Zero-voltage conductance peak from weak antilocalization in a Majorana nanowire

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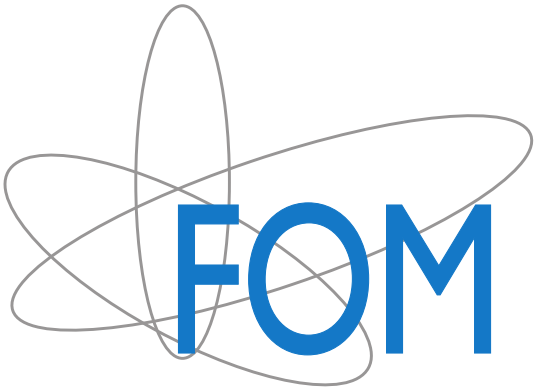
arXiv:1206.6687

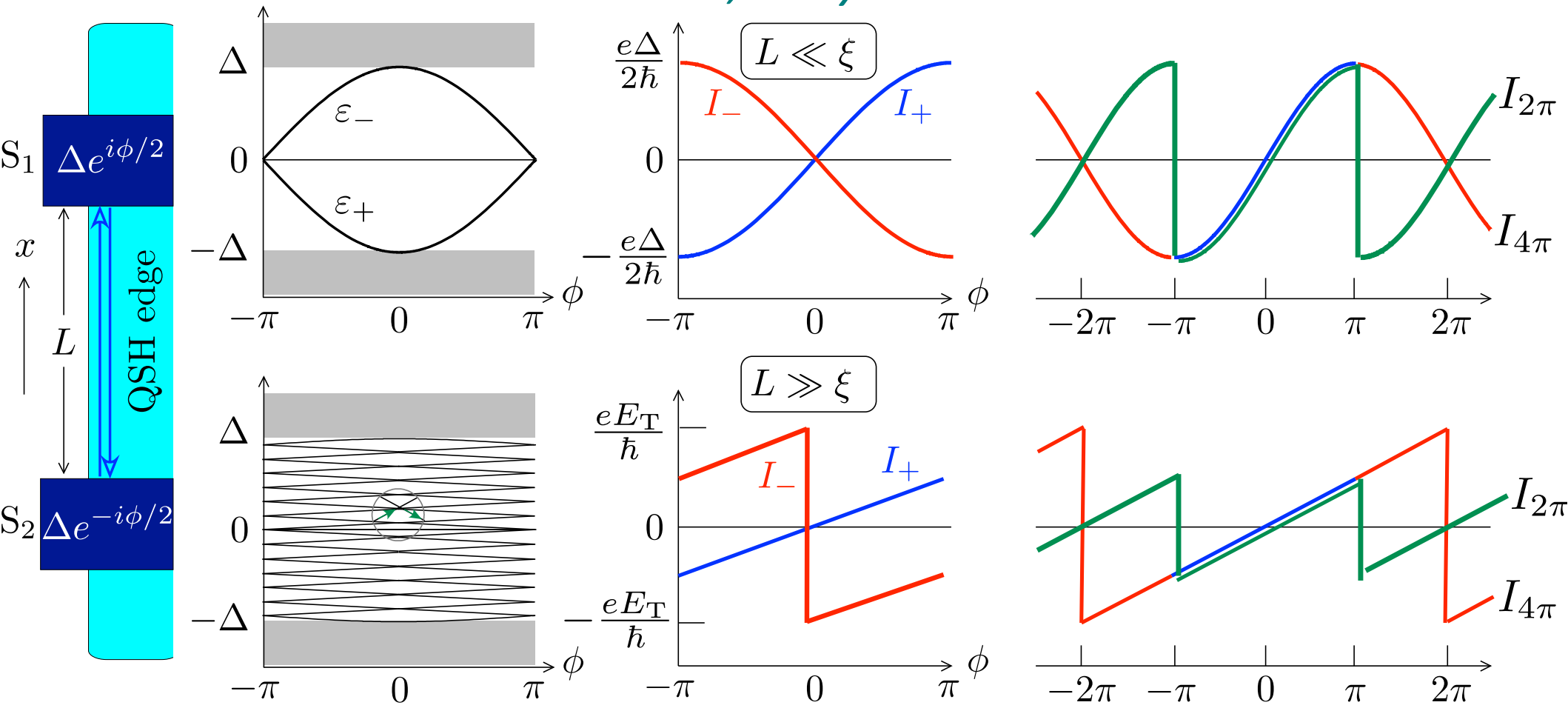


25.10.2012 Cargèse

Advertisement #1

Fermion-parity anomaly of the critical supercurrent in the quantum spin-Hall effect

