Topological Proximity Effect in Layer Systems

CPhT PhD Day 2018

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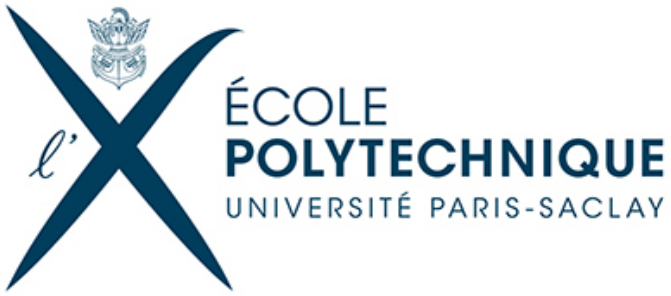
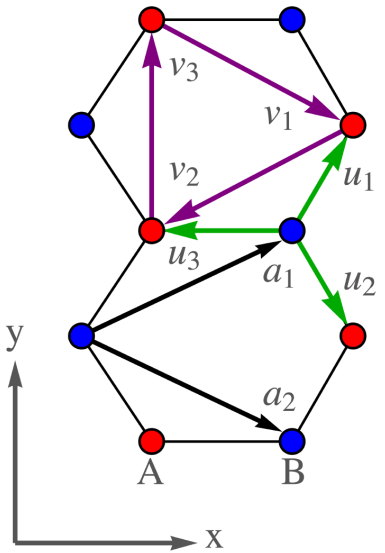


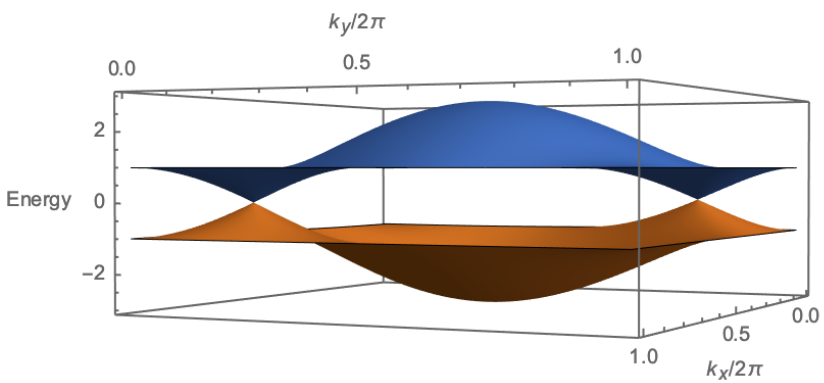
Haldane's graphene model

Haldane model

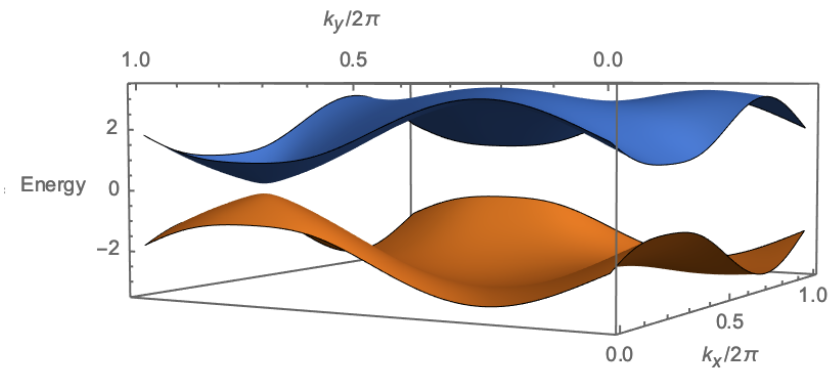
$$\mathcal{H}_0 = \sum_i (-1)^i M c_i^\dagger c_i - \sum_{<i,j>} t_1 c_i^\dagger c_j - \sum_{\ll i,j \gg} t_2 e^{i\phi_{ij}} c_i^\dagger c_j$$

F. D. M. Haldane, Phys. Rev. Lett. **61**, 2015 (1988)





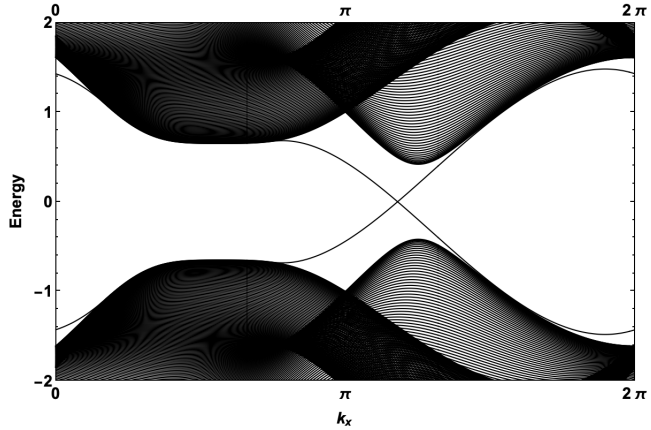
graphene



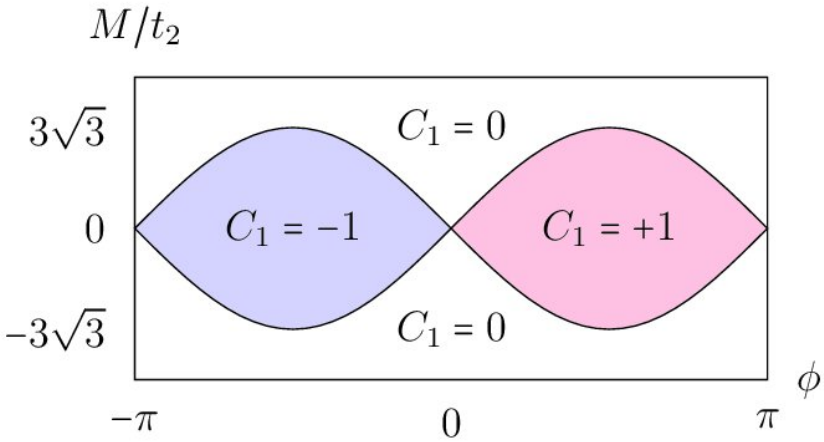
Haldane model

Haldane's graphene model

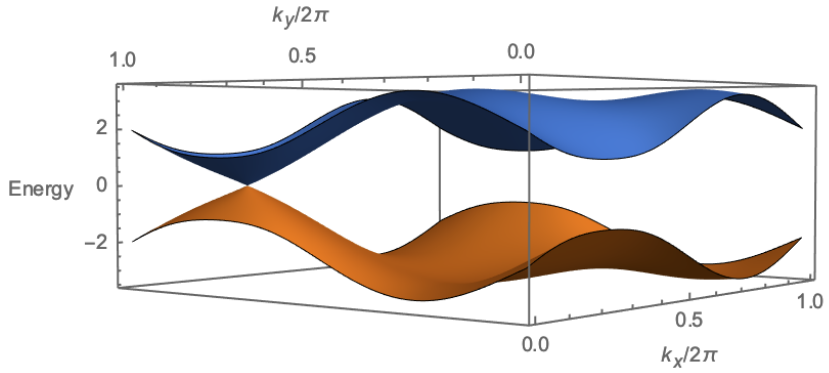
- bulk completely gapped for $M < 3\sqrt{3}t_2 \sin\phi$
- gap closing at $M = 3\sqrt{3}t_2 \sin\phi$
- *Chern insulator*: $C_1 = \pm 1$



Haldane model edge spectrum



Haldane model phase diagram



band spectrum at phase transition

Haldane-Graphene bilayer

Cheng, Klein (EP), Plekhanov (EP, Basel), Sengstock, Weitenberg (Hamburg), Le Hur (EP)

- consider two layer system:

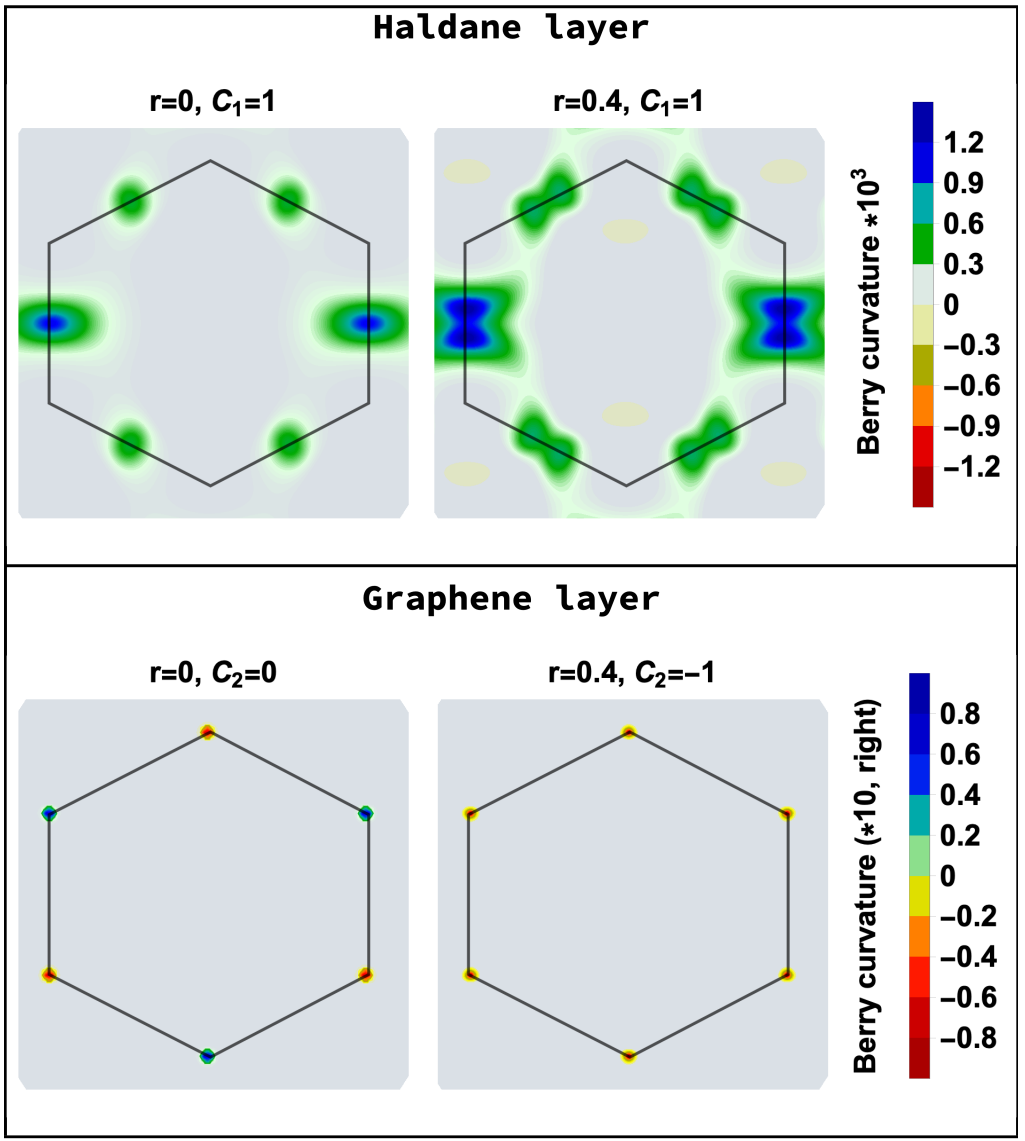
$$H = H_h + H_g + H_r$$

- graphene layer acquires non trivial topology, induced by Haldane layer

$$r = 0: \quad C_i = (1, 0, 0, -1)$$
$$r \neq 0: \quad C_i = (1, -1, 1, -1)$$

- note:

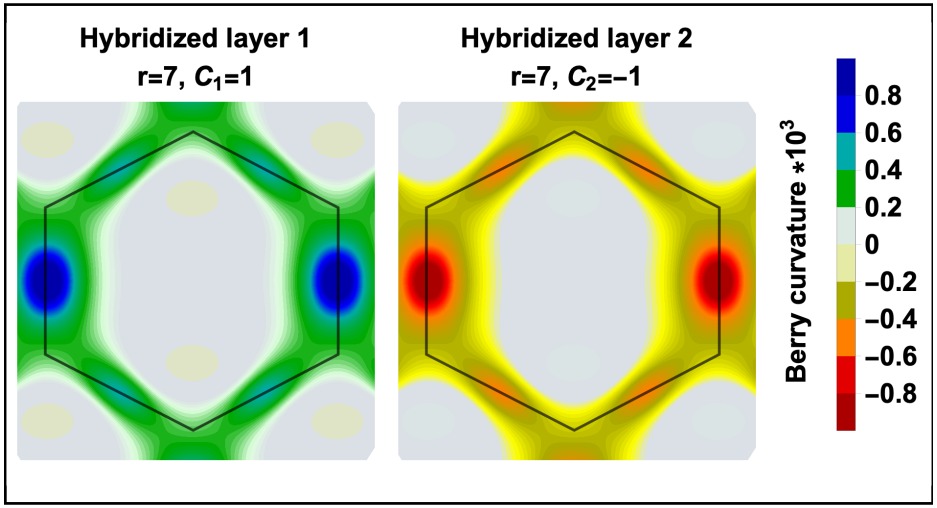
$$r \neq 0: \quad C_1 + C_2 = 0$$



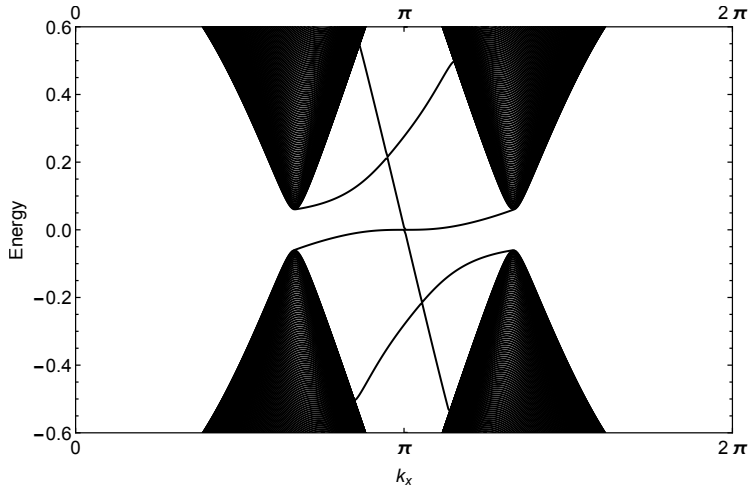
Haldane-Graphene bilayer

Cheng, Klein (EP), Plekhanov (EP, Basel), Sengstock, Weitenberg (Hamburg), Le Hur (EP)

- for large r, Berry curvature maps resemble each other
- suppress tunneling r at one edge
  $\rightarrow$ Kane-Mele like model but not $\mathbb{Z}_2$
  $\rightarrow$ counter-propagading but different velocities



Berry curvature at large r



suppressed r at one edge