

Groupe Théorie

Service de Photonique, Electronique, Ingénierie Quantiques (PHELIQS)

Institut Nanosciences et Cryogénie (INAC)

- Theory group in a joint unit of **CEA** and **Université Grenoble Alpes**
- 7 permanent researchers
5 PhD researchers
4 postdocs
- **analytical** and **numerical** approaches for condensed matter physics
- **strong links with experiments** at PHELIQS or Polygone scientifique

Quantum nanoelectronics

mesoscopic superconductivity, spintronics, correlations in quantum dots, strong interactions in low dimensions (1D), out-of-equilibrium dynamics

Magnetism

quantum and frustrated magnetism, Monte Carlo simulations, phase transitions

Superconductivity and superfluidity

unconventional superconductivity, topological superconductors (and insulators), vortices, Josephson junction arrays

Examples:

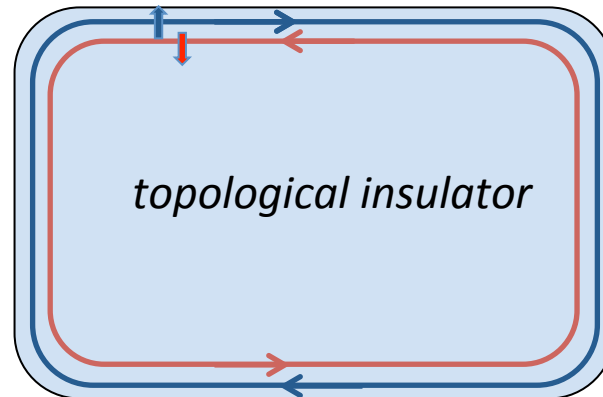
1. Antagonism of **superconductivity** and **ferromagnetism**



→ New effects in hybrid nanostructures

2. **Topological states of matter**

- no local broken symmetry
- no Landau theory with order parameter

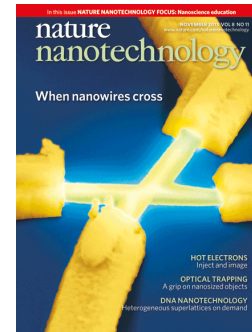
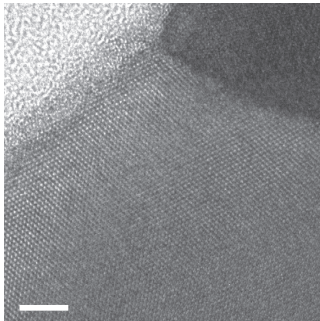


*metallic surface
states (helical)*

→ topological phases (2016 Nobel prize)

Examples:

3. Looking for **new quasiparticles** (Weyl, Dirac, Majorana fermions) protected by topology in hybrid structures



artificial matter
in $n - 1$ dimensions

quasi-momenta $k_x, k_y, k_z \dots$
in the Brillouin zone

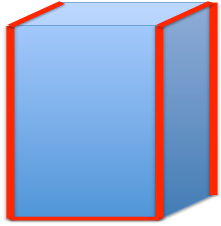
Bloch bands

Josephson junction
with n superconducting terminals

2π -periodic phase differences
 $\phi_1, \phi_2, \phi_3 \dots$

Andreev spectrum of
localized states in the junction

➔ new functionalities (quantum Hall effect in a superconducting device)



Higher-order topological insulators

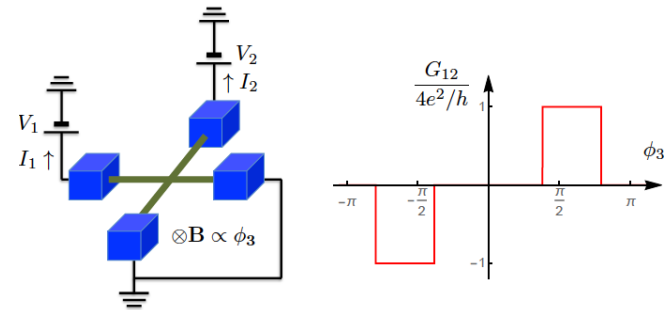
insulating bulk and surfaces, but metallic « hinge » states, disorder-induced coupling with residual bulk/surface states

julia.meyer@univ-grenoble-alpes.fr

Interaction effects on topological properties of multiterminal Josephson junctions

microscopic models, role of Coulomb repulsion, new topological phases in more-than-4 terminal junctions

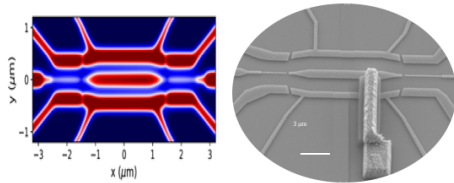
manuel.houzet@cea.fr



A predictive simulation stack for the elements of a semiconducting quantum computer

real time dynamics, correlations and electrostatics in flying qubit, machine learning algorithms to optimize the sample behavior

christoph.groth@cea.fr and xavier.waintal@cea.fr



Theoretical study of advanced magnetocaloric systems: geometrically frustrated and dipolar magnets

Spin liquids and exotic magnetic states for environment friendly refrigeration, analytic theories and Monte Carlo simulations of realistic spin models

mike.zhitomirsky@cea.fr