With C.W.J. Beenakker, T. Hyart and J.P. Dahlhaus



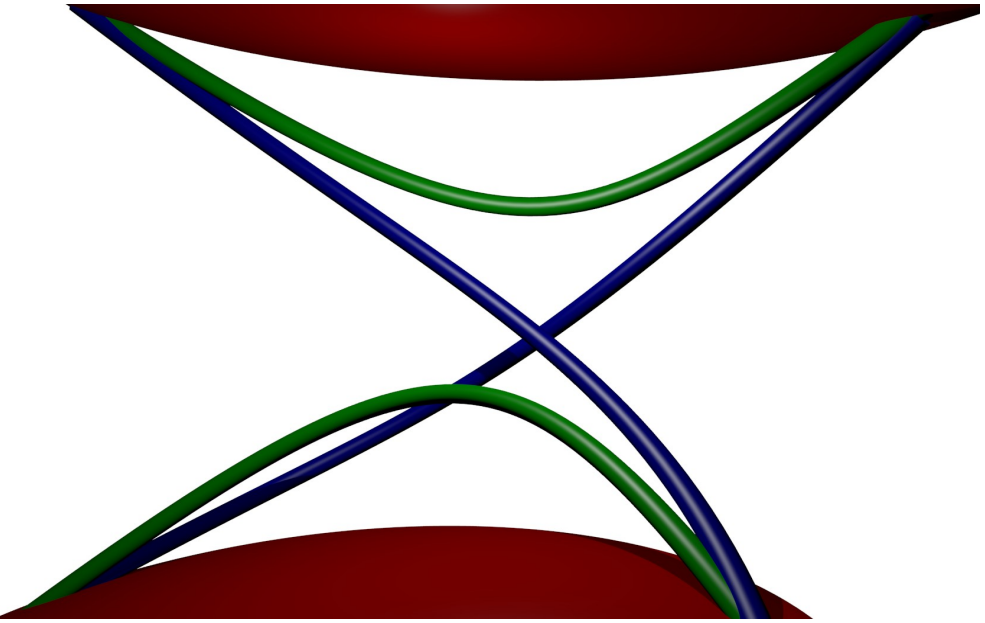
arXiv:1210.5412

Advertisement #2

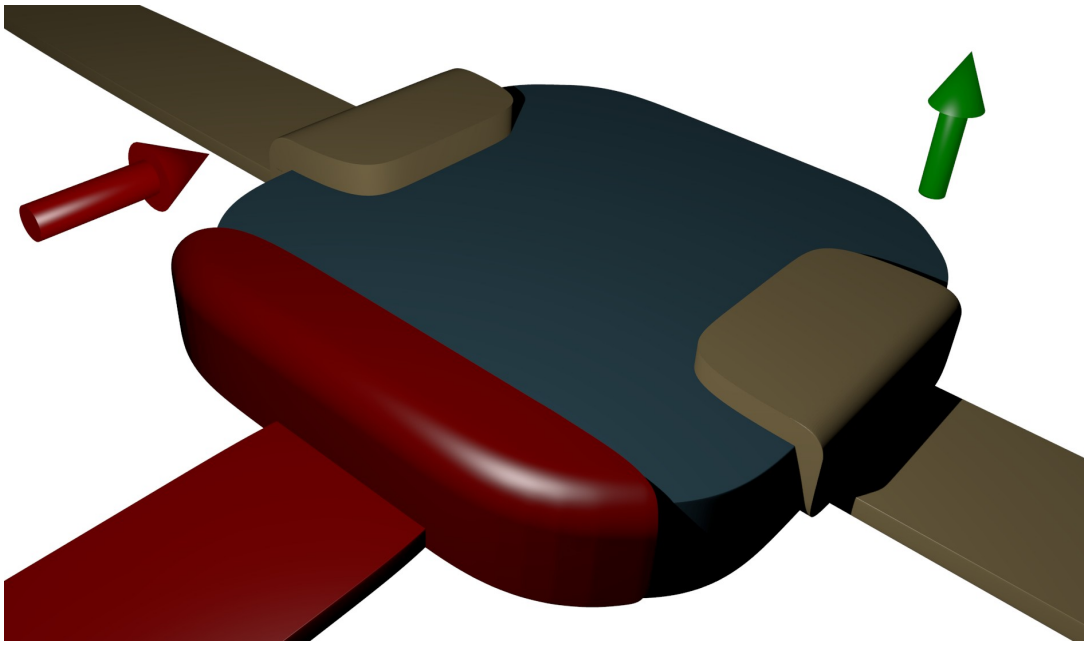
Topological transition due to dissipation in quantum spin Hall effect

With M.V. Medvedyeva and Yu.V. Nazarov

Poles of G



Realization in QSHE



Majorana Fermions

Talks of Panagiotis Kotetes and Mathias Diez

(just before this one)

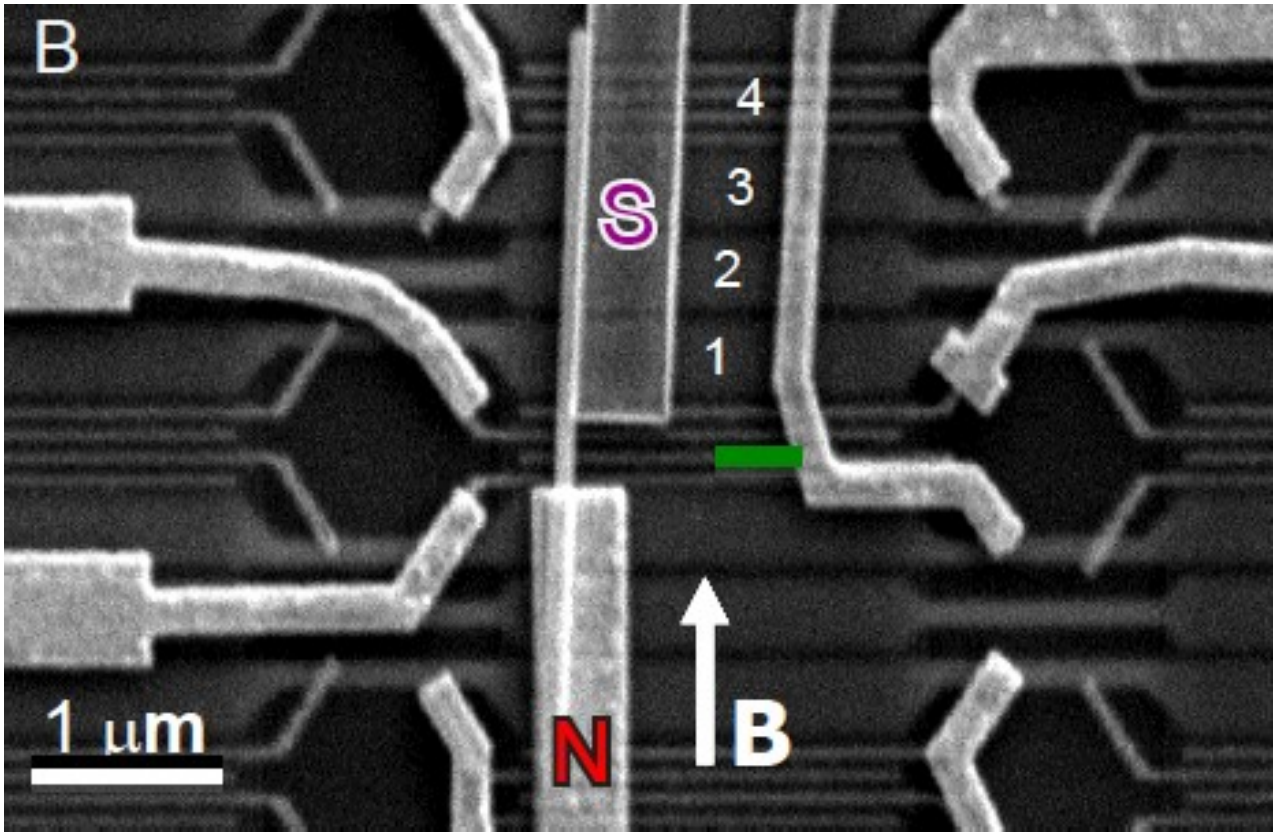
Most important:

