PURDUE UNIVERSITY

Joint PQSEI / BNC Seminar

Raphael Pooser - Oak Ridge National Laboratory

Tuesday, July 9, 2019

1:00 - 3:00 p.m.; BRK 1001

“21st Century Quantum Imaging and Sensing”

Quantum sensors are devices that exploit quantum mechanical effects to obtain enhanced sensitivity over their classical counterparts. Sensors that exploit quantum noise reduction, or squeezed light, have seen renewed interest in recent years as a growing number of devices that utilize optical readout – from gravitational wave detection to ultratrace, plasmonic sensing at the nanoscale – have approached their absolute limits of detection as defined by the Heisenberg uncertainty principle. At this limit, the noise is dominated by the quantum statistics of light (the shot noise limit when coherent light is used). Simultaneously, many devices, including nanoscale sensors, have reached tolerance thresholds in which power in the readout field can no longer be increased. Beyond these limits, squeezed light is required to further improve sensitivity in these platforms. Here, we present our work geared towards producing practical, ubiquitous quantum sensors that break through the shot noise limit to achieve state of the art sensitivities beyond the capabilities of classical devices. We demonstrate atomic magnetometers, atomic force microscopes, compressive imaging, quantum plasmonic imaging, and ultra-trace quantum plasmonic sensors with state-of-the-art quantum noise levels well below the shot noise limit. In particular, we will describe a new atomic force imaging platform that utilizes a ubiquitous, off-the-shelf configuration enhanced with squeezed light in order to beat the state of the art achieved in the analogous classical sensor. Further, we will explore the potential of compressive quantum imaging for parallelized plasmonic sensing at the quantum noise limit.

Dr. Pooser is an expert in continuous variable quantum optics. He leads the quantum sensing team within the quantum information science group. His research interests include quantum computing, neuromorphic computing, and sensing. He currently leads the Quantum Computing Testbed project at ORNL, a large multi institution collaboration. He has also developed a quantum sensing program from the ground up based on quantum networks over a number of years at ORNL. He has been working to demonstrate that continuous variable quantum optics, quantum noise reduction in particular, has important uses in the quantum information field. One of his goals is to show that the quantum control and error correction required in computing applications are directly applicable to quantum sensing efforts. He is also interested in highlighting the practicality of these systems, demonstrating their ease of use and broad applicability. His research model uses quantum sensors as a showcase for the technologies that will enable quantum computing. Dr. Pooser has over 16 years of quantum information science experience, having led the quantum sensing program at ORNL over the past eight. Dr. Pooser publishes in high impact journals, including in Science, Nature, and Physical Review Letters. He previously served as a distinguished Wigner Fellow. He also worked as a postdoctoral fellow in the Laser Cooling and Trapping Group at NIST after receiving his PhD in Engineering Physics from the University of Virginia. He received a B.S. in Physics from New York University, graduating Cum Laude on an accelerated schedule. Dr. Pooser is active in the community, having served as a spokesperson for United Way and for the Boys & Girls Clubs of the TN Valley on many occasions in addition to volunteer work.

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