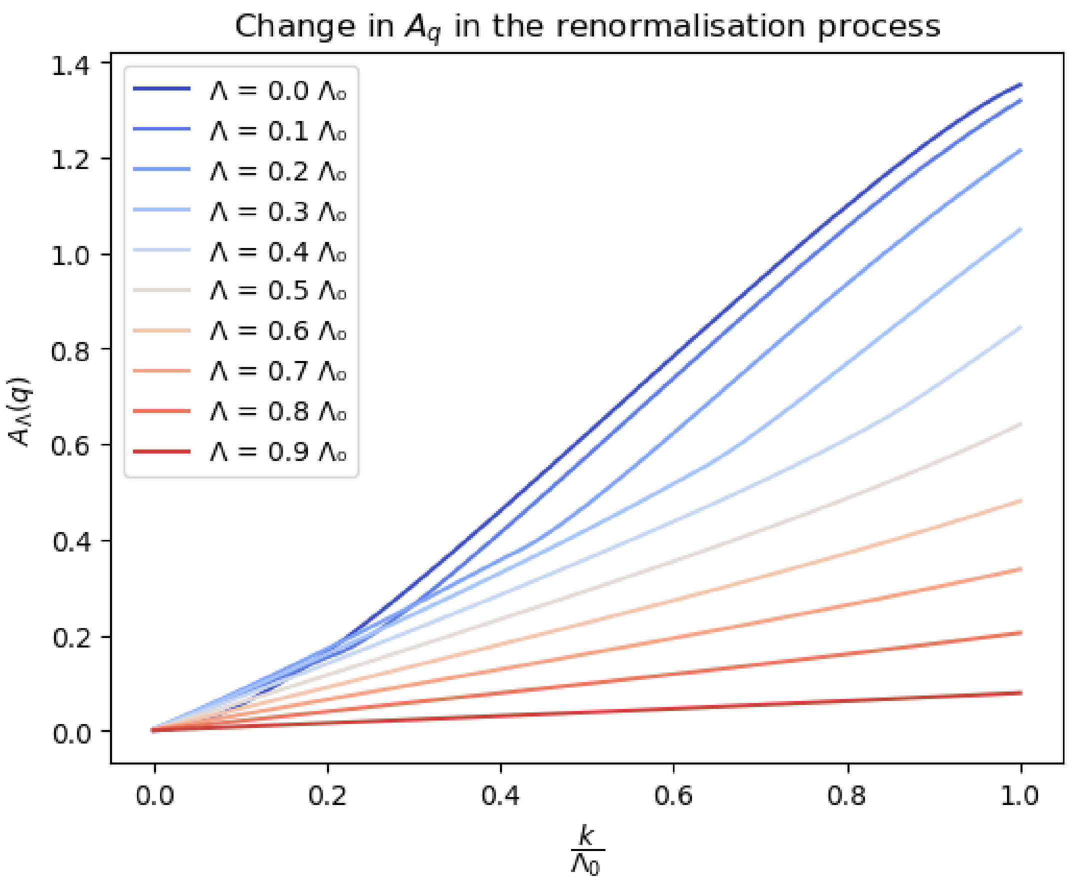
[7]:
```
plot(range(0,stop=1,length=length( q)), q)
title(L"Renormalised $\omega_q$");
xlabel(L"$\dfrac{k}{\Lambda_0}$");
ylabel(L"$ _q$");
```