- They arise on the edge on topological superconductor

Give rise to midgap differential conductance peak [Law, Lee, and Ng (2009), ...] => conductance peak as a signature of the Majorana bound state [Mourik et al., Deng et al., Das et el. (2012)]

Setup

[Mourik et al. (2012)]



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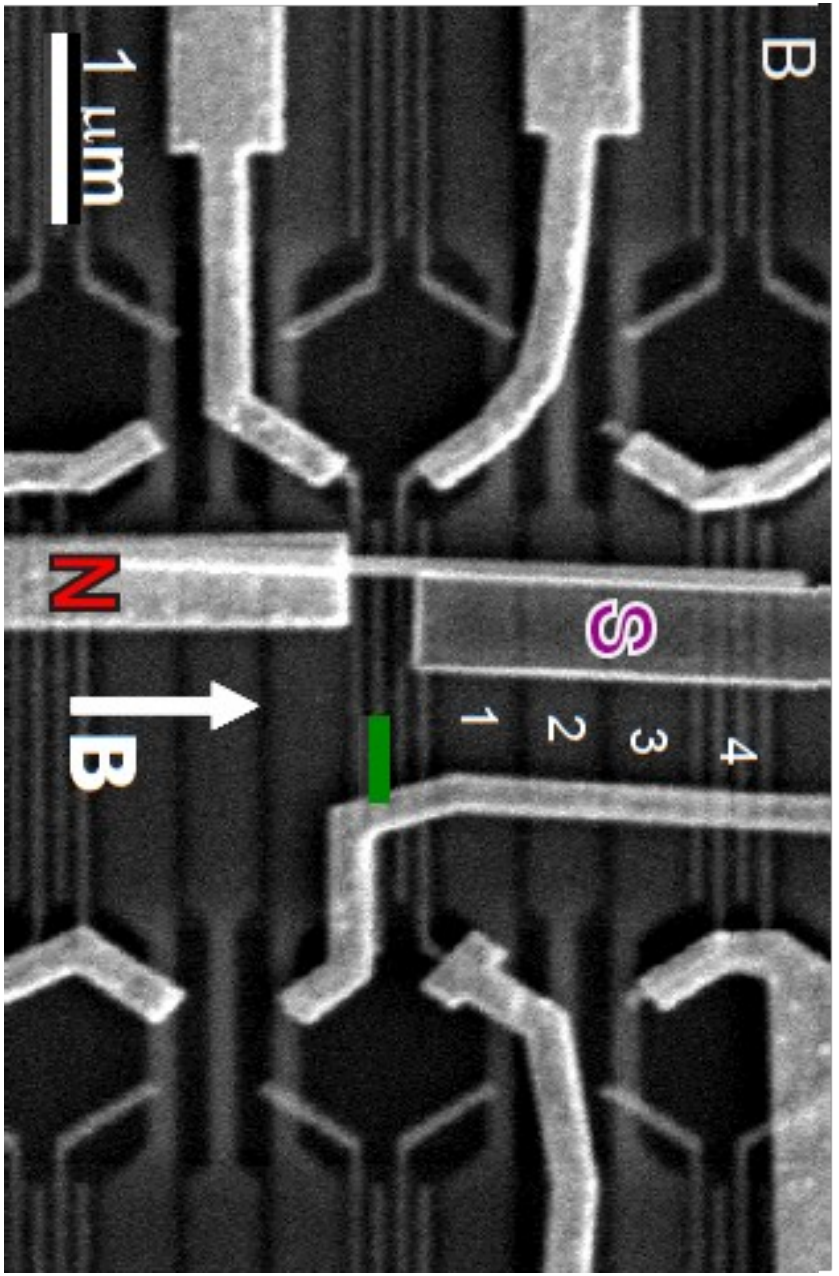

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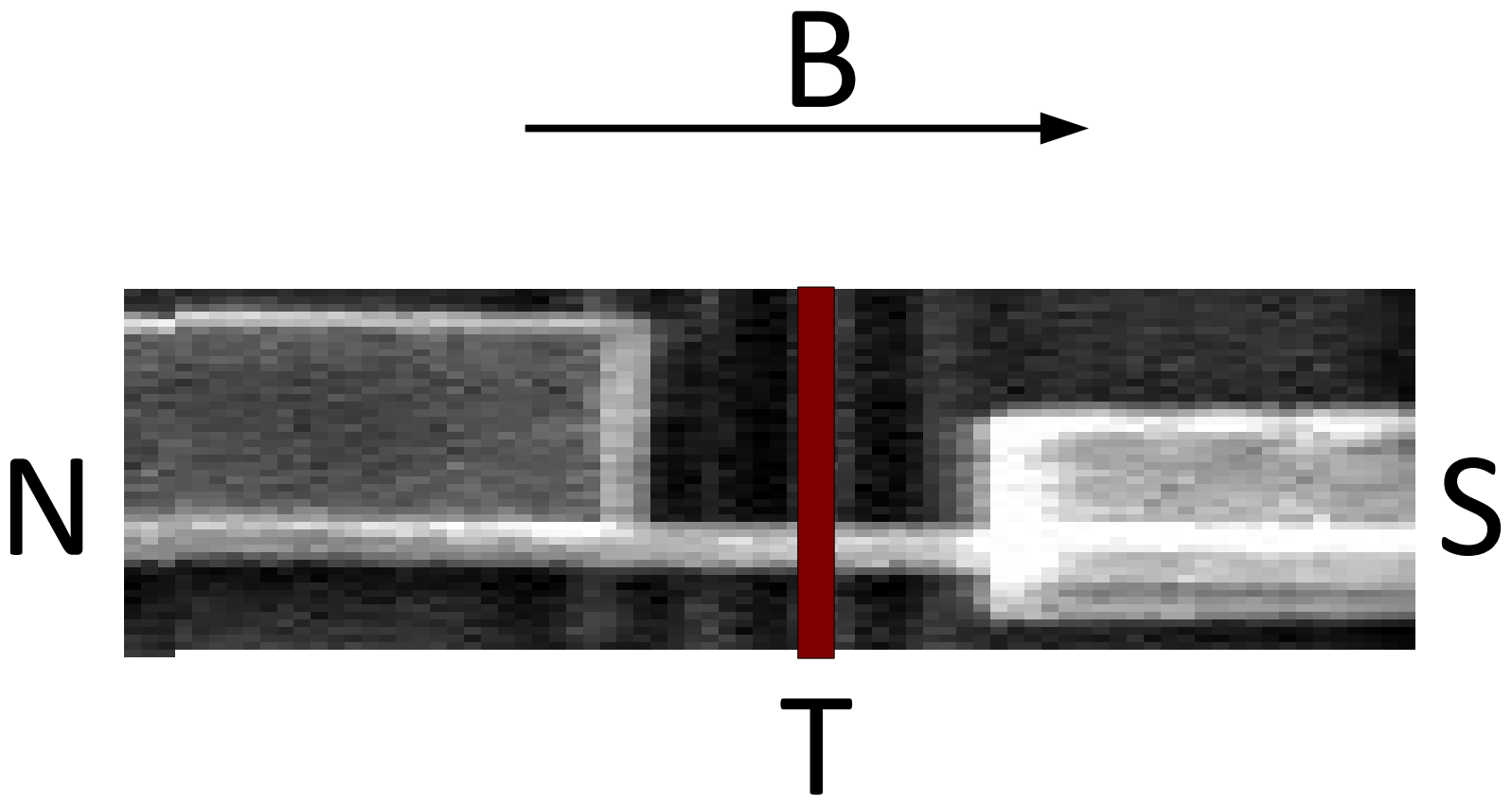

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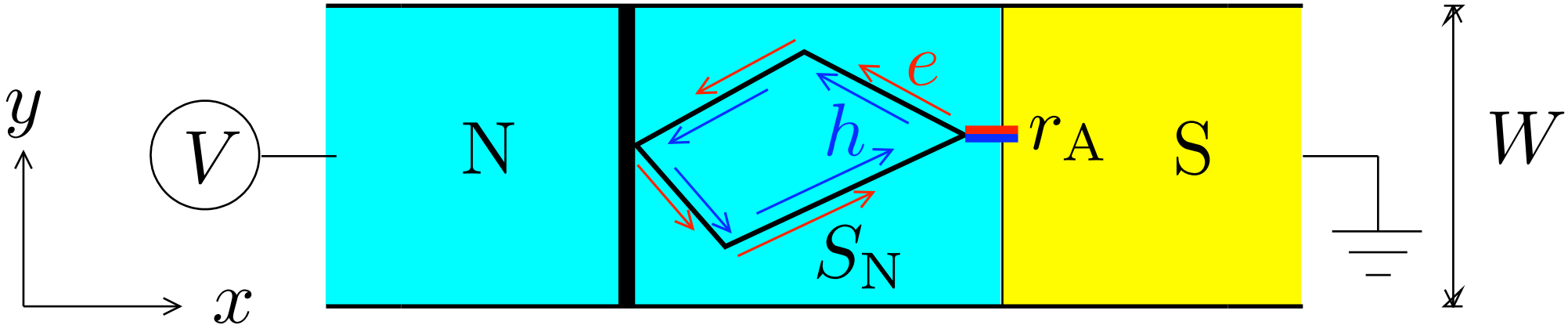
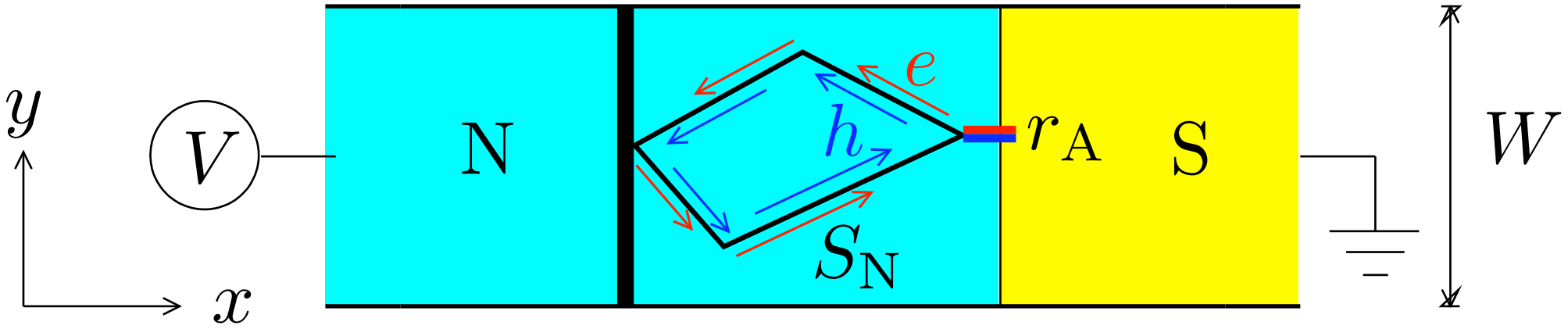


Weak anti-localization

- Systematic correction to conductivity due to interference of electron paths in disordered systems.
- Usually lost in magnetic field, but particle-hole symmetry helps to restore [Brouwer and Beenakker (1995), Altland and Zirnbauer (1996)]
- May be different for different values of bias voltage as the particle-hole symmetry is lost at non-zero bias



Object of study.

