

Keith Schwab – Colloquium – 12/7/2017

Title: Opportunities for Quantum Sensors based on Superfluid Helium

Abstract: Liquid helium-4 forms a truly remarkable, superfluid state of matter for temperatures below 2.172K. This material will flow without friction, demonstrates macroscopic quantum phase coherence, and is easily available in extremely chemically and isotopically pure states in large quantity. Despite these and other very advantageous properties, it has yet to be used in any technology or sensing application, beyond simply as a cryogenic fluid. In this talk, I will describe two directions we are currently pursuing. Together with Prof. Ben King (Univ. Nevada, Reno) we are investigating the use of new 2D nanoporous molecular crystals to realize a Josephson junction for superfluid helium 4. This would open up the possibility of quantum circuits, and ultra-sensitive matter-wave interferometers based on superfluid helium. Secondly, is the realization a gram-scale ultra-low dissipation acoustic resonator to realize quantum states at centimeter length scales. Our preliminary experiments show that quality factors of over 100M are readily achieved at temperature of 40mK and an improvement to $Q = 10^{11}$ appears possible. These experiments are expected to have impact on ultra-sensitive inertial sensing, gravitational wave detection, and quantum device technology (possibly qubits).