ribbon_dispersion_example

March 24, 2022

[1]:
```
# standard imports
import numpy as np
import kwant

from numpy import pi
from scipy import sparse as sp
from scipy.sparse import linalg as lsp
from scipy import linalg as la

from matplotlib import pyplot as plt
%matplotlib inline
```

[2]:
```
kwant.__version__
```

[2]:
```
'1.4.2'
```

[3]:
```
from tinyarray import array as ta

# Pauli matrices
sigma0 = ta([[1, 0], [0, 1]])
sigmax = ta([[0, 1], [1, 0]])
sigmay = ta([[0, -1j], [1j, 0]])
sigmaz = ta([[1, 0], [0, -1]])
```

[4]:
```
lat = kwant.lattice.square()
syst = kwant.Builder(kwant.TranslationalSymmetry((-1, 0)))

Wy = 101

def hop_x(to_site, from_site, t, B):
    x, y = to_site.pos
    return -t * np.exp(1j * B * (y-(Wy-1)/2)) * sigma0

def hop_y(to_site, from_site, t):
    x, y = to_site.pos
    return -t * sigma0

def onsite(site, t):
```

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    x, y = site.pos
    return  4 * t * sigma0

# onsite
for ny in range(Wy):
    syst[lat(0, ny)] = onsite

# x-direction hoppings
for ny in range(0,Wy):
    syst[lat(0,ny),lat(1,ny)] = hop_x

# y-direction hoppings
for ny in range(1,Wy):
    syst[lat(0,ny-1),lat(0,ny)] = hop_y

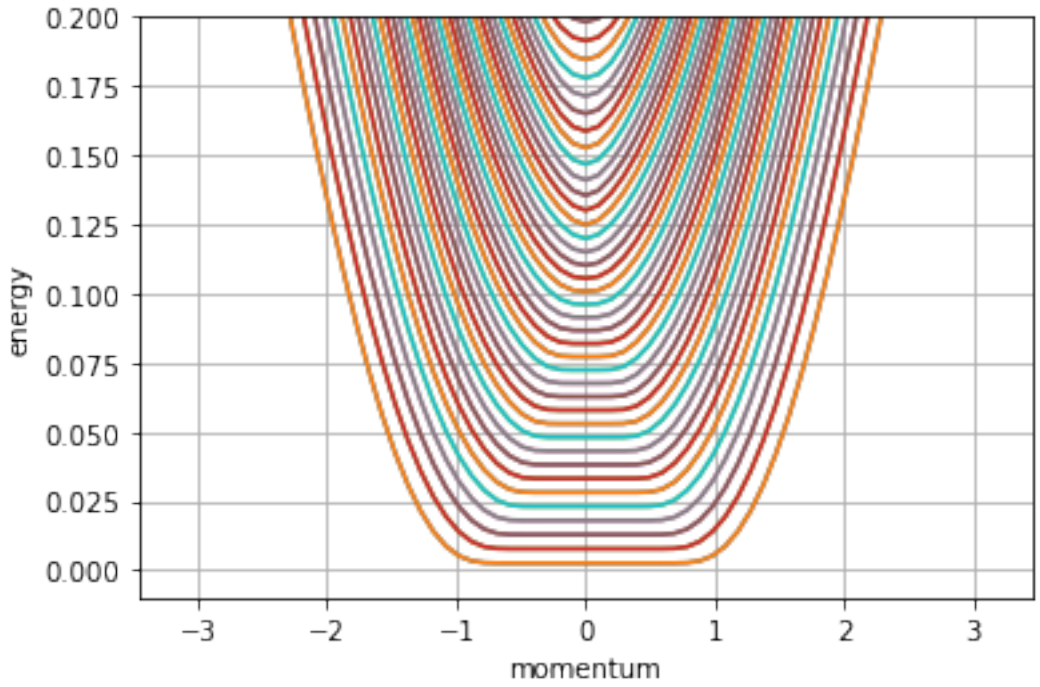

## PBC boundary: be very carefull to add properly if needed
#syst[lat(0, Wy-1), lat(0, 0)] =  hop_y

fsyst = syst.finalized()

fig, ax = plt.subplots(1, 1)
ax.set_xlabel("momentum")
ax.set_ylabel("energy")
ax.set_ylim(-0.01, 0.2)