- The systematic influence of disorder (averaged over disorder configurations) on differential conductance in multimode wires (Majorana or not). As a function of:
  - Bias voltage
  - Magnetic field

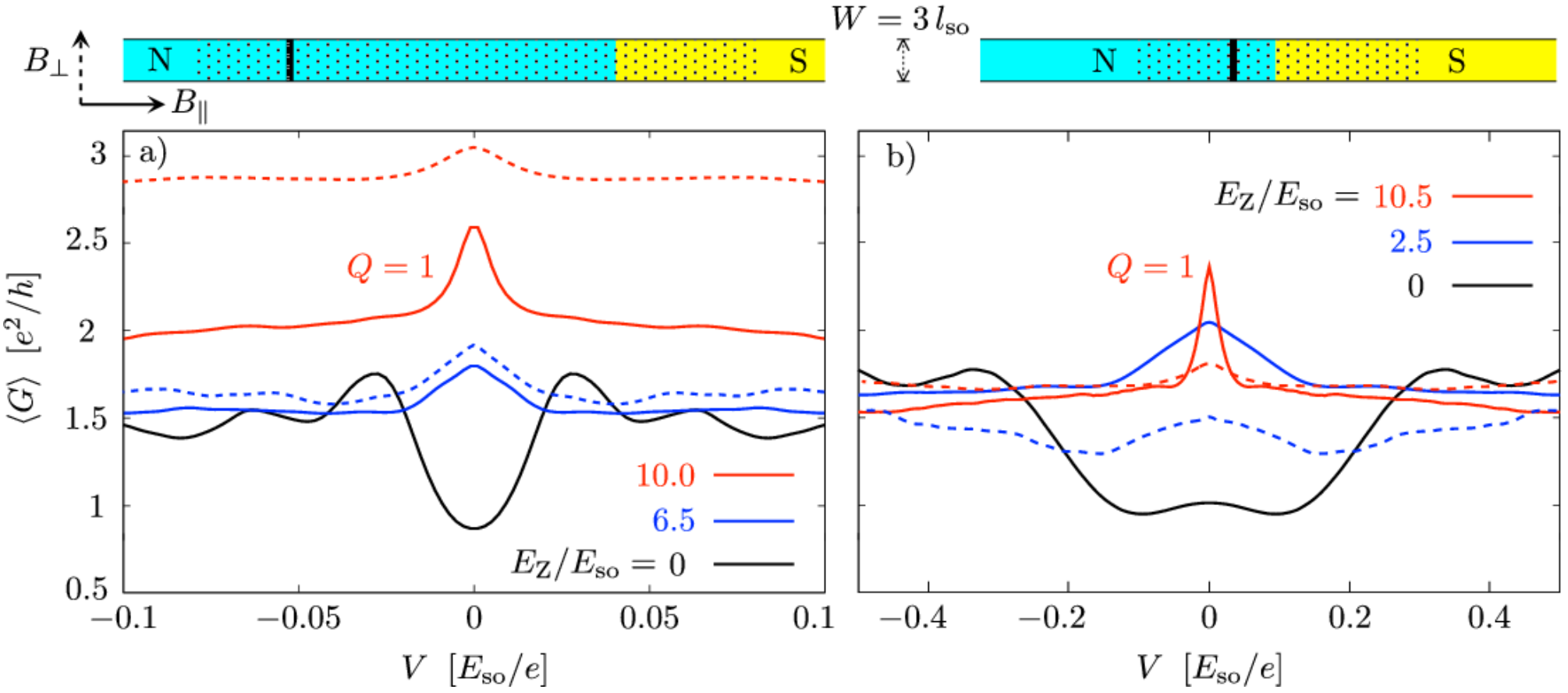
Methods in use.

- RMT
- Numerical solution of Hamiltonian with disorder, spin-orbit coupling and magnetic field on a lattice

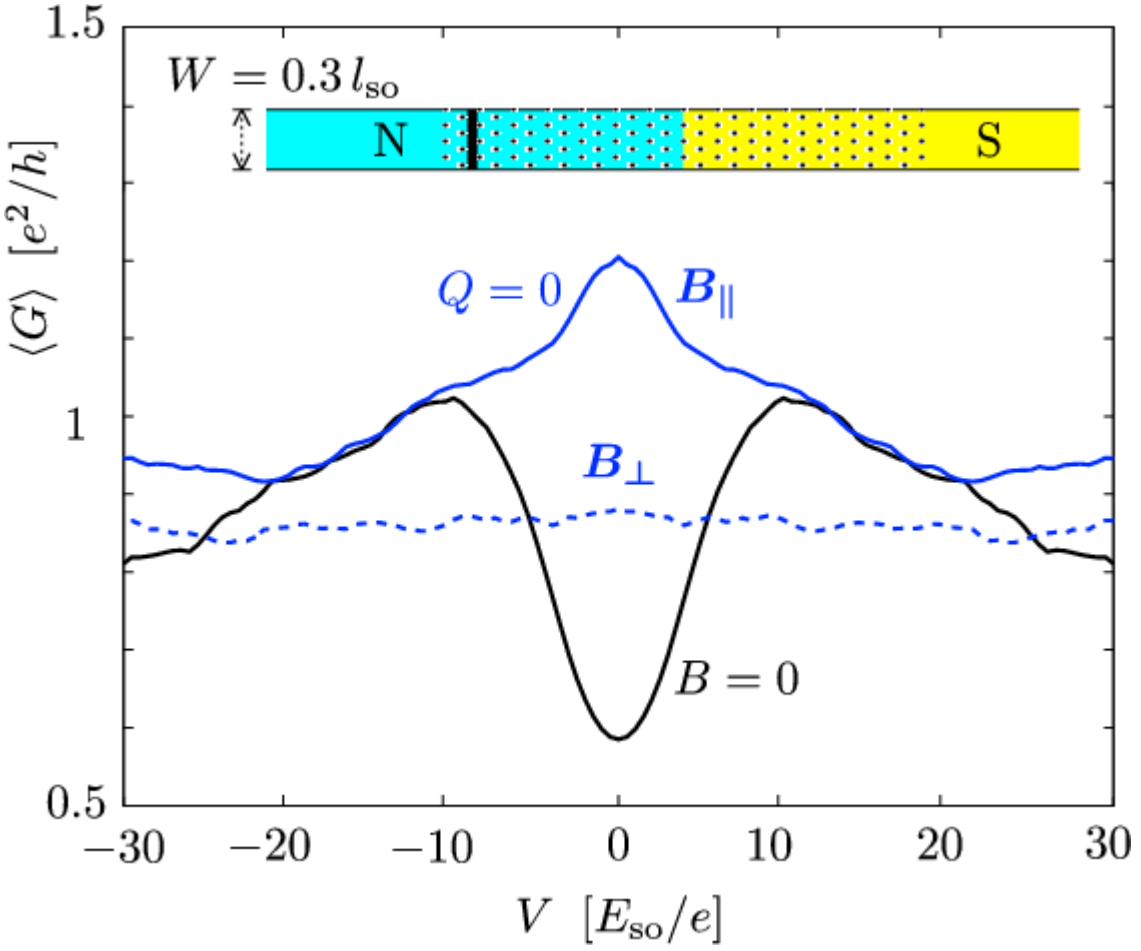
$$\mathcal{H} = \begin{pmatrix} H_0 - E_{\mathrm{F}} & \Delta\sigma_y \\ \Delta^*\sigma_y & E_{\mathrm{F}} - H_0^* \end{pmatrix},$$

