Quantum Nanophotonics: Deterministic Photon-based Quantum Computing  
By Exploiting Few-Photon Nonlinearity

PhD Dissertation Defense

Zihao Chen
PhD Candidate

Abstract: Photon-based quantum computing has manifest substantial advantages over conventional atom-based implementations due to a longer coherence time and an inherent compatibility with quantum communication protocol of flying qubit, photons. As a vital logic gate for universal quantum computing, the two-photon controlled-phase gate demands either a few-photon nonlinearity, which has longstanding suffered from an in deterministic nature in the linear optics regime, or a weak nonlinearity of nature-occurring materials in the nonlinear regime. Quantum nanophotonics, devoted to study light-matter interactions in the quantum limit, may offer desired nonlinearity. Down to the quantum limit, interactions between light quanta (photons) and individual matter formation of emitters (atoms) are taken into account. The underlying physics here is that, an atom can interact with at most one photon at the same time. When multiple photons interact with one atom, one photon can adequately saturate the atom, thereby introducing the atom-mediated few-photon nonlinearity. In this talk, I will present my doctoral work towards a deterministic two-photon logic gate proposal enabled by such a nonlinearity. I will first present the exotic photonic trimer state generation to demonstrate the few-photon nonlinearity. I will then report the breakdown of non-Hermitian Hamiltonian for correlated multi-photon process to unveil the non-trivial effects of few-photon nonlinearity. Finally by exploiting such a nonlinearity, I will present a deterministic two-photon controlled-phase gate proposal, and further showcase universal quantum computing logic gate designing in quantum nanophotonic systems.

Date: Monday, July 1, 2019
Time: 11:00 a.m.
Location: Green Hall, Room 0120

Dissertation advisor:
Dr. Jung-Tsung Shen