Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

Contribution ID: **2272** Type: **Invited Speaker / Conférencier(ère) invité(e)**

# Building synthetic quantum systems with atoms and photons —from waveguide QED with neutral atoms to "gauged" quantum materials with cavity-dressed Rydberg polaritons. (I)

*Thursday 14 June 2018 08:00 (30 minutes)*

An exciting frontier in quantum information science is the creation and manipulation of quantum systems that are built and controlled quanta-by-quanta. In this context, there is active research worldwide to achieve lithographic quantum optical circuits, for which atoms are trapped in nanoscopic dielectric structures and wired by photons propagating through complex circuit elements. I will discuss a designer's method to create synthetic quantum matter utilizing neutral atoms embedded in photonic crystal waveguides. The strong interplays between quantum excitations of spins, light, and sound are all utilized to create the effective "gauge" bosons that mediate arbitrary Hamiltonians in the spin matter. I will also discuss a new regime of analog quantum spin-ice models and more generally string-net models that are accessible by strongly-coupled cavity Rydberg polaritons. In the pursuits of both research directions, I will complement the theoretical descriptions with the experimental progresses in the Laboratory of Ultracold Quantum Matter & Light (UQML) at the University of Waterloo.

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**Session Classification:** R1-6 Quantum Computing and Communication (DAMOPC/DTP/DCMMP) | Calcul et communication quantiques (DPAMPC/DPT/DPMCM)

**Track Classification:** Division of Atomic, Molecular and Optical Physics, Canada / Division de la physique atomique, moléculaire et photonique, Canada (DAMOPC-DPAMPC)