ISTA

## Physical Sciences Seminar

# Probing Photonic States and Sensing Absolute Power


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We report on quantum optics phenomena on chip and their emerging devices for present and future applications. First, we demonstrate that when a non-linear medium is scaled down to a single quantum scatterer, a series of effects beyond classical physics are revealed. In particular, Quantum Wave Mixing (QWM) [1] is a result of elastic scattering of electromagnetic waves on a single artificial atom. We investigate two regimes of QWM: Coherent wave mixing and quantum wave mixing with non-classical superposed states. In the former, two pulsed waves with frequencies slightly detuned to each other are scattered on the single artificial atom resulting in a symmetric spectrum with an infinite number of side peaks. The amplitude of each of these peaks oscillates in time according to Bessel functions with the orders determined by the number of interacting photons. In the latter regime, a time delay between the two pulses is introduced causing a striking difference in the spectrum, which now exhibits a finite number of narrow coherent emission peaks. Furthermore, the spectrum in the latter regime is asymmetric with the number of positive frequency peaks (due to stimulated emission) always exceeding by one compared to the negative frequency peaks (due to absorption).Thus in QWM, the spectrum of elastically scattered radiation is a fingerprint of the interacting photonic states. Moreover, the artificial atom visualizes photon-state statistics, for example distinguishing coherent, one- and two-photon superposed states in the quantum regime. Our results give new insight into nonlinear quantum effects in microwave optics with artificial atoms.Then, we addresses the challenge of measuring the absolute power of a microwave signal in a transmission line at cryogenic temperatures which is critical for applications in quantum optics, quantum computing and quantum information. We demonstrate that a two-level system strongly coupled to the open space can act as a quantum sensor of absolute power [2]. We realise the quantum sensor using a superconducting flux qubit that is strongly coupled to the environment. The quantum sensor is independent of dephasing of the two-level system.[1] A. Yu. Dmitriev et al. Quantum wave mixing and visualisation of coherent and superposed photonic states in a waveguide. Nature Communications, 8(1):1352, 2017[2] T. Hnigl-Decrinis et al. Two-level system as a quantum sensor of absolute power. In preparation.?


**Wednesday, June 27, 2018 11:00am - 12:00pm**

Big Seminar room Ground floor / Office Bldg West (I21.EG.101)

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