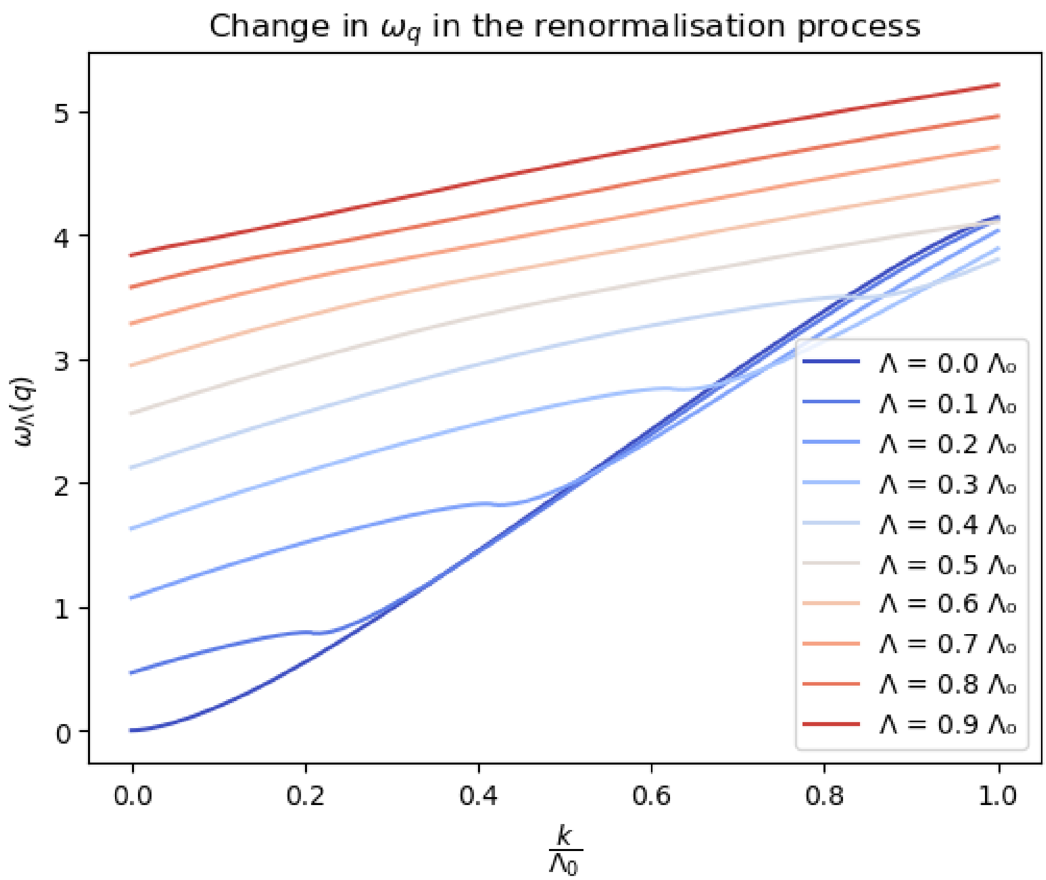


[12]:
```
m = length(dielectric[1,:])
n = length(dielectric[:,1])
mpl = pyimport("matplotlib.cm")
cmap = mpl.get_cmap("coolwarm")
fig1 = figure()
fig2 = figure()
ax1 = fig1.add_subplot(111)
ax2 = fig2.add_subplot(111)
for i in 1:34:m
    Xp = dielectric[:,i]
    Yp = dielectric2[:,i]
    Aqp = -(Xp .- 1.0).^2 ./Yp;
     qp = -(Xp .* (Xp .- 1.0)) ./Yp;
    ax1.plot(range(0,stop=1,length=n),Aqp,color=cmap((i)/m),label="Λ =␣
 ↪$(round((i)/m,digits=1)) Λ ")
    ax2.plot(range(0,stop=1,length=n), qp,color=cmap((i)/m),label="Λ =␣
 ↪$(round((i)/m,digits=1)) Λ ")
end
```

```
ax1.legend()
ax1.set_title(L"Change in $A_q$ in the renormalisation process")
ax1.set_xlabel(L"$\dfrac{k}{\Lambda_0}$")
ax1.set_ylabel(L"$A_{\Lambda}(q)$")

ax2.set_title(L"Change in $\omega_q$ in the renormalisation process")
ax2.set_xlabel(L"$\dfrac{k}{\Lambda_0}$")
ax2.set_ylabel(L"$\omega_{\Lambda}(q)$")
ax2.legend();
```





0.2 Real Part of the Self Energy

0.2.1 At k=0

[6]:
```
vel = load("correction.jld","velocity");
velocity = vel[:,1];
```

[7]:
```
save("renormalised_data.jld","velocity",velocity,"Aq",Aq," q", q)
```

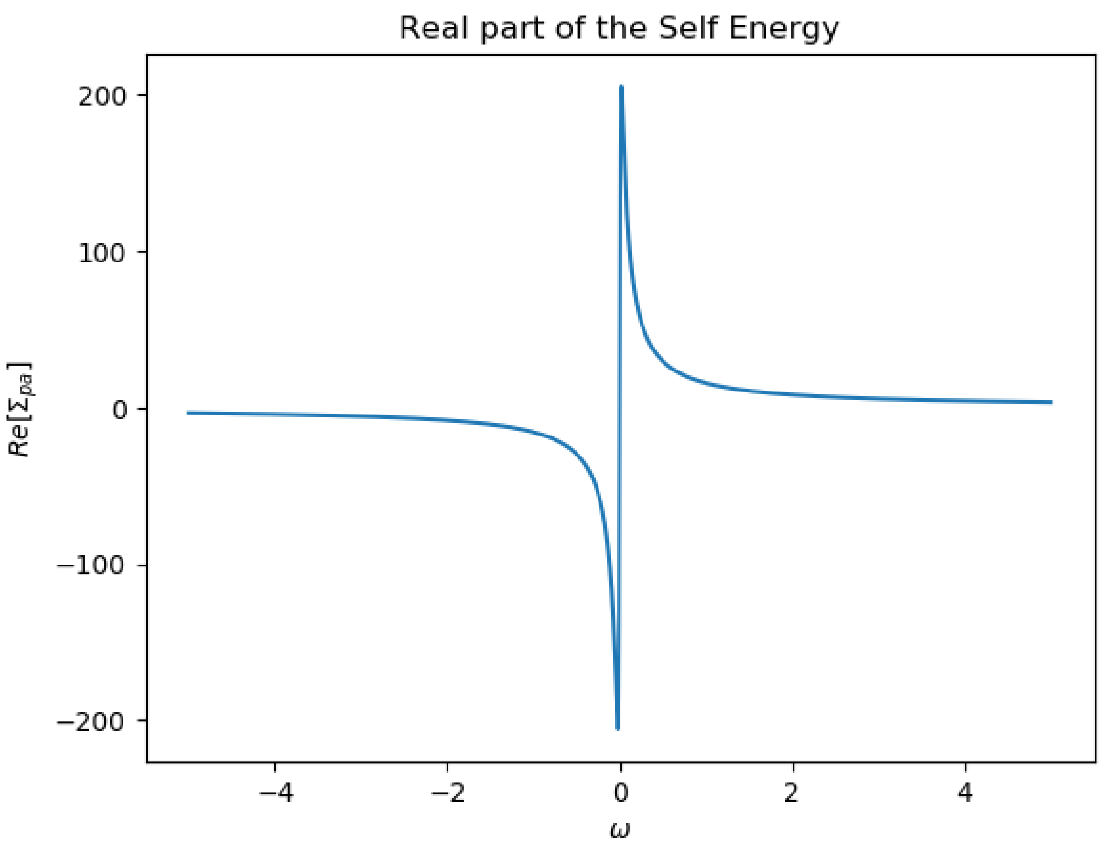
[13]:
```
1/n
```

[13]: 0.0029154518950437317

[36]:
```
list = []
for j in 1:10000
    omega = 10*j/10000 - 5
    int = 0.0
    for i in 1:n
```

```
        int += pi^2*Aq[i]*((omega -  q[i])/((i/n)^2*velocity[i]^2 + (omega -␣
↪q[i])^2) + (omega +  q[i])/((i/n)^2*velocity[i]^2 + (omega +  q[i])^2))/
↪(2* q[i]^2)
    end
    int = int/n
    list = [list;int]
end
```

[41]:
```
plot(range(-5,stop=5,length = 10000),list)
title("Real part of the Self Energy");
xlabel(L"\omega");
ylabel(L"Re[\Sigma_{pa}]");
```



[ ]: