Band Insulator to Mott insulator tuning a gate voltage

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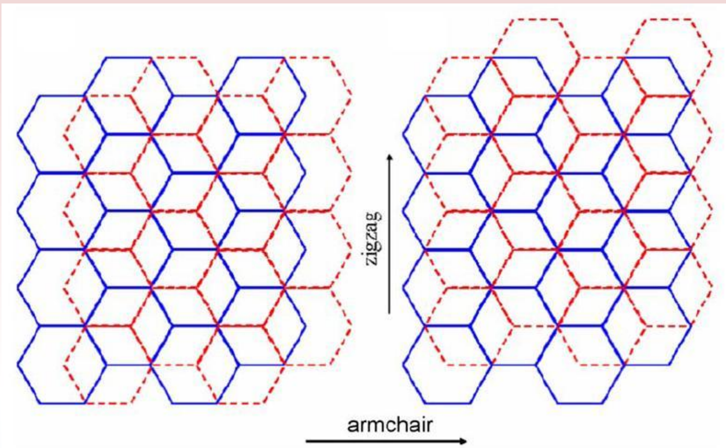
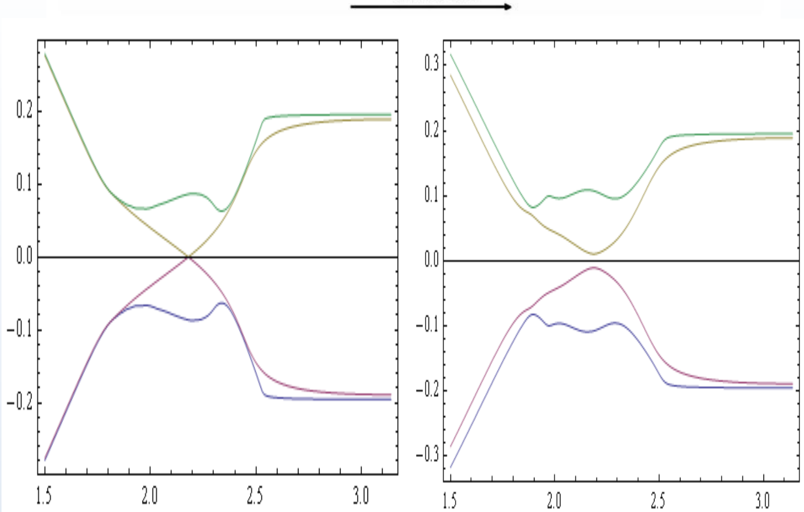
In a ribbon...

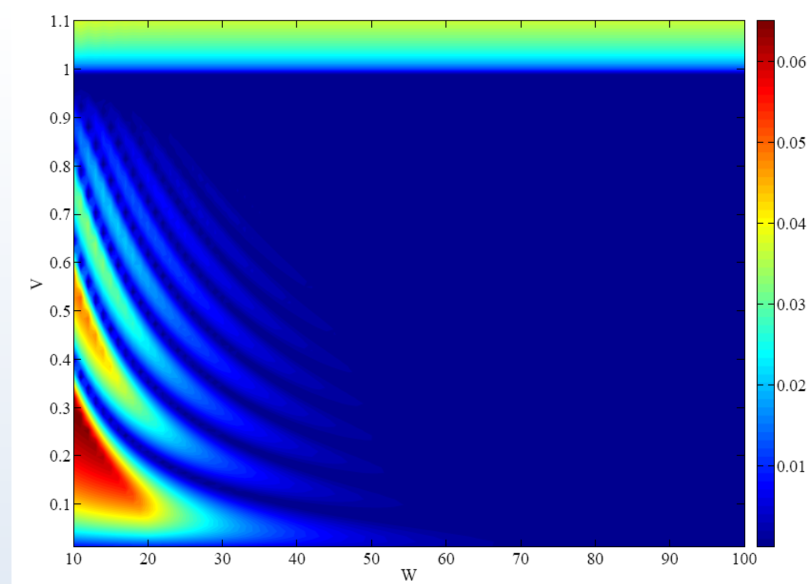
When a perpendicular electric field is applied, two of the bands become massive, with and the two other bands cross each other





Gap appears only for small values of width W (each edge "sees" the other)

THE RIBBON IS ALMOST METALLIC (WITHOUT INTERACTIONS)



The role of interactions

$$H = \sum_{\mu=\rho,\sigma} \int dx \frac{g_b}{2\pi^2\alpha^2} \cos\left(\sqrt{8}\Phi_\mu\right)$$

