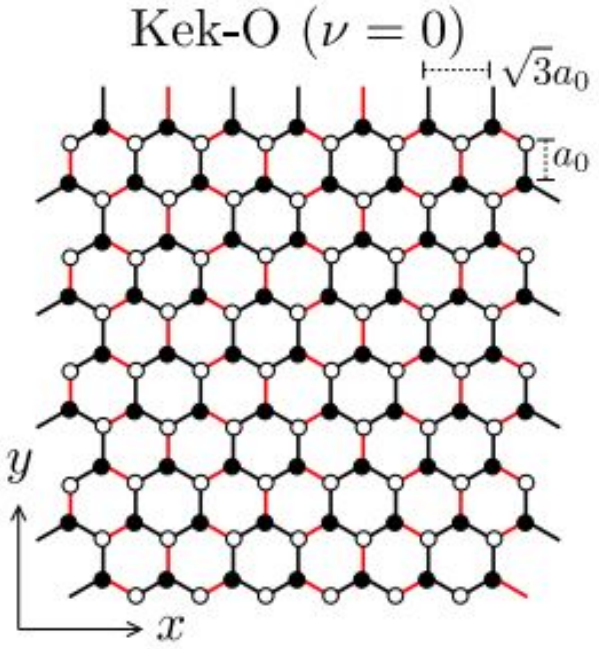
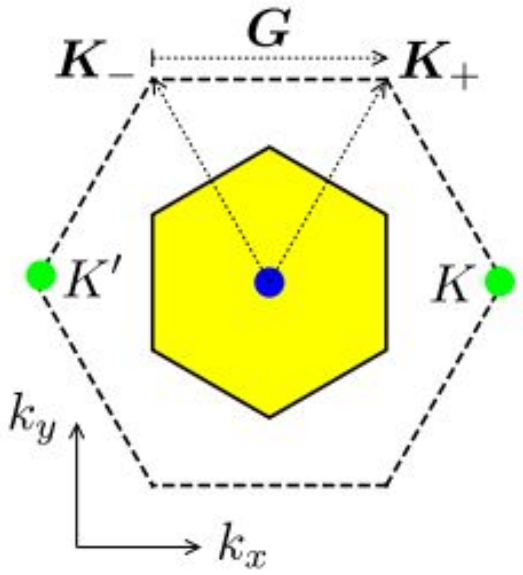
Broken Valley Degeneracy In Strained Kekule Lattices

Kek-O

- Two Dirac valleys K/K’ folded to center of new BZ, coupled by wave vector G.
- Bond distortion opens a gap in the spectrum around dirac point.



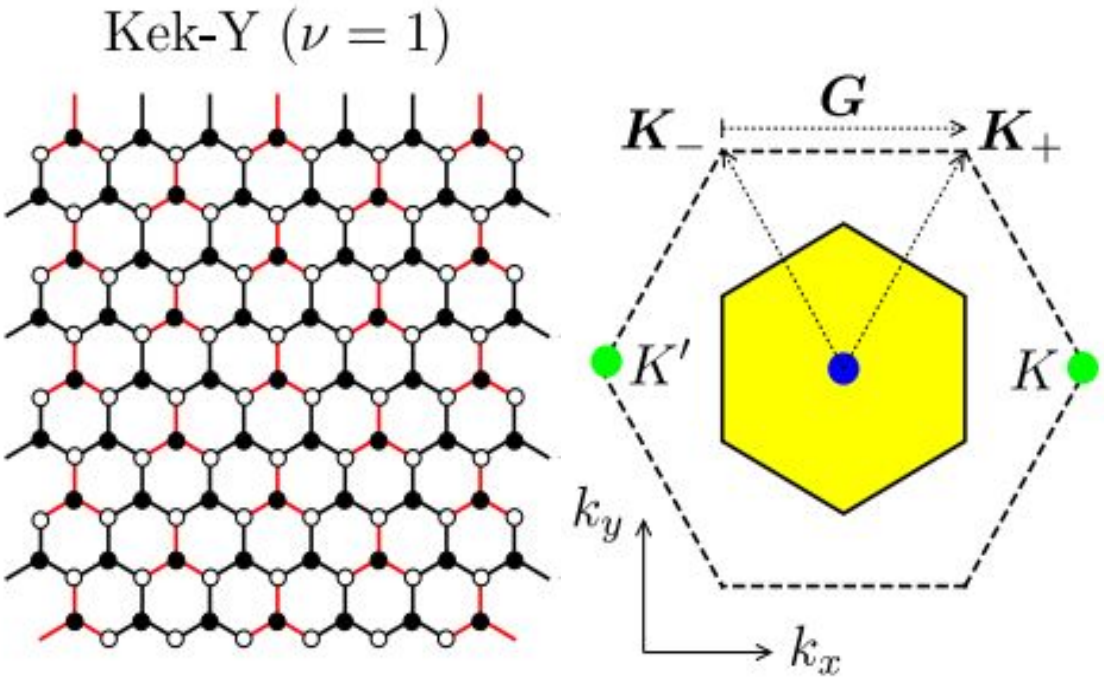


$$E^2 = v_0^2|\boldsymbol{p}|^2 + (3t_0\Delta_0)^2 \text{ for } \nu = 0.$$

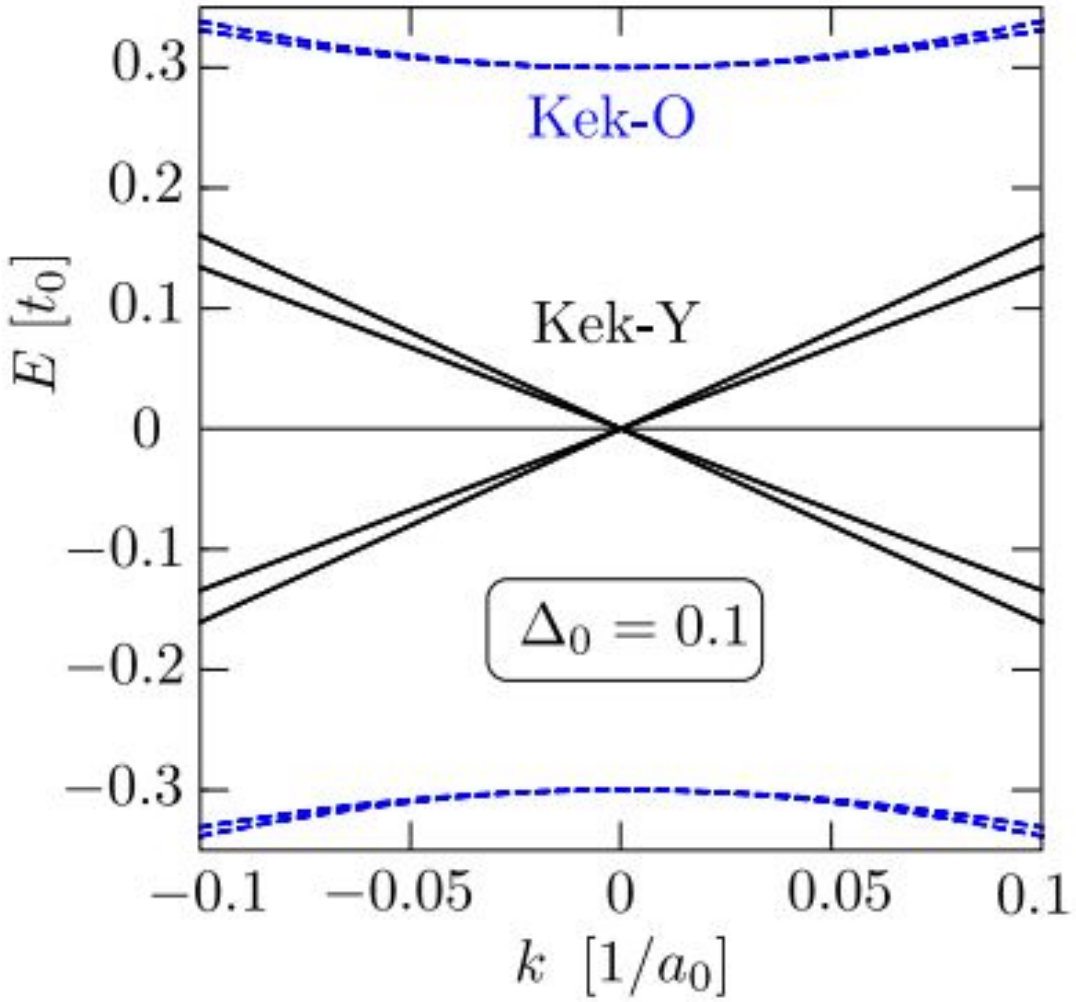
Kek-Y

- Gapless spectrum at the Dirac point made up of pair of linearly dispersing modes.

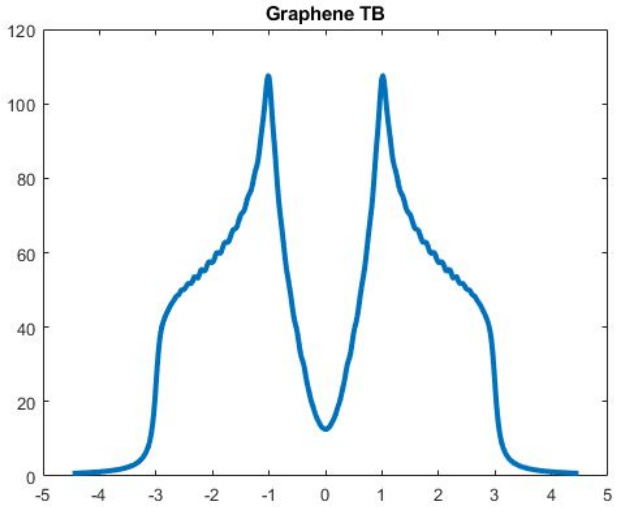
- Two gapless modes are helical - valley isospin and sublattice pseudospin aligned with direction of motion.

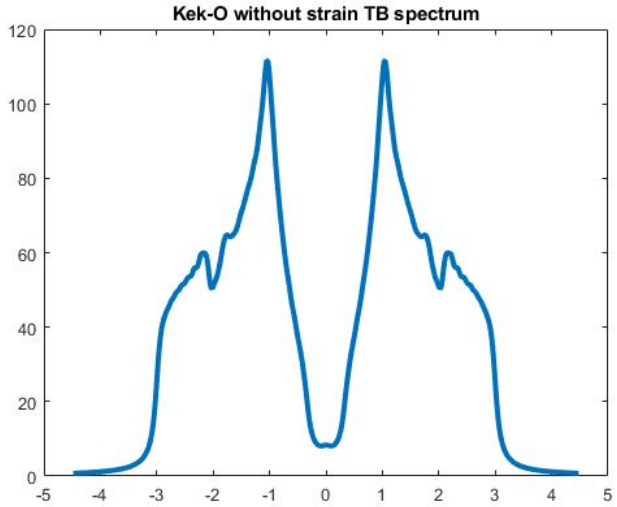


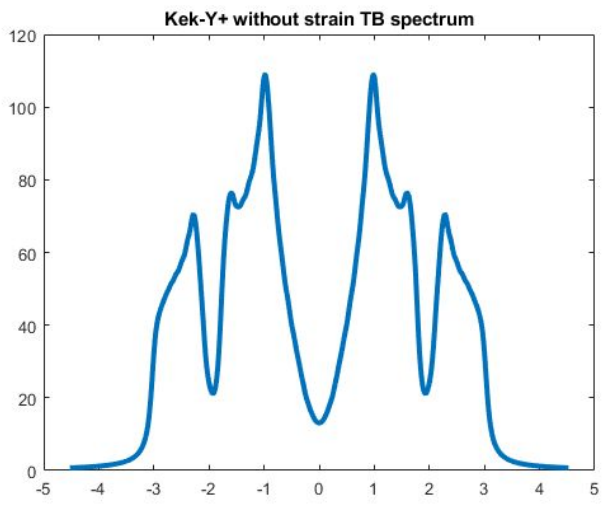
$$E_{\pm}^2 = v_0^2(1 \pm \Delta_0)^2|\boldsymbol{p}|^2, \quad \text{for } |\nu| = 1,$$


0.3
0.2
0.1
0
−0.1
−0.2
−0.3
$E\ [t_0]$
Kek-O
Kek-Y
$\Delta_0 = 0.1$
−0.1
−0.05
0
0.05
0.1
$k\ \ [1/a_0]$

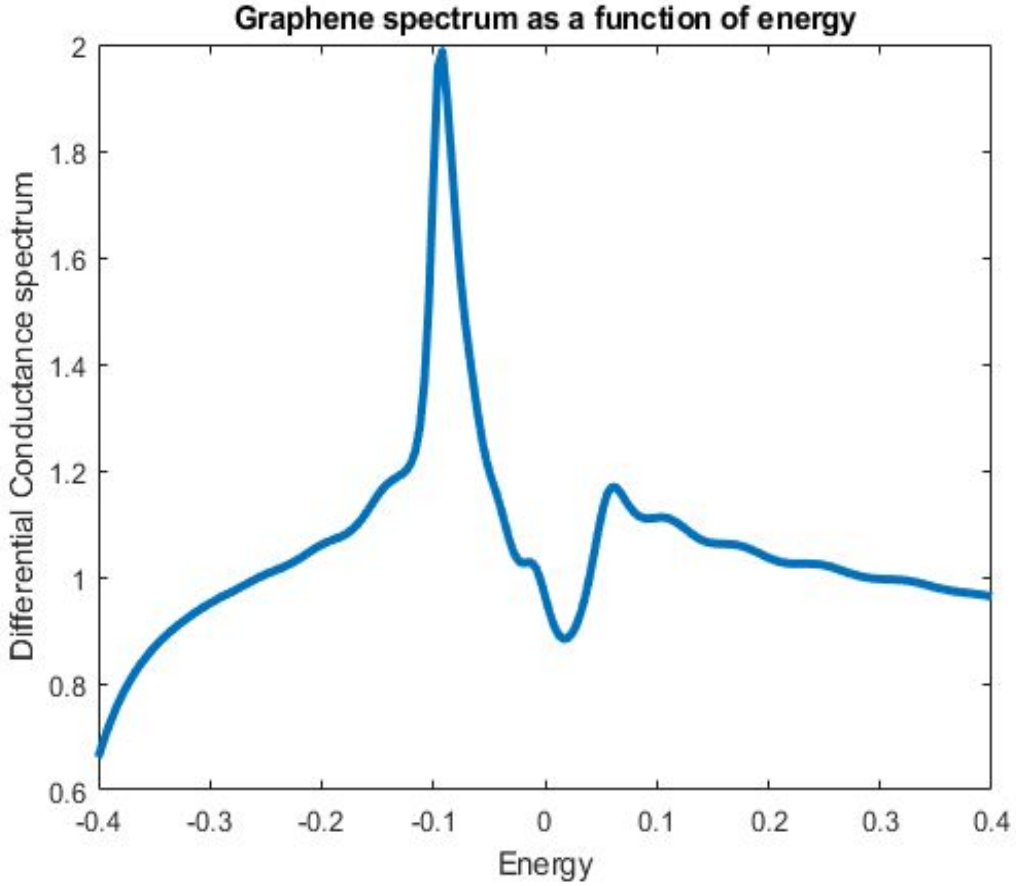
Tight Binding Simulations





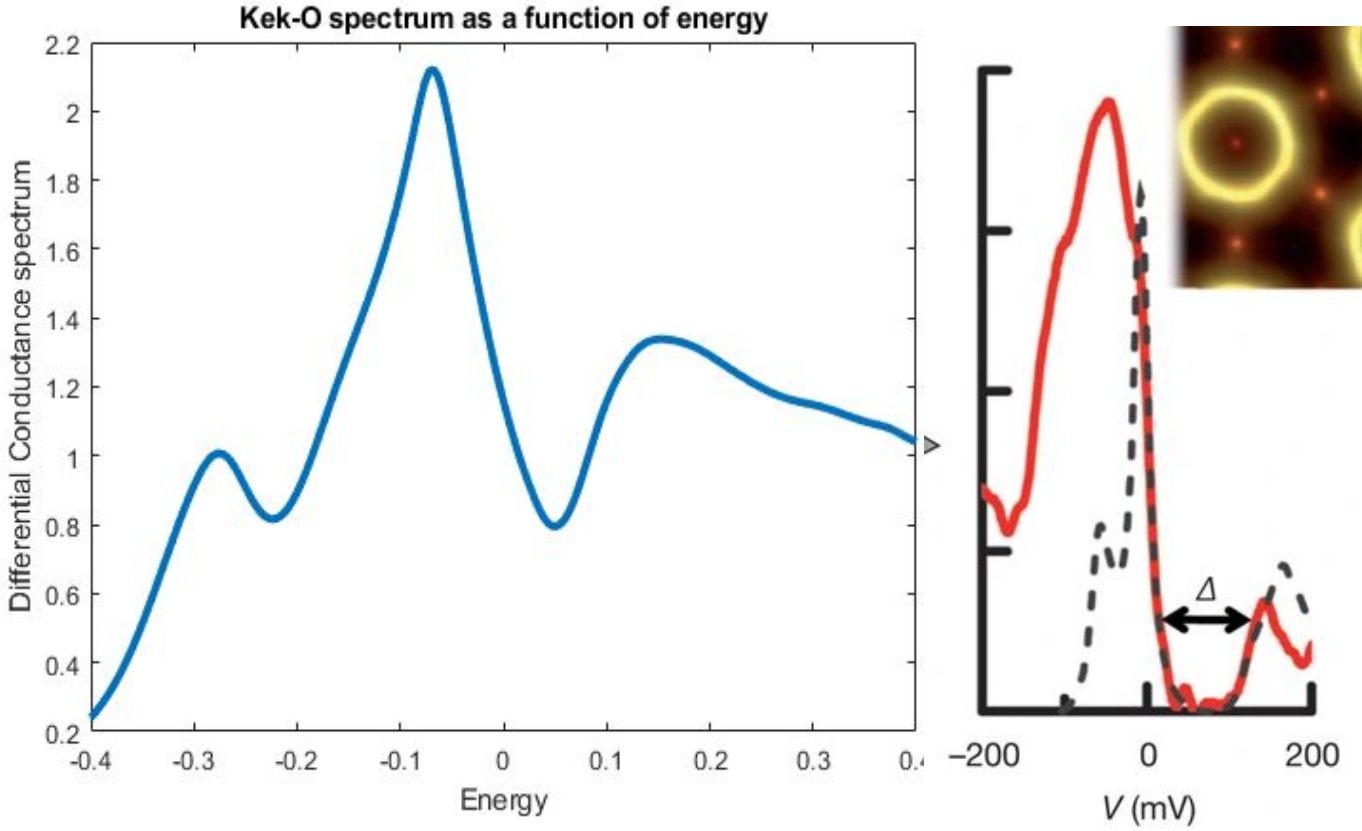


Scattering: Graphene



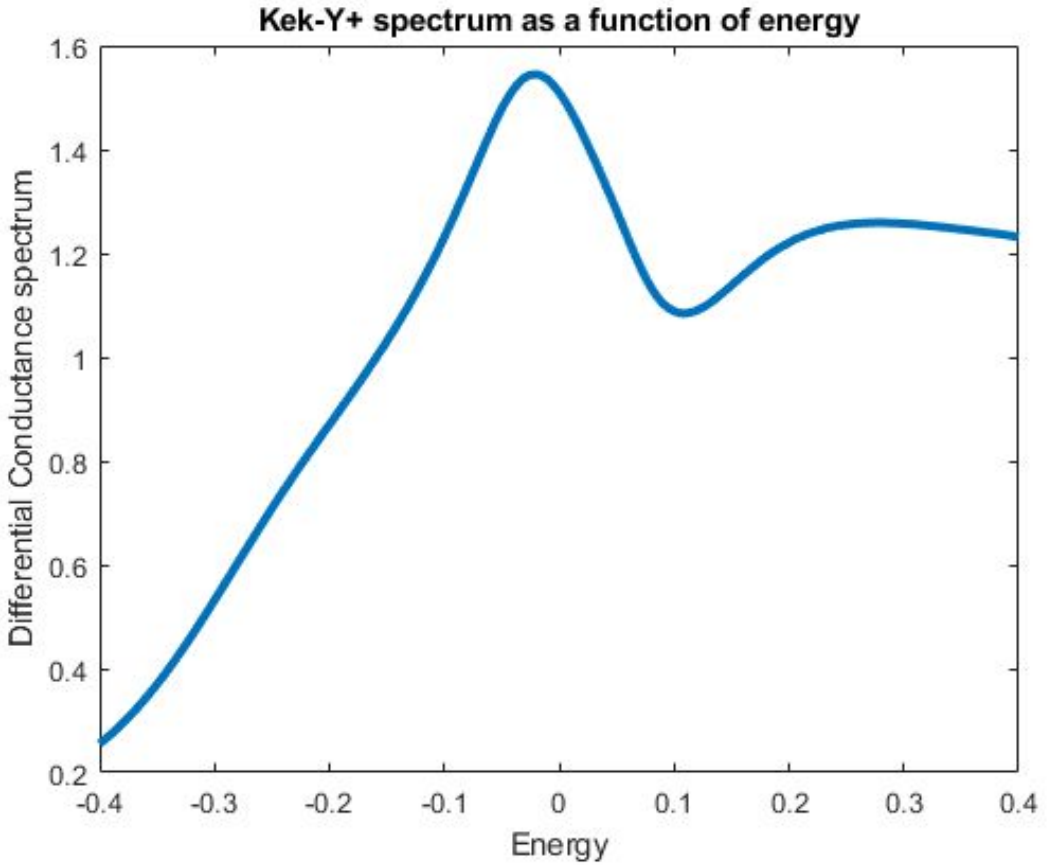
Scattering: Kek-O

- Dip in LDOS at Dirac point implies weak detuning, full gap not opened.
- Scattering approx might be further from TB than MOTA realization.



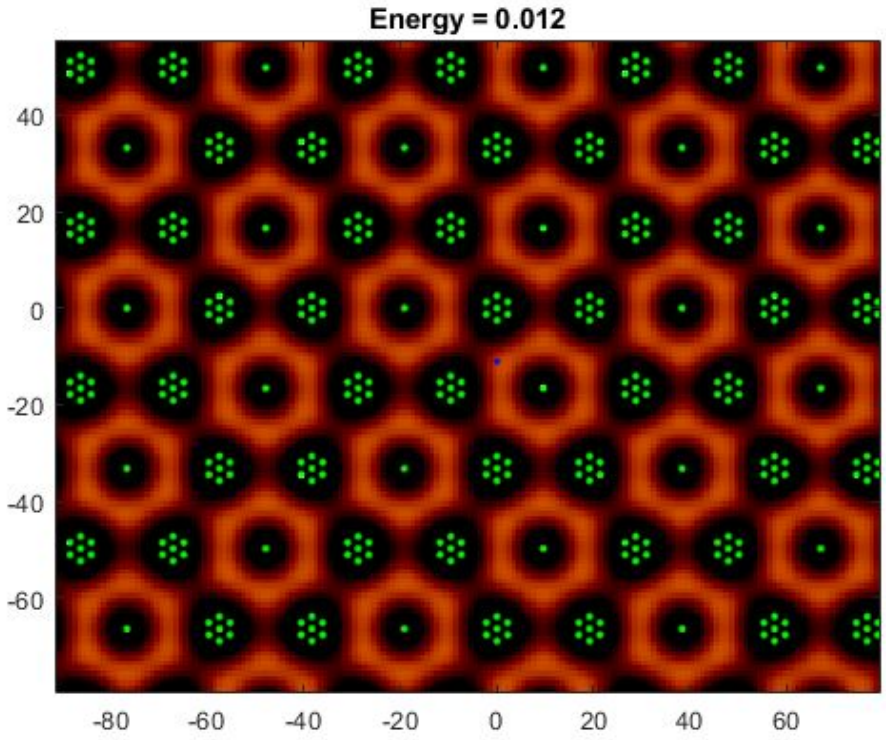
Scattering: Kek-Y

- Scattering model provides little info, could be weakness of CO lattice design.
- Differences between scattering and TB imply detuning magnitude is much smaller than bare hopping.

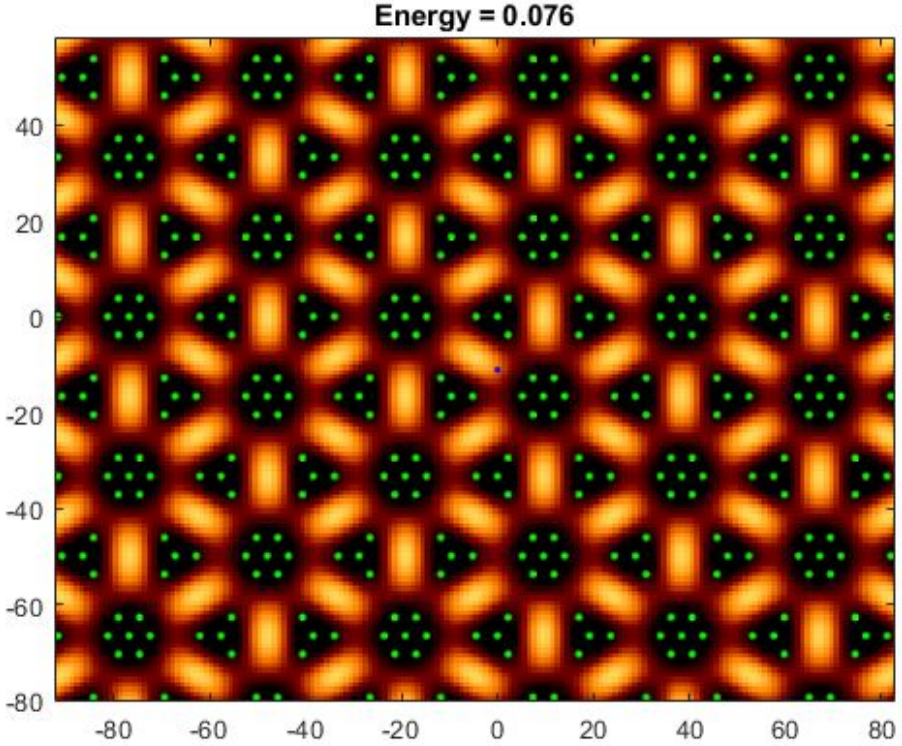


Real Space Examples

Kek-O

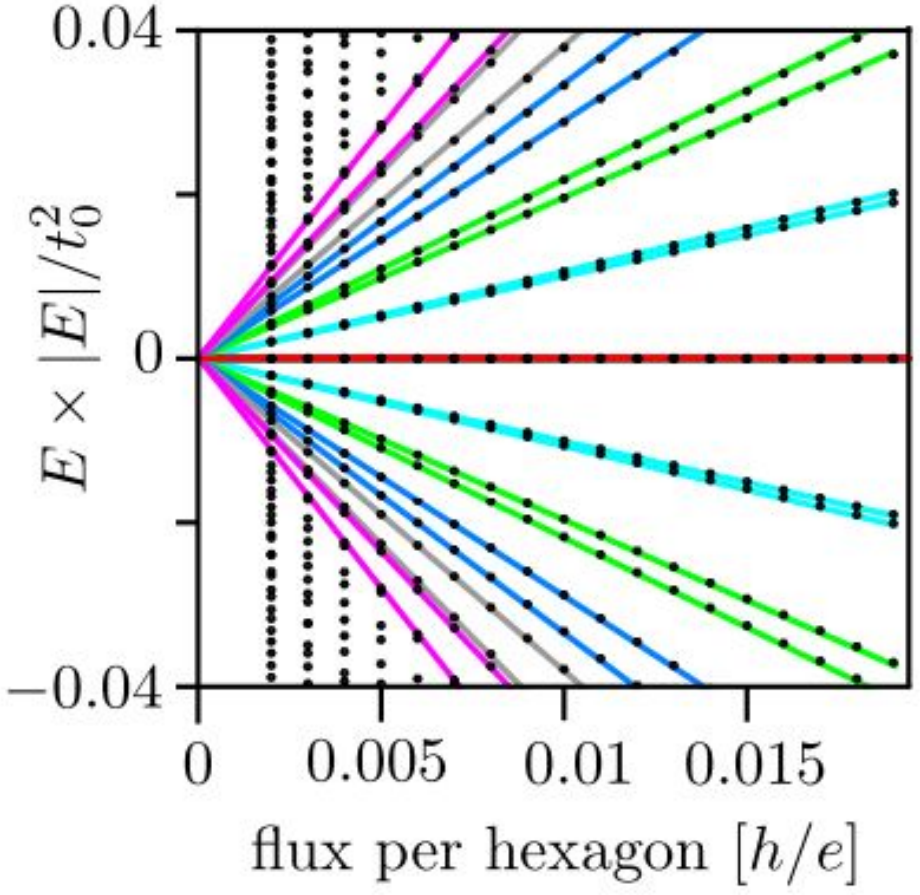


Kek-Y



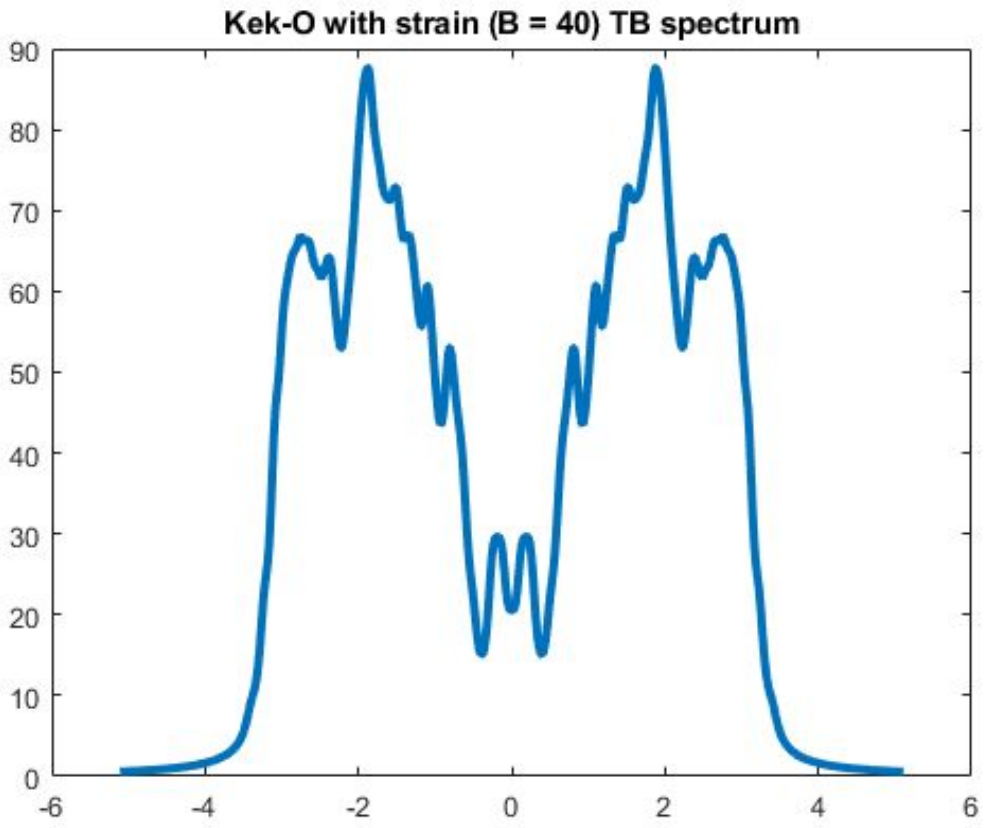
Strained Kekule: Theory

- Landau quantization is valley-degenerate in Graphene.
  - Distortions create splittings in some LLs but not others
- For Kek-Y, only LL0 remains degenerate.

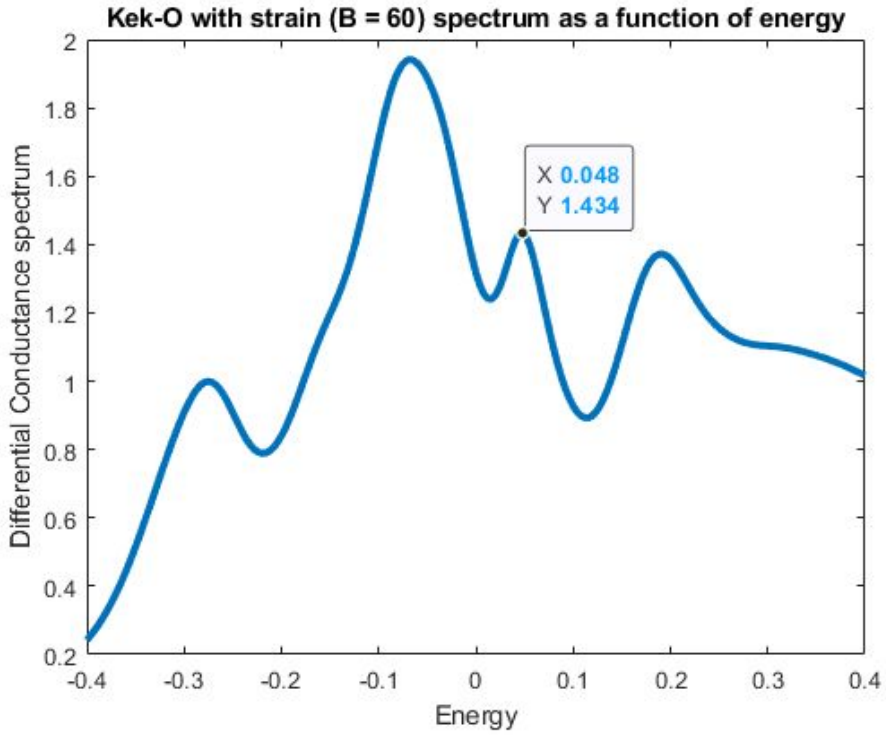


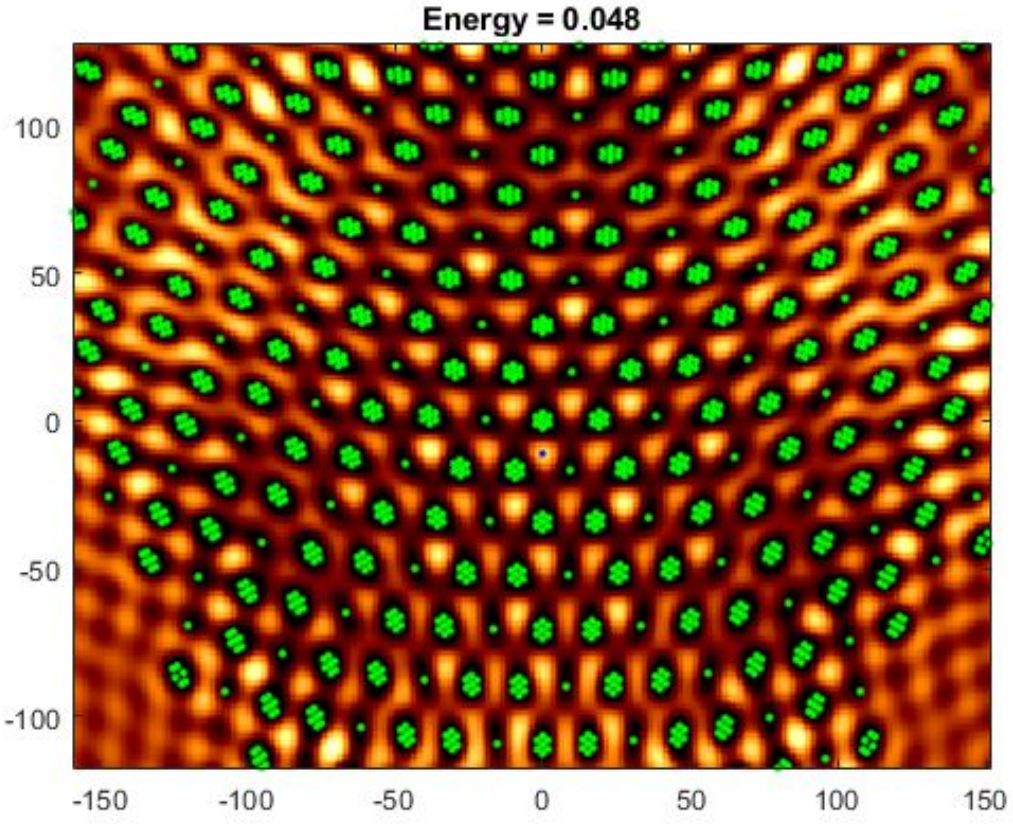
Strained Kekule: Theory

For Kek-O, situation is reversed. LL0 is split independent of magnetic field, but requires larger detuning than can be realized in scattering. (On the right, DeI = .25)

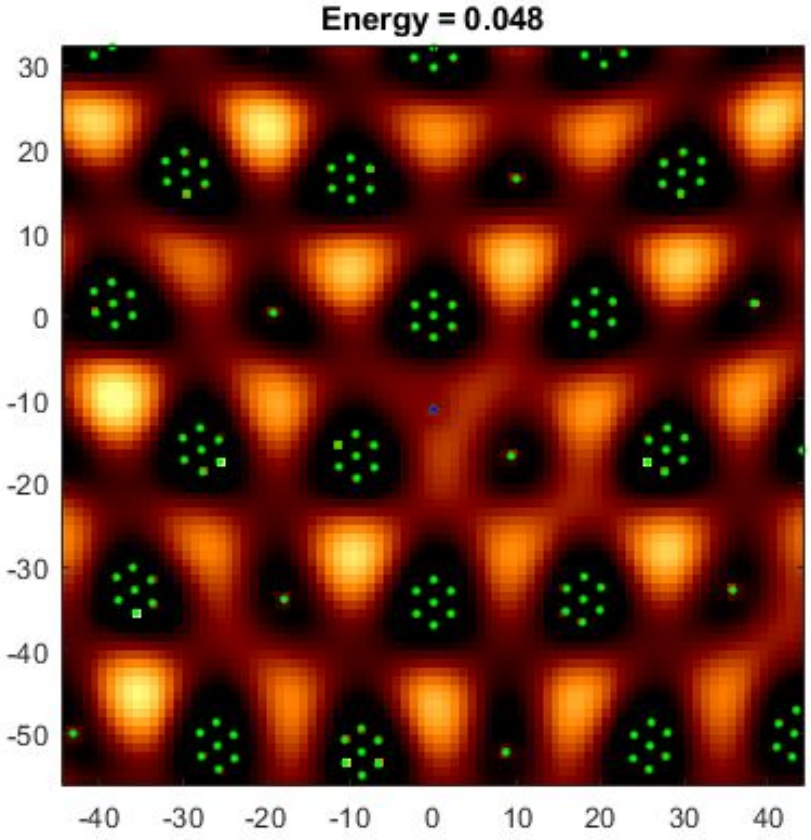


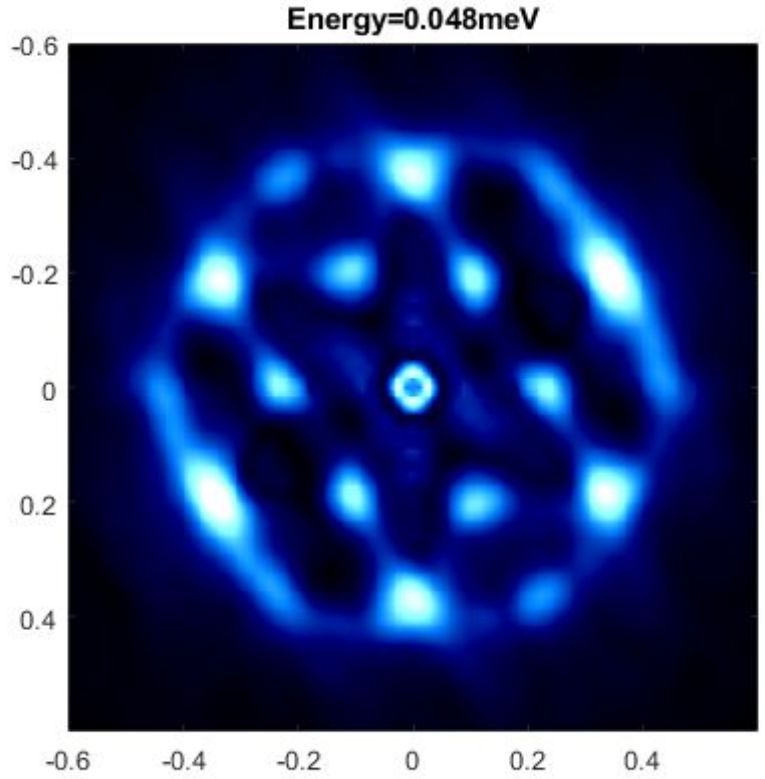
Strained Kek-O



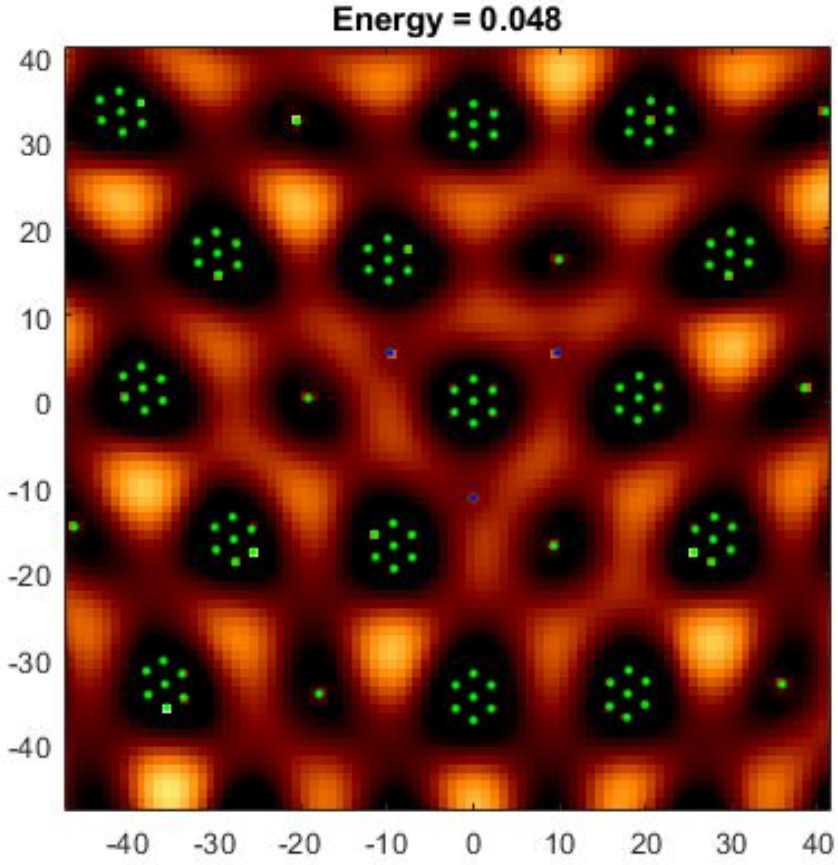


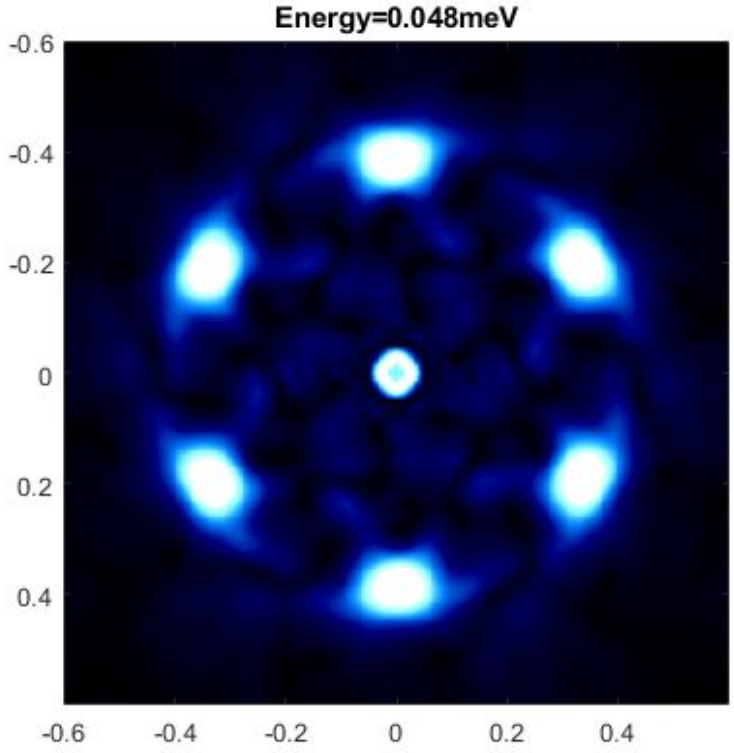
Strained Kek-O: QPI at LL0



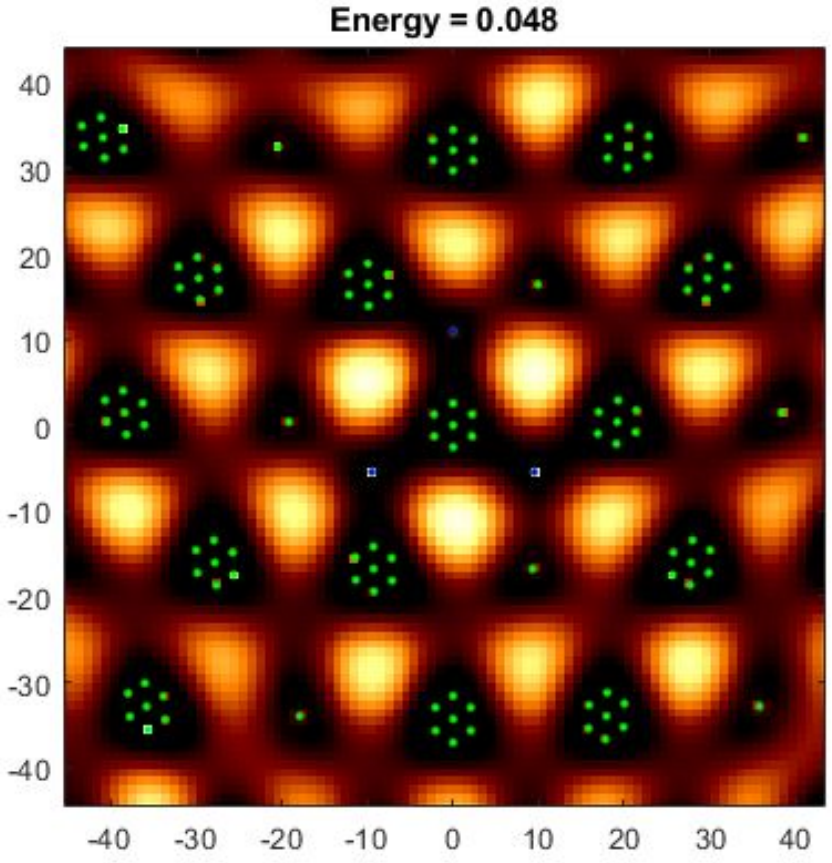


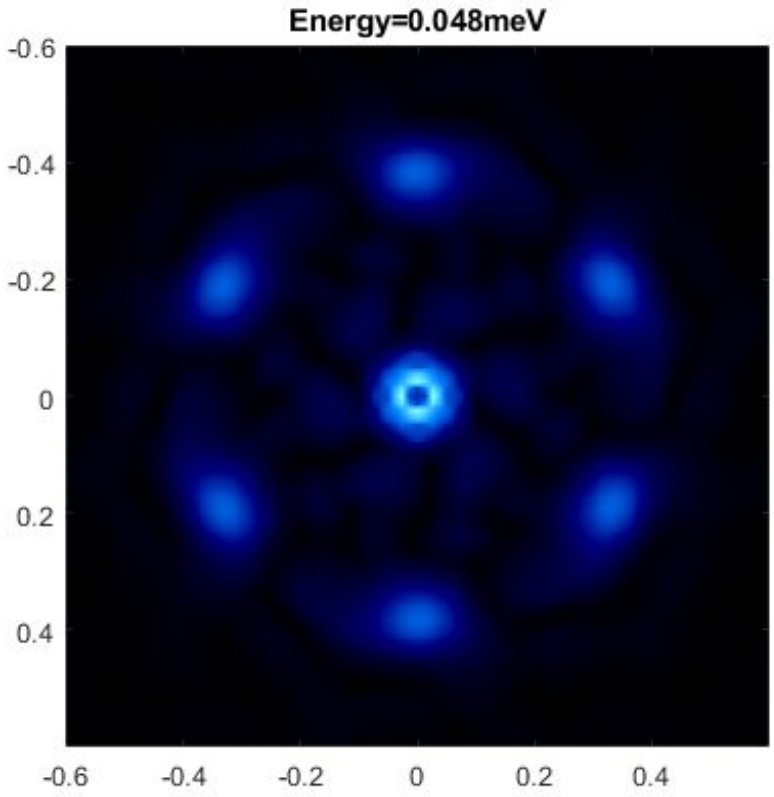
Strained Kek-O: QPI at LL0



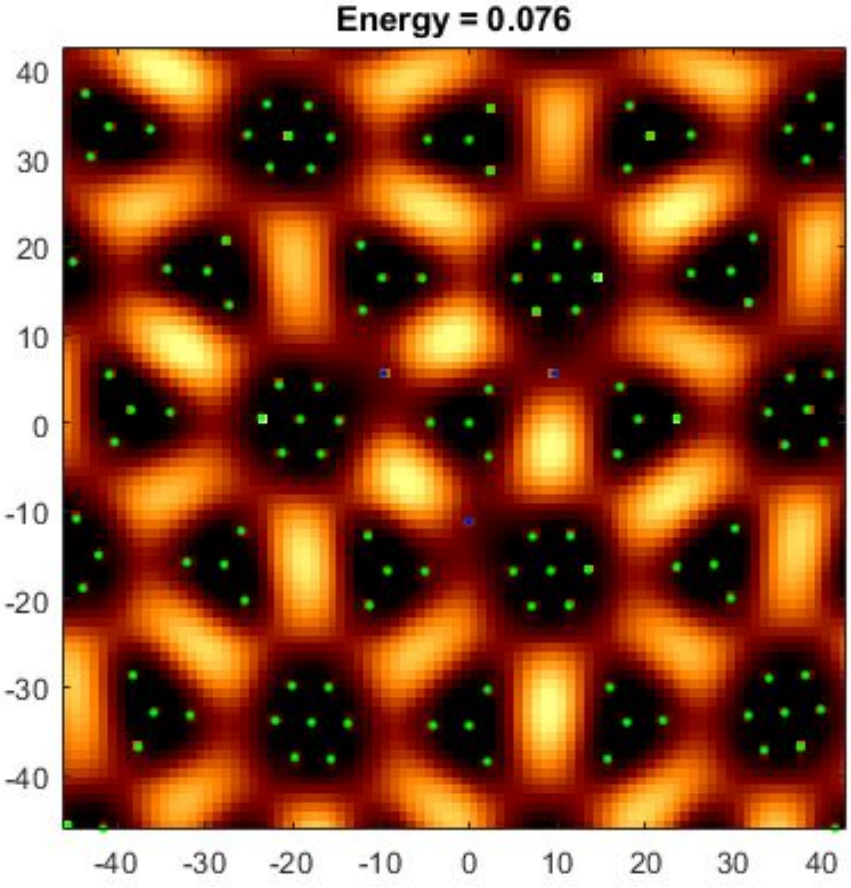


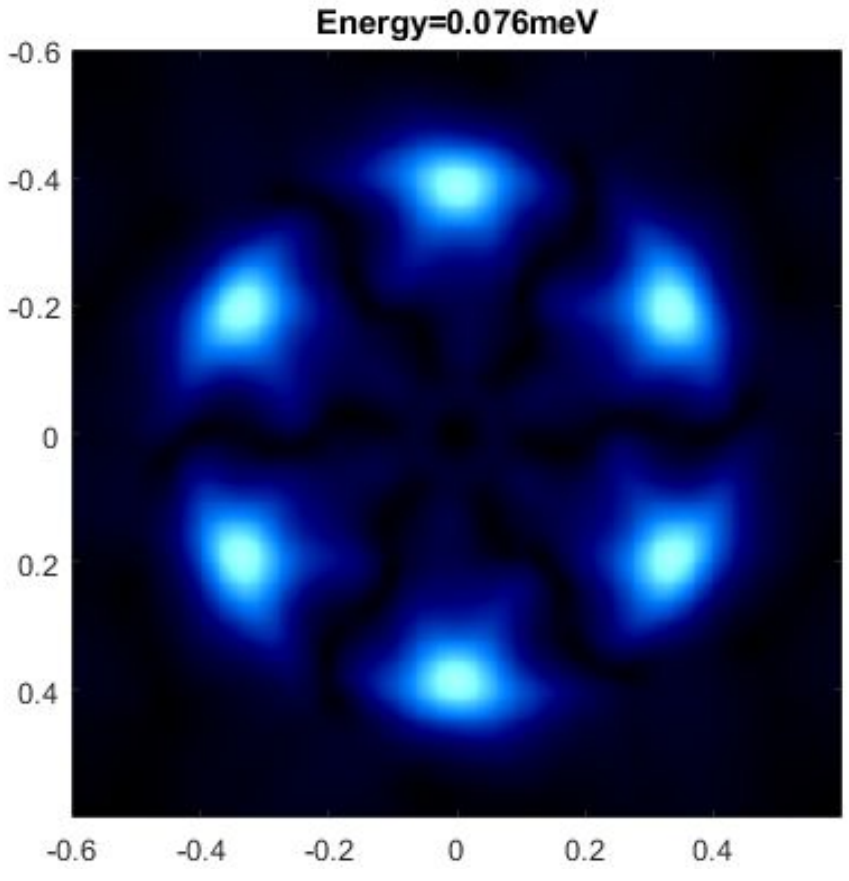
Strained Kek-O: QPI at LL0





Strained Kek-Y: QPI at LL0





Strained Kek-Y: QPI at LL0