Reservoir Size

July 26, 2022

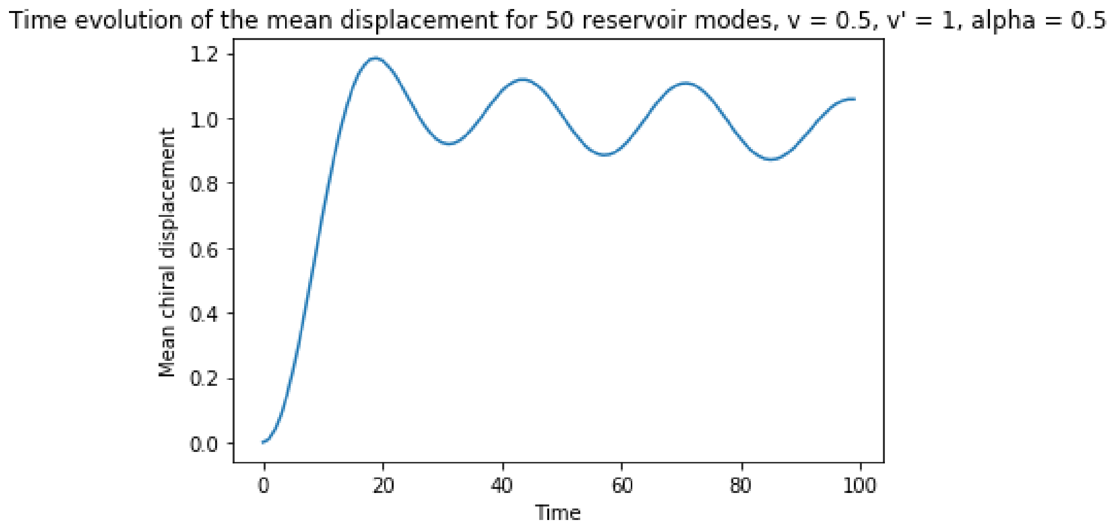
[21]:
```python
import numpy as np
from matplotlib import pyplot as plt
from qutip import *
import scipy
```

[30]:
```python
#Defining the system in momentum space

#Some parameters

t = 100
v1 = 1
v2 = 0.5

def v(k):
    return v1 + v2*np.exp(1j*k)
def phi(k):
    return np.angle(v(k))

n_res = 50
n_sites = 50
E_res = np.linspace(0,1/8,n_res)
E = np.insert(E_res,0,0)
BZ = np.linspace(-np.pi/n_sites*(n_sites-1),np.pi/n_sites*(n_sites-1),n_sites)

#The Hamiltonian

def n(k,j,alpha):
    return 1/50*v(k)*E_res[j-1]**(alpha/2)

def H(k,alpha):
    H_0 = np.diag(E)
    H_0 = np.array(H_0, dtype = 'complex')
    for i in range(1,n_res+1):
        H_0[0,i] += n(k,i,alpha)
        H_0[i,0] += np.conjugate(n(k,i,alpha))
    return H_0

#The inital state
```

```python
psi_0 = np.zeros(n_res+1)
psi_0 = np.array(psi_0, dtype = 'complex')
psi_0[0] = 1

#The relevant observable

def pr(state):
    return np.linalg.norm(state)**2 - state[0]*np.conjugate(state[0])
dphi = np.gradient(phi(BZ), BZ[1] - BZ[0])

def sol(k, alpha):
    H_0 = H(k, alpha)
    U = scipy.linalg.expm(-1j*H_0)
    temp = np.zeros((t,n_res+1), dtype = 'complex')
    temp[0] = psi_0
    for i in range(1,len(temp)):
        temp[i] = U@temp[i-1]/np.linalg.norm(U@temp[i-1])
    return temp

def data(alpha):
    temp = np.zeros((len(BZ),t,n_res+1), dtype = 'complex')
    for i in range(len(BZ)):
        for j in range(t):
            temp[i,j] += sol(BZ[i],alpha)[j]
    return temp

def m(a):
    arr = data(a)
    temp = np.zeros(t, dtype = 'complex')
    for i in range(t):
        for j in range(len(BZ)):
            temp[i] += 1/n_sites*pr(arr[j,i])*dphi[j]
    return np.real(temp)
```