$$H_0 = \frac{p_x^2 + p_y^2}{2m_{\mathrm{eff}}} + U(x,y) + \frac{\alpha_{\mathrm{so}}}{\hbar}(\sigma_x p_y - \sigma_y p_x) + E_{\mathrm{Z}}\hat{n}\cdot\boldsymbol{\sigma}.$$

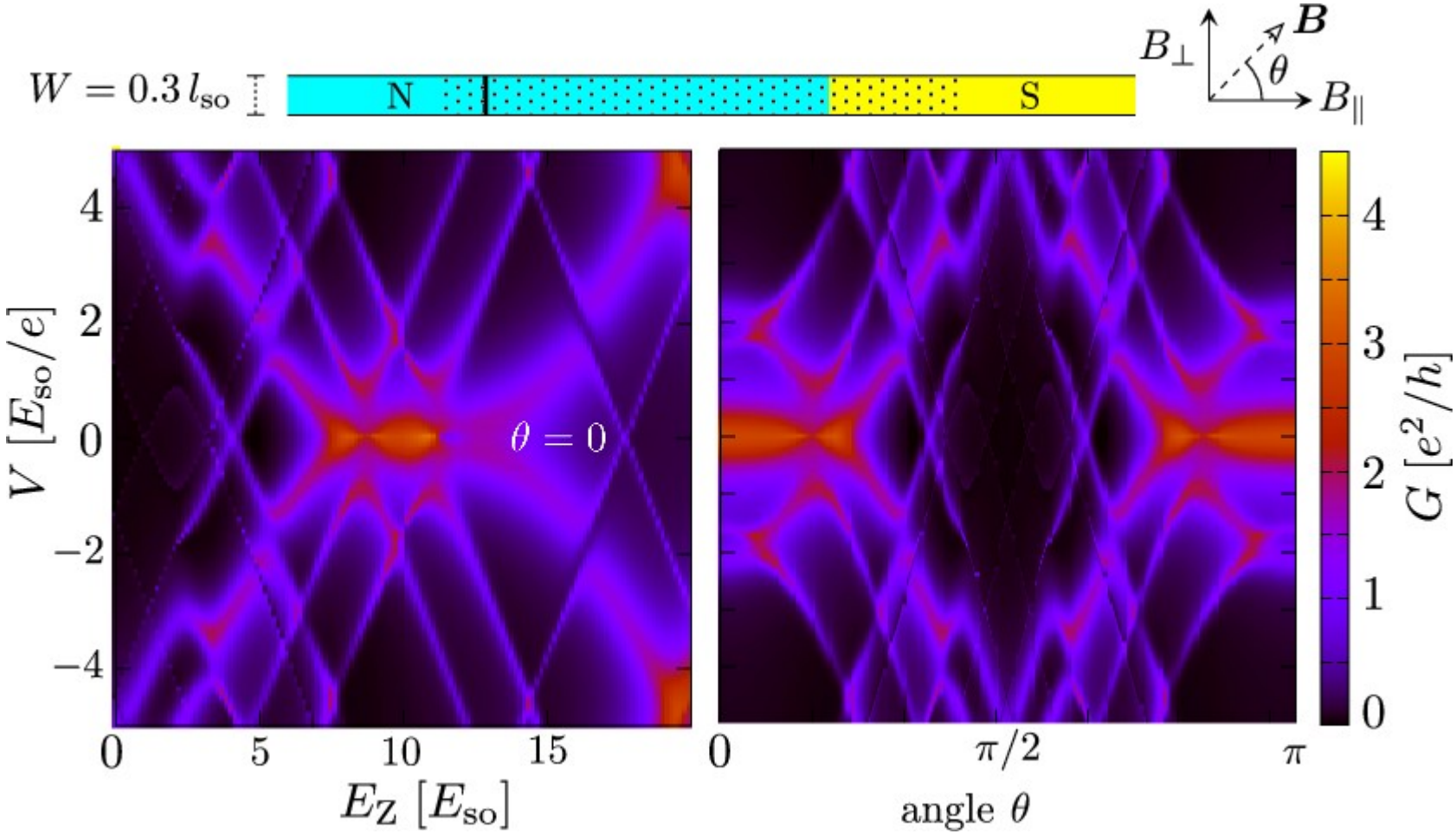
Results. Ensemble average. Wide wire



