Ebrahim Karimi
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Title: Structured Quantum Waves

Abstract: In quantum mechanics, the wavefunction serves as a mathematical expression that characterises the quantum state of a system. Nonetheless, a debate persists regarding whether the wavefunction encompasses all necessary features or whether there exists a requirement for hidden variables, either local or non-local. Photons, particles of light, and electrons, particles of charge, can possess wavefunctions labelled by various quantum numbers, such as frequency (energy), polarisation and spin, and spatial and temporal modes. The ability to generate, manipulate, and detect a quantum wavefunction with specific states is essential in quantum information processing. For example, it is crucial to accurately create and detect photon states when performing secret key sharing via quantum key distribution, complex computations, or electron states when using them to detect objects in a quantum imaging/sensing setup. These fields of research can be categorised as the study of structured waves.

In my talk, I will provide an overview of how to engineer the quantum states of photons and electrons and show examples of how structured waves can help us understand fundamental questions in science. I will also briefly discuss their applications in quantum key distribution, quantum simulators, and quantum microscopy.

Biography: Professor Ebrahim Karimi is a Canada Research Chair in Structured Quantum Waves and co-director of uOttawa Quantum Institute (NexQT). He has authored over 180 publications and holds 3 patents, exploring the quantum properties of electrons and photons. He has received recognition from Optica, the Global Young Academy, and the Royal Society of Canada, and is a fellow of the National Research Council Canada and Max Planck Institute for the Science of Light in Germany. He has been awarded the Ontario Early Researcher Award, the uOttawa Early Career Researcher of the Year Award, the CAP Herzberg Medal, the NSERC Arthur B. McDonald Fellowship, and the Rutherford Memorial Medal from RSC.