

ECE 695: Quantum Signal Processing (Spring 2018)

Instructor: Prof. Zubin Jacob

www.zjresearchgroup.org

Tue-Thurs: 12:00pm – 1:15pm Mech. Engg. Room:1009

Ultrasensitive signal detection buried in noise has come to the forefront of research over the last decade through important events such as detection of gravitational waves using optical interference. For example, to detect a gravitational wave, distances have to be measured using optical signals with sub-atomic accuracies [1,2]. It has also been recently revealed that systems in nature might inherently take advantage of the quantum nature of signals to boost biological processes in the presence of noise. Possible examples include efficient energy transfer in photosynthesis, navigation in birds and the molecular origins of the sense of smell [3,4].

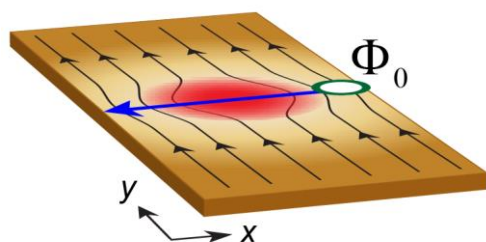


Figure 1: Ultra-sensitive signal detection using superconductors

This course will help graduate students develop the necessary tools to advance their understanding of traditional signal processing through the modern context of quantum metrology.

[1] Classical and Quantum Gravity 27.8: 084006. (2010)

[2] <http://ligo.org/science/Publication-SqueezedVacuum/index.php>

[3] Nature 446, 782-786 (2007)

[4] Nature Physics 9, 10–18 (2013)

Module 1: Quantum Noise	Module 2: Quantum Metrology	Module 3: Quantum Biology
Shot Noise, Thermal Noise, Flicker Noise	Optical coherence and statistics:	Classical vs. quantum random walk:
Classical vs. Quantum Noise:	Ultrasensitive interferometry with squeezed light:	Fokker-Planck equation:
Quantum Fourier Transform:	P-,Q-Representation and Wigner transforms:	Classical vs. Quantum coherence:
Fractional Fourier Transform:	Quantum estimation theory	Quasi-crystals and disordered media:
Single photon detectors, superconducting detectors	Quantum state tomography:	

Along with weekly lectures, there will be a schedule of industry guest lectures through skype which will augment some of the topics taught in class. The attendance is completely optional and in no way affects the grades of the students. However, it will help students understand the broad context of modern optical signal processing in industry.