RICE QUANTUM GROUP MEETING SEMINAR SERIES

Fuyang Tay

Prof. Junichiro Kono group

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4 PM, SST 300

Ultrastrong multimode light-matter coupling in a three-dimensional photonic-crystal cavity

***Abstract*:**

Three-dimensional (3D) photonic crystals are artificial structures that exhibit a full three-dimensional photonic band gap. Cavity formation in 3D photonic crystals has the potential to display unique characteristics such as high quality factors, tight confinement in three dimensions, and discrete in-plane translational symmetry. However, studies on 3D photonic-crystal cavities (PCCs) have been mainly limited to the weak coupling regime. Here, we demonstrate ultrastrong and superstrong coupling between multiple photonic modes of a terahertz 3D-PCC and a Landau-quantized two-dimensional electron gas (2DEG) in GaAs. The mixing between cavity modes, mediated by the cyclotron resonance of the 2DEG, is significantly influenced by the in-plane reciprocal lattice vectors of the 3D-PCC. We observe different multimode light-matter coupling scenarios for orthogonal polarizations in a woodpile cavity lacking inversion symmetry in the stacking direction. Numerical simulations and a microscopic model, which accounts for the spatial variation of the cavity field, show excellent agreement with the experimental results. The model suggests a finite correlation between the cavity modes in the ground state of this light-matter hybrid system. This work paves the way for utilizing 3D-PCCs to explore cavity quantum electrodynamics in the non-perturbative regime.

***Bio*:**

Fuyang Tay is a fifth-year PhD candidate in the group of Prof. Junichiro Kono. He obtained his B.S. degree in Physics from Nanyang Technological University (NTU) in Singapore in 2018. Afterwards, he worked as a project officer at NTU with Prof. Baile Zhang for a year. During this time, he conducted research on the dynamics of free-electron radiation and a fluid-flow invisibility cloak. His current research interests include cavity quantum electrodynamics in solid-state systems and terahertz magnetospectroscopy of quantum materials. Specifically, his research focuses on using the vacuum electromagnetic field inside a cavity to induce novel material properties in the equilibrium state.

Snacks and Coffee will be served during the event. Wine & cheese will be served after the talk. Everyone is welcome to stay around after the seminar for further informal discussions.