Diffusion at the surface of Topological Insulators

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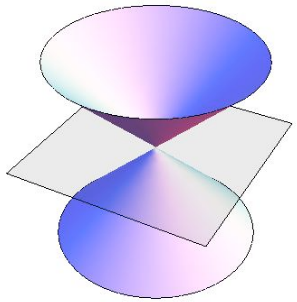
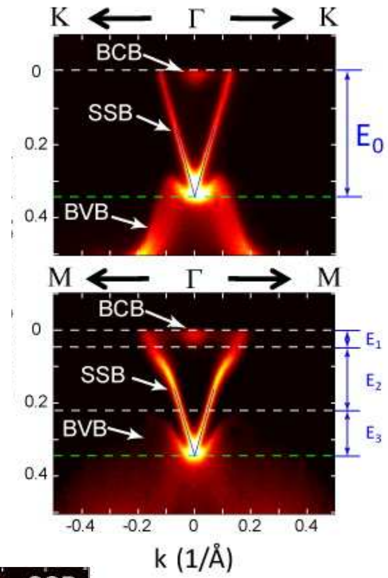
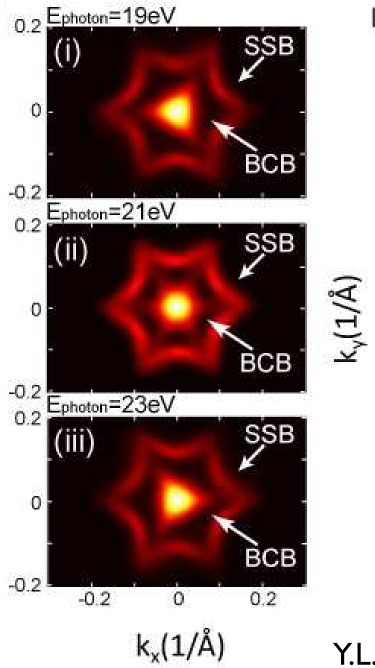
Topological insulators surface states

- Robust characteristic surface states : Dirac fermions





- ARPES experiments : richer structure, hexagonal shape of the Fermi surface

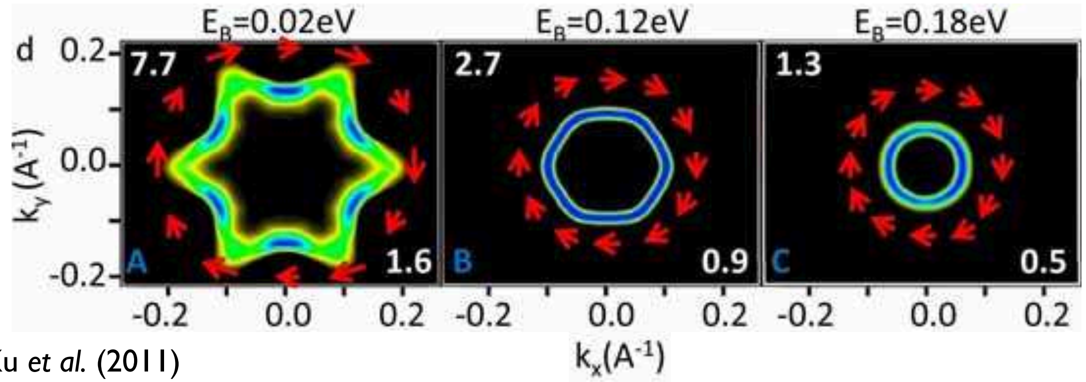


→ Transport of these surface states

Y.L. Chen et al. , 2009

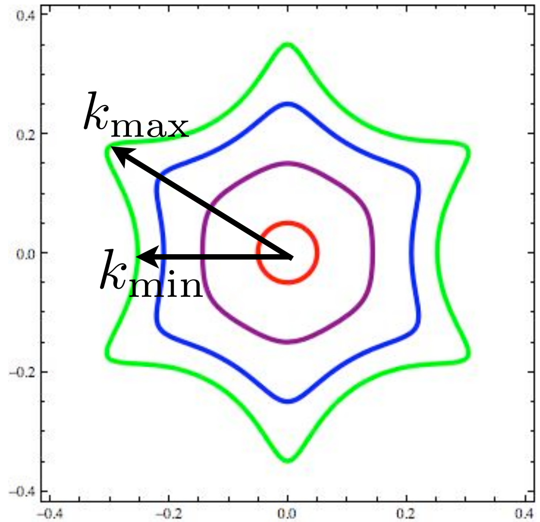
Characterization of hexagonal warping

- Fermi surface deformation



S.Y. Xu *et al.* (2011)

Different energies Fermi surfaces

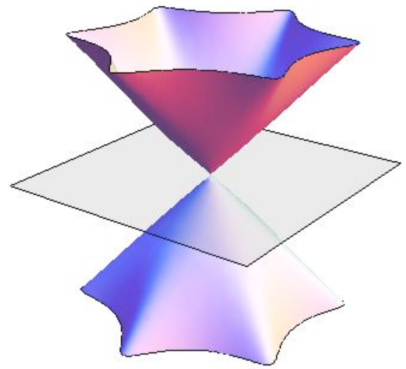


- Warping hamiltonian

$$\mathcal{H} = \hbar v_F \vec{\sigma}.\vec{k} + \frac{\lambda}{2}(k_+^3 + k_-^3)\sigma^z + V(\vec{r})$$

(L. Fu, 2009)

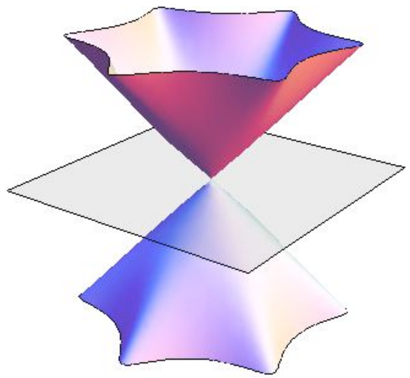
$$w = w_{\max}\frac{k_{\max} - k_{\min}}{k_{\max} + k_{\min}} \quad ; \quad b = \frac{w(w + w_{\max})^2}{2(w_{\max} - w)^3},$$



Regime of diffusive transport

- Experimental regime : far from the Dirac point
- Sample length >> mean free path
- Semi classical approach, $k_f l_e \gg 1$

  - Boltzmann equation
  - Diagrammatics



Boltzmann approach

- Density of states : $f(\vec{k})$
- Scattering probability :$|\langle \vec{k'}|V|\vec{k}\rangle|^2 = g_{\vec{k}}(\theta)$

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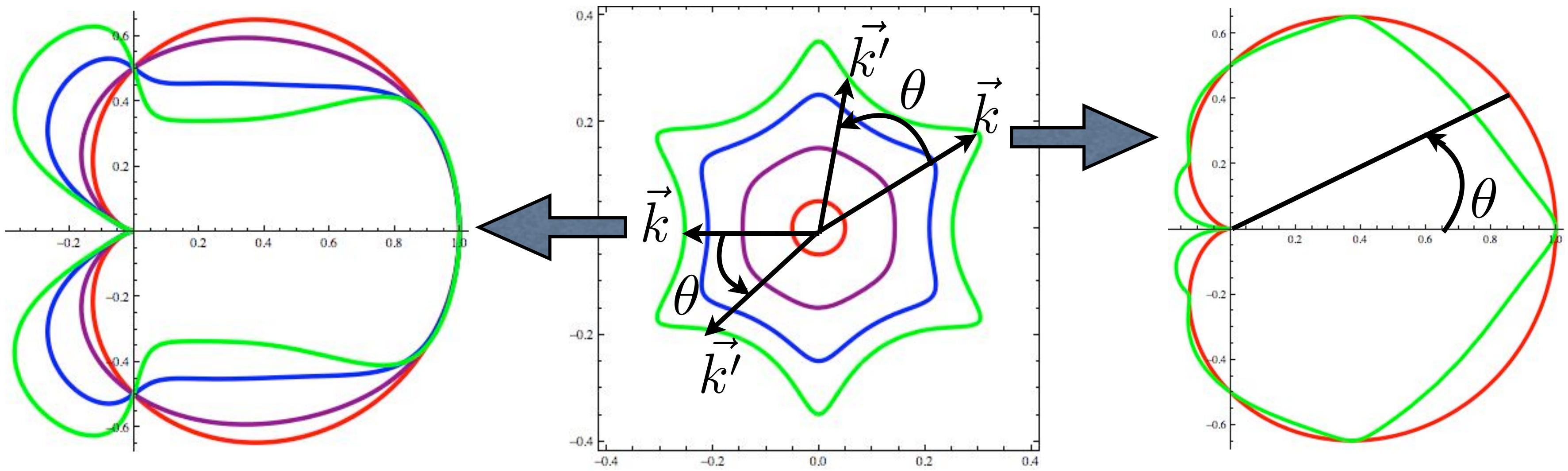
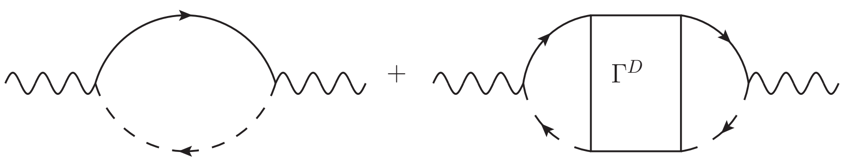
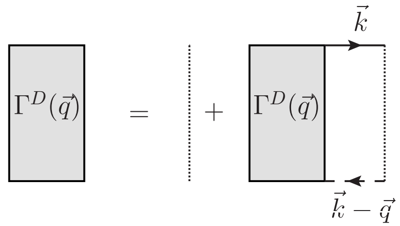


<u>Perturbative result</u> $\sigma = \frac{e^2}{h}\frac{2\hbar^2 v_F^2}{\gamma}(1 + 8b^2 - 58b^4 + o(b^4))$

Non perturbative diagrammatics

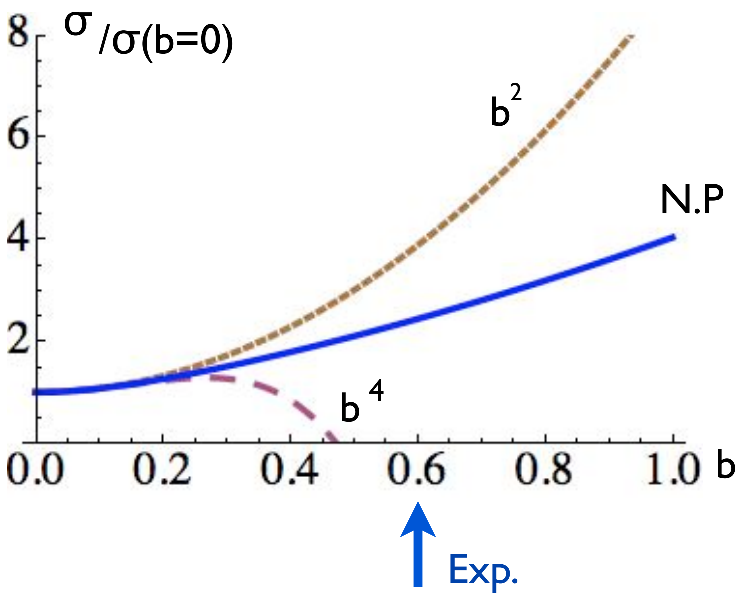
- Kubo formula + weak disorder diagrammatics

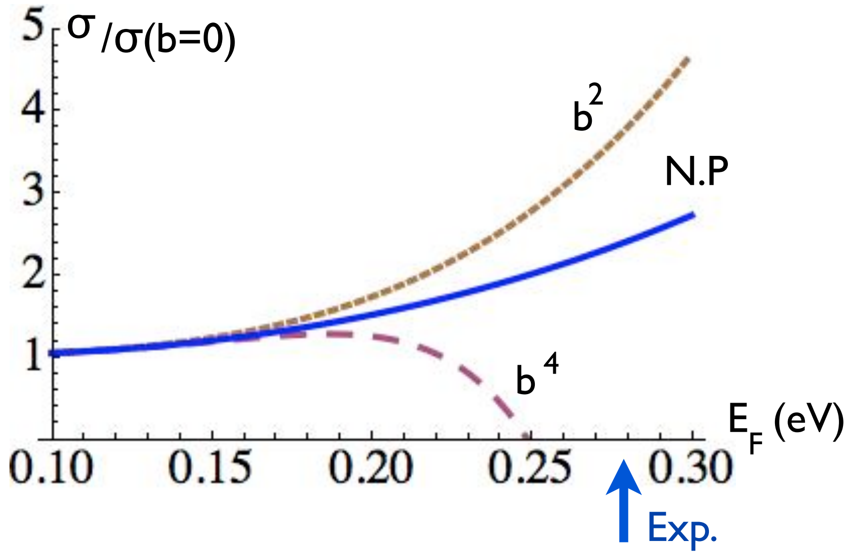




(G.Montambaux and E.Ackermans, *Mesoscopic physics of electrons and photons*)

- <u>Results non perturbative in warping</u>

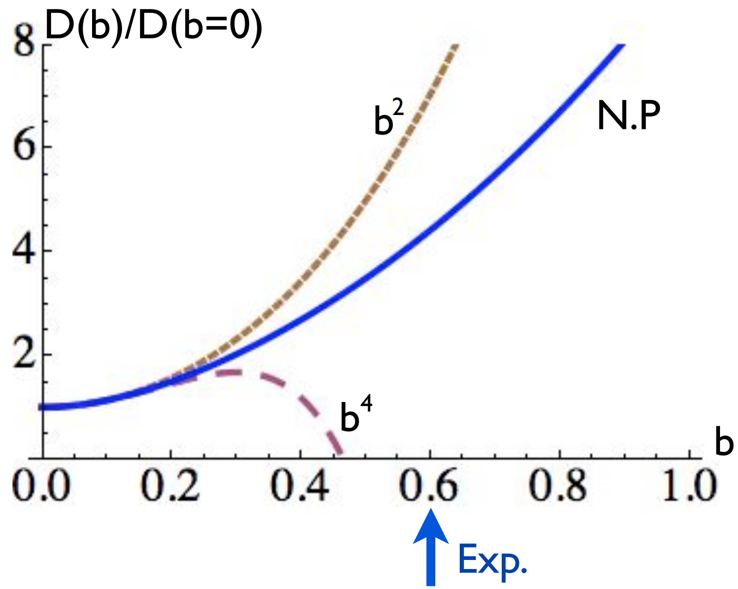




Coherent regime

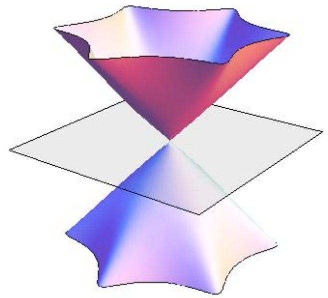
- $L \sim l_\phi$
- Symplectic class (same as electrons in random SO)
- Quantum correction to conductivity $\langle \delta\sigma \rangle$ and conductance fluctuations $\langle \delta\sigma^2 \rangle$ only paramaterized by D

➡ Non perturbative in warping result



Conclusion

- Hexagonal warping crucial for transport properties



- Conductance : non perturbative in warping