Topological States, Protected Quantum Transport and Light-Matter Control

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With potential applications in quantum information and spintronics, topological order, topological insulators and topological superconductors are currently in the center of interest of quantum physics. There is an on-going active search for feasible realizations in and outside of solid-state systems. Experimentalists investigating ultracold atoms in optical lattices and photons in artificial lattices have also made impressive steps towards simulating many-body physics, artificial gauge fields and spin-orbit couplings using light-matter engineering.

We review our current efforts to simulate topological states of matter in materials, circuit QED, Josephson junctions and ultra-cold atom systems. Topological states can emerge from the quantum Hall physics, the Su-Schrieffer-Heeger and Kitaev models. We describe interaction effects and novel probes. We also show that the light-matter and mesoscopic control can allow to address new limits of quantum transport, in relation with efforts in quantum impurity hybrid systems and RC circuits.

Recent Reviews:

• Many-Body Quantum Electrodynamics Networks: Non-Equilibrium Condensed Matter Physics with Light, Karyn Le Hur, Loïc Henriet, Alexandru Petrescu, Kirill Plekhanov, Guillaume Roux, Marco Schiró, C. R. Physique 17 (2016) 808-835, arXiv:1505.00167.

• Driven dissipative dynamics and topology of quantum impurity systems, Karyn Le Hur, Loïc Henriet, Loïc Herviou, Kirill Plekhanov, Alexandru Petrescu, Tal Goren, Marco Schiro, Christophe Mora, Peter P. Orth, arXiv:1702.05135.