# MECHANICAL ENGINEERING STUDENT SEMINAR

**Tuesday, May 17 2022 at 15:30**, Schulich Faculty of chemistry, Seminar room

## Ultrafast Dynamics of Vibrational Polaritons: Transport against the flow and Vacuum-Field Chemistry

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Vibrational polaritons are quasi-particles formed by strong coupling resonant electromagnetic field with molecular vibrational modes. These hybrid modes of both photonic and molecular nature, have been proposed as a platform for manipulating chemical properties. Recently, an exotic hypothesis of vacuum-field chemistry received a lot of attention. According to this hypothesis, the merely presence of a (resonant) cavity, even if not populated by photons, can alter properties of molecules inside the cavity and even alter the course of chemical reactions. Although some experimental demonstrations were reported, many researchers remain skeptical about the validity of those experiments.

Vibrational strong coupling is achieved by confining light for a relatively long time in an optical cavity, typically a Fabry-Perot resonator or similar. Yet, these so-called "closed" cavities have an intrinsic flaw, as they have a spectral window defined by their resonant frequency, leaving the rest of the electromagnetic spectrum "dark". For this reason, directly probing the full spectral range of a polaritonic system with a closed cavity remains challenging. Recently, it was suggested to overcome this obstacle with an "open" cavity approach, which employ antenna-lattice resonances (ALR). This type of resonance, generated by the interference of a local antenna mode with a diffraction grating cut-off, can generate a high-quality resonance at a desired frequency, while the optical system remains almost perfectly transparent for the rest of the electromagnetic spectrum.

In this talk, I will discuss the design of such ALR-based cavities, and their usage as a platform for vibrational polaritonic systems. I will demonstrate the third-order non-linear two-dimensional infra-red spectroscopy for studies of ultrafast dynamics of ALR strongly coupled to the carbonyl stretching vibration in PMMA. Finally, I will show that ultrafast ion pairing dynamics is dramatically affected by strong interaction between solvent molecules and vacuum fields of the cavity.

Note: the seminar will be given in English

Seminars Coordinator: Assoc. Prof. Matthew Suss.