Quantum Condensed Matter Research Group. **Objective: to study quantum condensed matter theory, quantum devices, quantum information, and optics.**

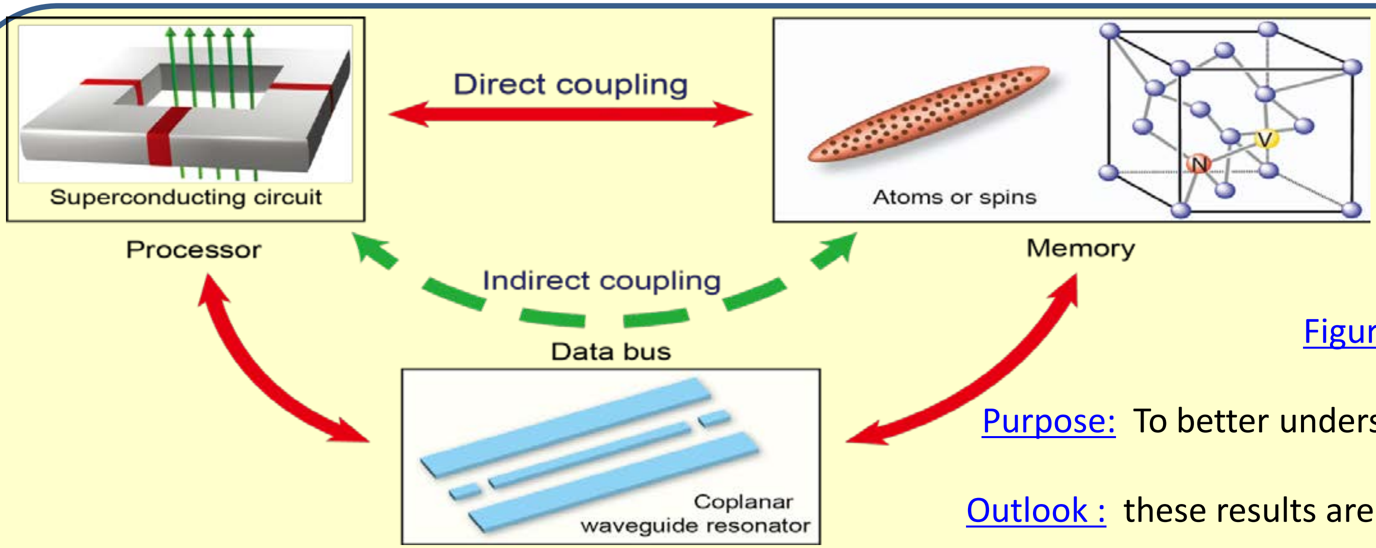

Figure: hybrid quantum processor.

Purpose: To better understand quantum hybrid circuits.

Outlook : these results are being studied experimentally.

Achievements:

- proposed how to realize high-fidelity quantum storage using a hybrid quantum architecture including two coupled flux qubits and a nitrogen-vacancy center ensemble (NVE). One of the flux qubits acts as the quantum-computing processor and the NVE serves as the quantum memory (PRA 2013).

- proposed and analyzed a new hybrid quantum circuit for achieving a strong coupling between a spin ensemble and a transmission-line resonator via a superconducting flux qubit used as a data bus. The resulting coupling can be used to transfer quantum information between the spin ensemble and the resonator (PRB 2013).

- proposed how to achieve photon-mediated electron transport in hybrid circuit-QED (EPL 2013).

Reference:

Xiang, Ashhab, You, Nori, *Hybrid quantum circuits: Superconducting circuits interacting with other quantum systems,* Rev. Mod. Phys. (2013). ISI Highly Cited paper.

Quantum Condensed Matter Research Group found several new results in: electromagnetism, optics, and quantum weak measurements.

Problem: In standard electromagnetism (EM), the field Lagrangian is not dual symmetric. This leads to problematic dual-asymmetric forms of the energy–momentum, spin and orbital angular-momentum tensors.

Purpose and achievement: To resolve these problems, we derive a dual symmetric Lagrangian formulation of EM. This dual EM preserves the form of Maxwell equations, yields meaningful energy–momentum and angular-momentum tensors, and ensures a self-consistent separation of the spin and orbital degrees of freedom.

Reference: Bliokh, Bekshaev, Nori, *“Dual electromagnetism: helicity, spin, momentum, and angular momentum”,* New J. Phys. (March 2013) [ISI highly cited paper for 2013].

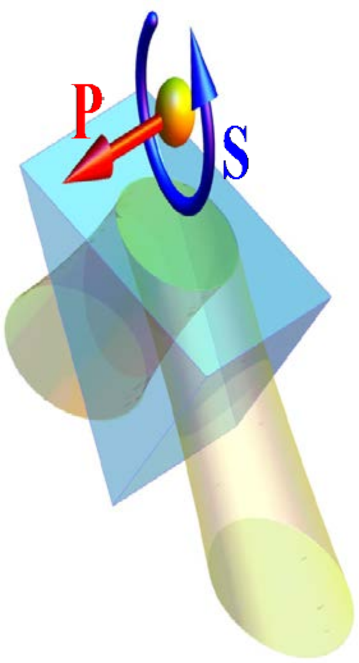

Figure: Extraordinary momentum and spin in *evanescent* waves.

Purpose and achievement: propagating optical waves (photons) carry momentum and longitudinal spin determined by the wave vector and circular polarization, respectively. We have shown that exactly the opposite can be the case for evanescent optical waves.

Outlook: experiments on this just started.

Reference: Bliokh, Bekshaev, Nori, *“Extraordinary momentum and spin in evanescent waves”,* Nature Communications (March 2014). [ISI highly cited paper].