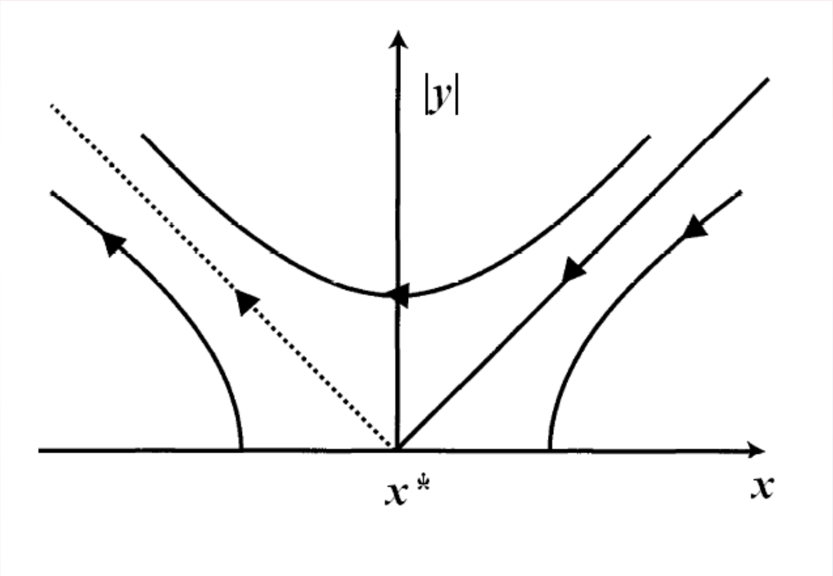
Standard One loop RG calculation

$$\frac{dx}{dl} = -y^2$$

$$\frac{dy}{dl} = -xy$$

$$K_\rho = \sqrt{\frac{1}{1+\frac{g}{\pi\hbar v_f}}}$$

$$K_\sigma = \sqrt{\frac{1}{1-\frac{g}{\pi\hbar v_f}}}$$



$$x_\mu = 2(K_\mu - 1)$$

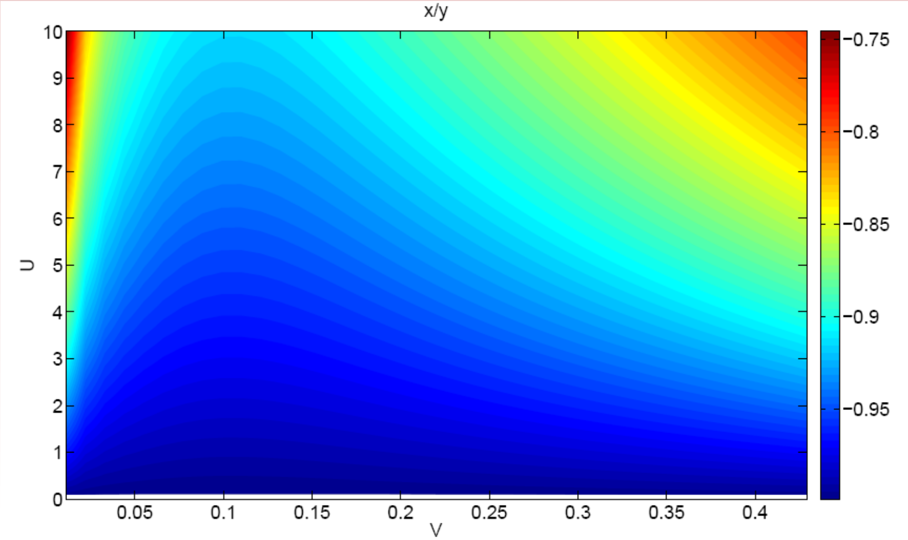
$$y = \frac{g_b}{\pi\hbar v_\mu}$$

$$v_\rho = \sqrt{\left(v_F + \frac{g_f}{2\pi\hbar}\right)^2 - \left(\frac{g_b}{2\pi\hbar}\right)^2}$$

$$v_\sigma = \sqrt{\left(v_F - \frac{g_f}{2\pi\hbar}\right)^2 - \left(\frac{g_b}{2\pi\hbar}\right)^2}$$

Spin-charge separation: Spin
And charge have different
Velocities and K parameters

The role of interactions



The ratio x/y is always smaller than 1, but pretty near to 1!!
We are in the region $|x|=y$

$$\Delta_\mu = \frac{V v_\mu}{2 v_F} e^{-\frac{\pi \hbar v_F}{g}}$$

We have estimated the UV cutoff as $\Lambda \approx \frac{V}{\hbar v_F}$

For g>0 (repulsive interactions) the spin sector remains gapless, but the charge sector gets a gap
The matrix elements do not depend on the width of the ribbons, simply because the edge states do not overlap, so g only depends on U and V