COLLOQUIUM

Quantum interference in coupled cavity-qubit systems

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Quantum networks will enable extraordinary capabilities for communicating and processing quantum information. These networks require a that node that receives two coherent inputs and sends a conditional output to the next cascaded node through a quantum channel. Here, we demonstrate this basic functionality by exploiting a controllable interaction between electromagnetic quanta and discrete levels in a superconducting resonator coupled to a transmon qubit to create tunable polariton states. The two coherent inputs can then interact to suppress the transmission, an effect typically referred to as electromagnetically induced transparency (EIT), We first review the essential physics of circuit QED and demonstrate that transmission of the probe tone is conditional upon the presence of the control tone. This switches the state of the device with up to 99.73 % transmission extinction. Importantly, our EIT scheme uses all dipole allowed transitions. We infer high dark state preparation fidelities of greater than 99.39 % with group velocities of microwaves on the chip down to -0.5 km/s.