Results. Ensemble average. Narrow wire

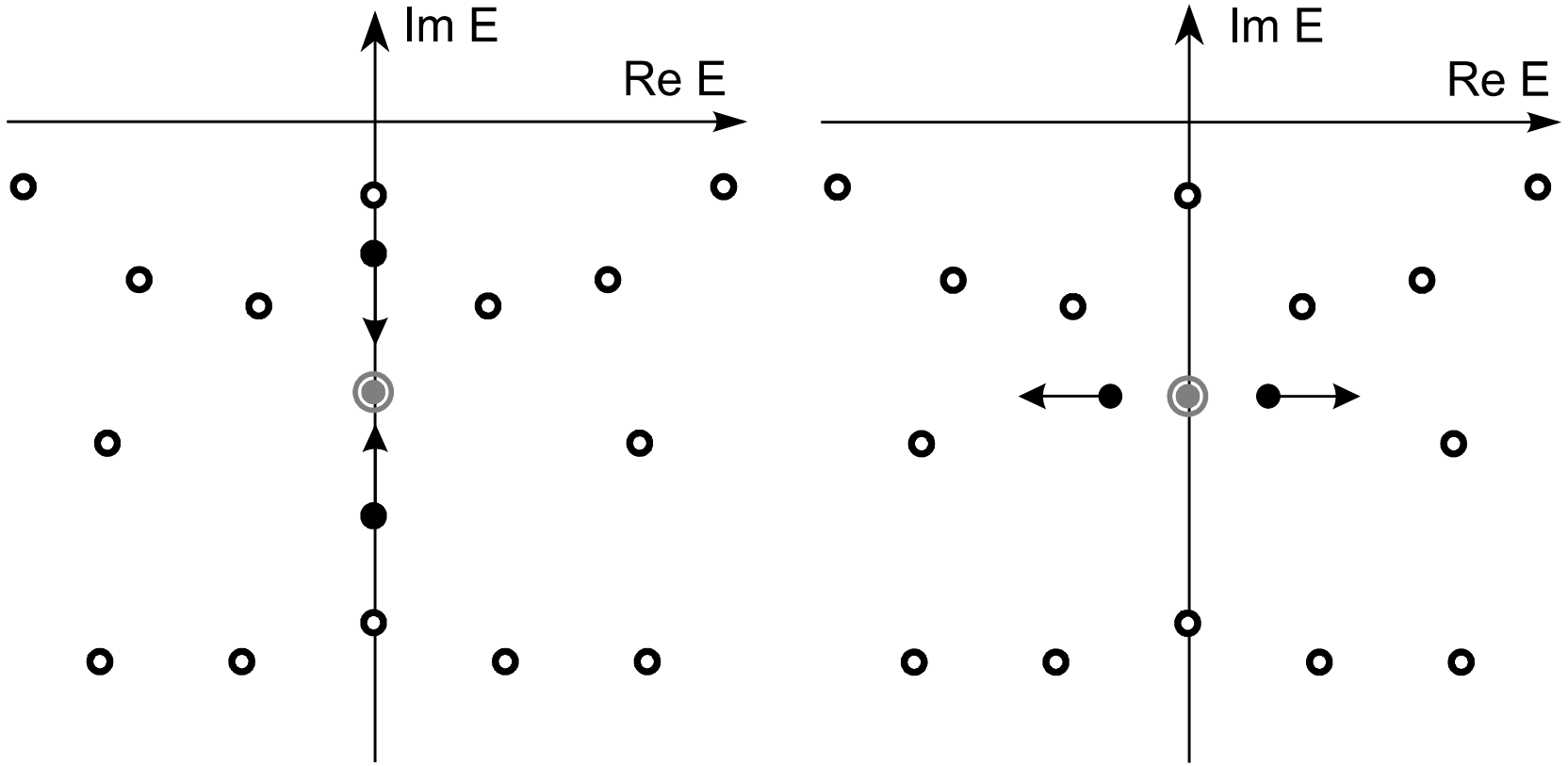


Results. Single realization



Mechanism of sticking

Transition in Wigner poles in S-matrix



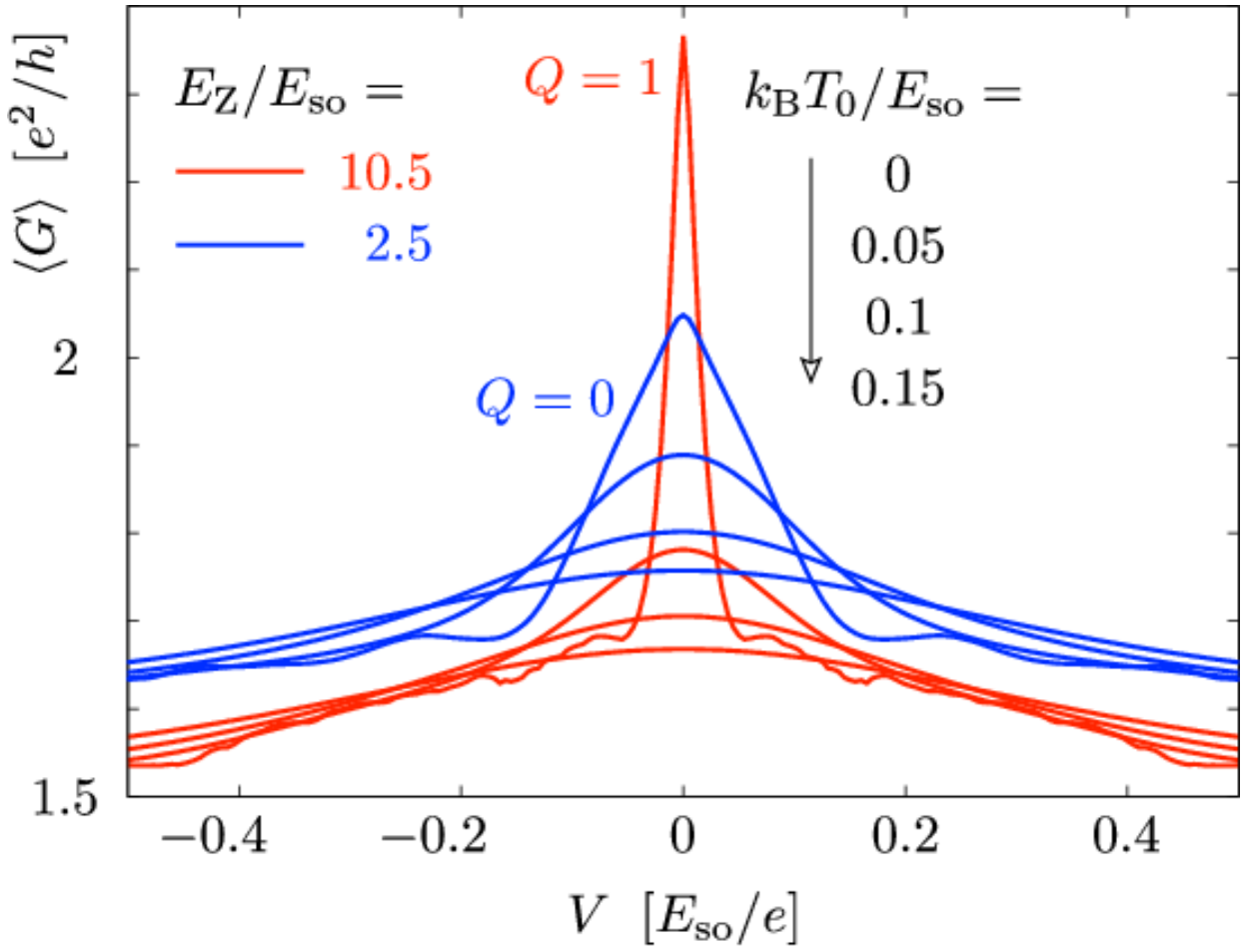
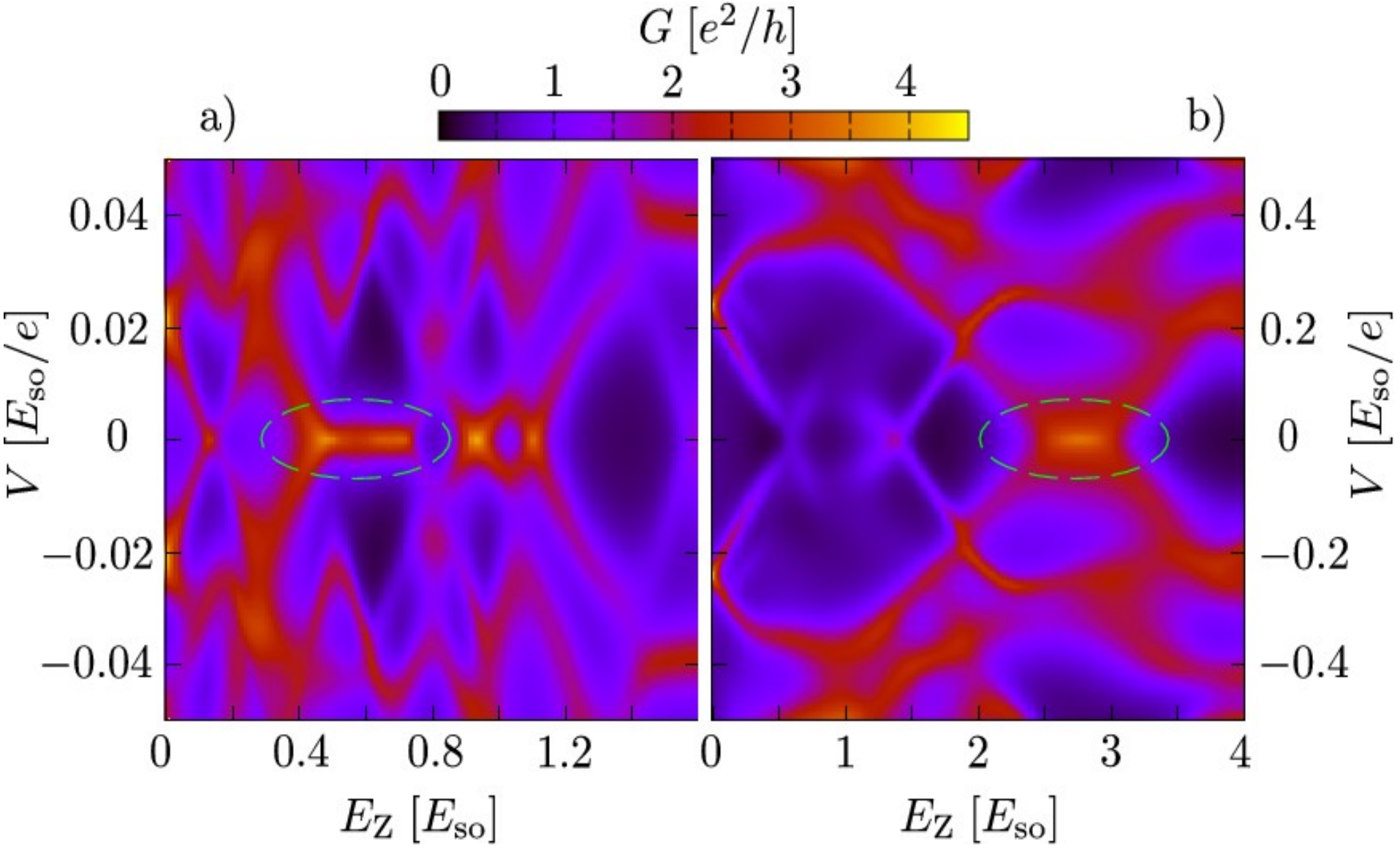
[DP and Nazarov (2011)]

Conclusion

- Zero-bias peaks have been studied in Majorana and non-Majorana wires
- Weak anti-localization peak mimics Majorana peak
- May be distinguished with QPC measurements [M. Wimmer *et al.* (2011)]

Thank you!

Temperature dependence



Results. Single realization