Bcrit = 2*np.pi/Wy
params = dict( B=Bcrit/3, t=1/8)

kwant.plotter.bands(fsyst, ax=ax, params=params)
ax.grid()
```



[5]:
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#### dictionary containing the parameters
params = dict( t = 1/8, B = Bcrit/3 )

## Lead bands: calculation with a better control
#               sparse matrix diagonlization

# prepare H_0 and V for our lead
ham0  = fsyst.cell_hamiltonian(params=params, sparse=True)  #.tocsc()

_hop  = fsyst.inter_cell_hopping(params=params, sparse=True)
shp = (_hop.shape[0], _hop.shape[0] - _hop.shape[1])
_zeros = sp.coo_matrix( shp, dtype=complex)
vhop = sp.hstack( [_hop, _zeros] )                          #.tocsc()

momenta=np.linspace(-np.pi, np.pi, 301)
ens = []
for kpar in momenta:
    # H_k = H_0 + V e^-ik + V^\dagger e^ik
    hmat  = vhop * np.exp(-1j*(kpar))
    hmat += hmat.conjugate().transpose() + ham0

    #evals = la.eigh( hmat, eigvals_only=True ) ## dense solver
    evals = lsp.eigsh( hmat, k=10, return_eigenvectors=False,
                       which='LM', sigma=0.01, tol=10**(-8) )
```
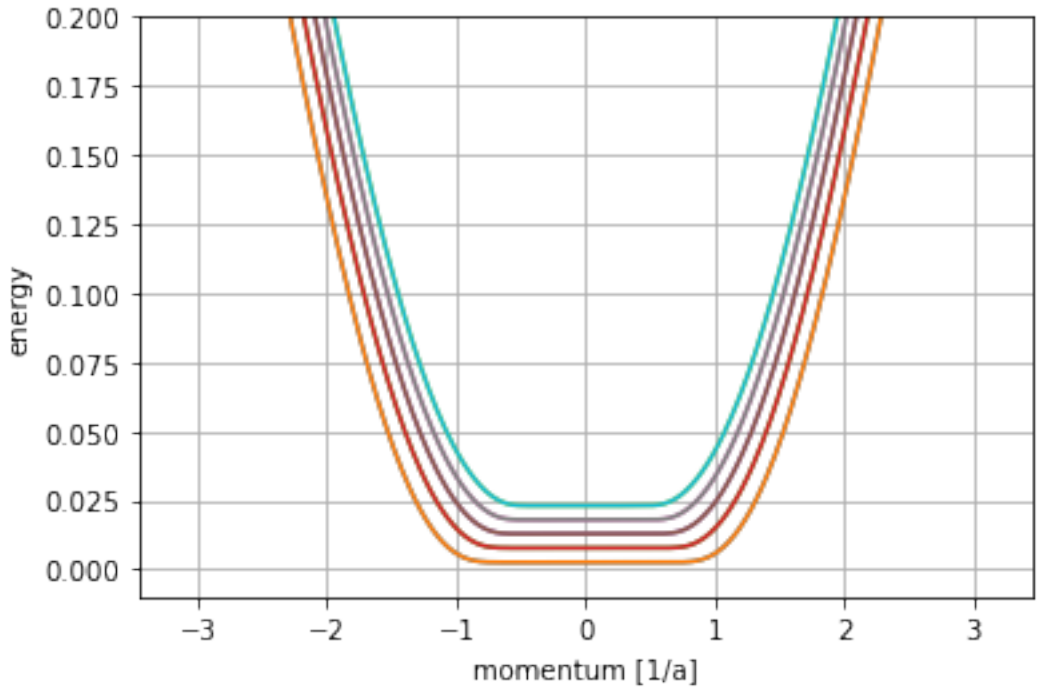

```
    ens.append(np.sort(evals))


plt.grid()
#plt.xlim(-1, 1)
plt.ylim(-0.01, 0.2)
plt.xlabel('momentum [1/a]')
plt.ylabel('energy')

#plt.plot(momenta,ens,'.',ms=1)
plt.plot(momenta,ens)
plt.show()
```



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