PHY 8191 (C) Quantum Information and Metrology
Fall 2018

Robert Boyd
robert.boyd@uottawa.ca
25 Templeton (ARC), Room 456

Boris Braverman
bbraverm@uottawa.ca
25 Templeton (ARC), Room 454

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Lectures: Tuesdays 1:00 PM – 3:50 PM, in THN124

This course will focus on two major areas of quantum science: quantum information and quantum metrology. Both of these areas focus on applying entanglement to practical problems in quantum technologies.

Quantum information is an area of intense research and development over the past 30 years, spurred on by the discovery of efficient quantum algorithms for integer factorization and unstructured search problems. Since then, a wealth of theoretical and experimental advances have brought us to the threshold of quantum supremacy: using quantum effects to perform computations impractical with classical computers.

Quantum metrology similarly seeks to exploit quantum entanglement to improve the precision and accuracy of sensors, and enable measurements that are otherwise difficult or impossible.

Prerequisites

Students should have a strong background in quantum mechanics, equivalent to two semesters, for example PHY 3370/3770 and PHY 4370. This background should include continuous and discrete Hilbert spaces, spin operators, and density matrices.

Grading Rubric

Evaluation component	Grade percentage
Pre-lecture questions	5%
Problem sets	30%
Mid-term exam	30%
Term paper	35%

Prior to each lecture, we will publish a few questions about background material relevant to the lecture, or assigned pre-lecture readings.

Problem sets will be posted every 2 weeks, and will be due 2 weeks later.

The mid-term exam will be in mid-November, and will cover the first 2/3 of the course material.

Topics Covered

Quantum computation basics, gates for universal quantum computing. Quantum algorithms: Grover's, Shor's, and others. Quantum simulation, complexity theory, and error correction. Alternatives to gate-based quantum computing. Physical implementations of quantum computers. Quantum metrology and sensors. Entanglement for sensing: its generation, its treatment as a resource, and limitations to its applicability. Harmonic oscillator and spin squeezing. Quantum imaging.