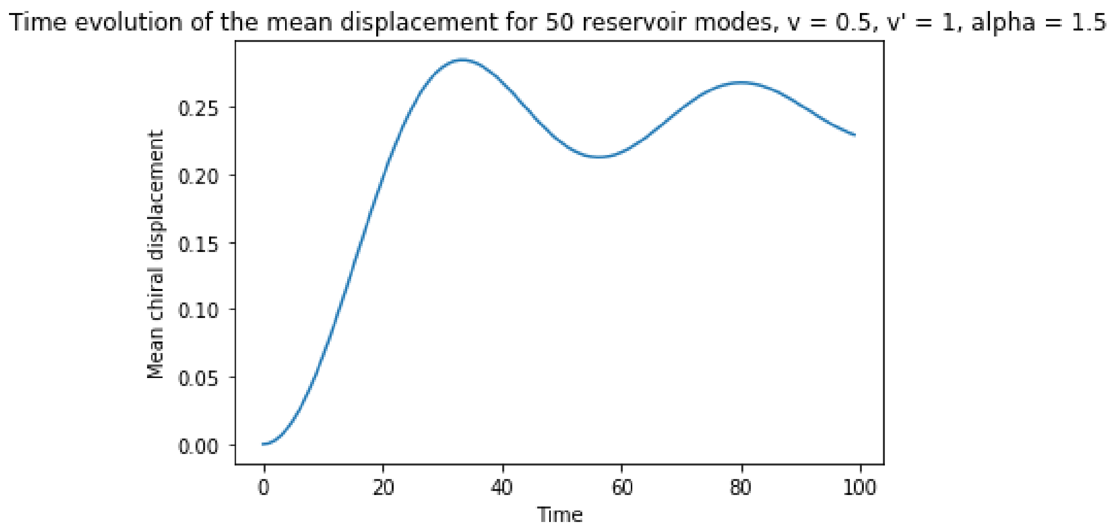
[29]:
```python
plt.plot(2*m(0.5))
plt.xlabel('Time')
plt.ylabel("Mean chiral displacement")
plt.title("Time evolution of the mean displacement for 50 reservoir modes, v =␣
↪0.5, v' = 1, alpha = 0.5")
```

[29]:
```
Text(0.5, 1.0, "Time evolution of the mean displacement for 50 reservoir modes,
v = 0.5, v' = 1, alpha = 0.5")
```



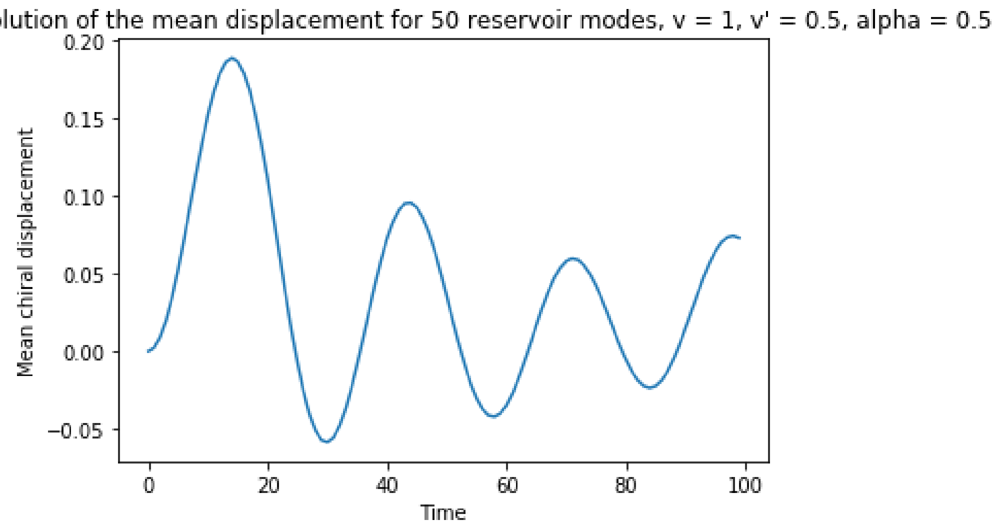

```
[28]: plt.plot(2*m(1.5))
plt.xlabel('Time')
plt.ylabel("Mean chiral displacement")
plt.title("Time evolution of the mean displacement for 50 reservoir modes, v =␣
↪0.5, v' = 1, alpha = 1.5")
```

```
[28]: Text(0.5, 1.0, "Time evolution of the mean displacement for 50 reservoir modes,
v = 0.5, v' = 1, alpha = 1.5")
```



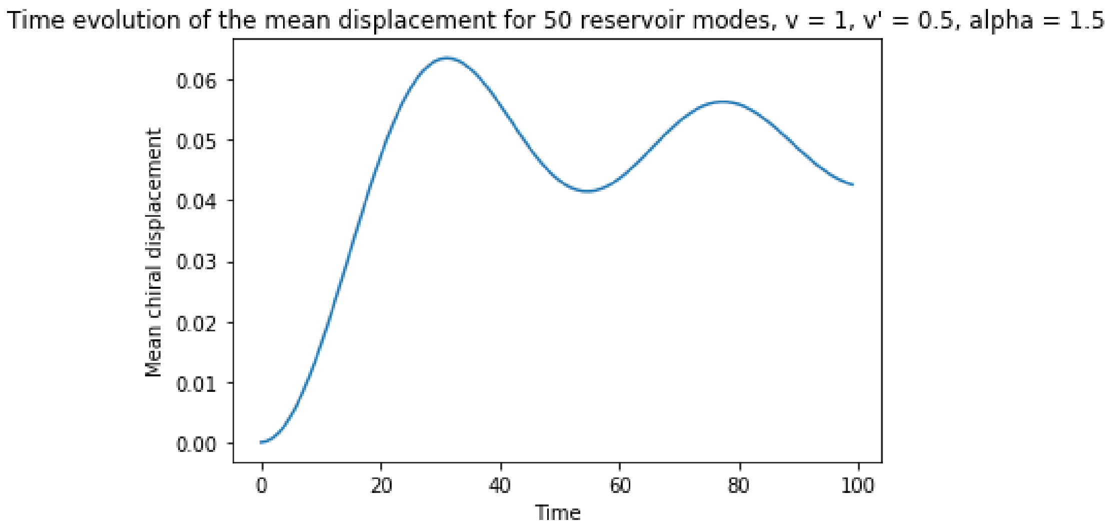
[31]:
```
plt.plot(2*m(0.5))
plt.xlabel('Time')
plt.ylabel("Mean chiral displacement")
plt.title("Time evolution of the mean displacement for 50 reservoir modes, v =␣
↪1, v' = 0.5, alpha = 0.5")
```

[31]:
```
Text(0.5, 1.0, "Time evolution of the mean displacement for 50 reservoir modes,
v = 1, v' = 0.5, alpha = 0.5")
```



[32]:
```
plt.plot(2*m(1.5))
plt.xlabel('Time')
plt.ylabel("Mean chiral displacement")
plt.title("Time evolution of the mean displacement for 50 reservoir modes, v =␣
↪1, v' = 0.5, alpha = 1.5")
```

[32]:
```
Text(0.5, 1.0, "Time evolution of the mean displacement for 50 reservoir modes,
v = 1, v' = 0.5, alpha = 1.5")
```


Time evolution of the mean displacement for 50 reservoir modes, v = 1, v' = 0.5, alpha = 1.5
Mean chiral displacement
Time
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0
20
40
60
80
100

[ ]: