THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

DEPARTMENT OF APPLIED MATHEMATICS
應 用 數 學 系

Dr. Lee Heung-wing, Joseph

Research interests include:

- Computational Optimal Controls
- Optimal Discrete-valued Controls
- Control of Chaotic Systems
- Optimization
- Computational Semi-infinite Programming Problems
- Supply Chain Management

On-going GRF project

Coherent feedback control of quantum optical systems

Abstract

As an important branch of quantum physics, quantum optics is also undergoing an explosive growth in quantum technology because it offers building blocks for constructing quantum computing and communication devices to realize the dream of quantum nanoscale technology. As sound approximations to the fundamental field theoretical models in quantum optics, linear quantum optical systems have been derived in terms of quantum stochastic differential equations (QSDEs), based on which a vast body of measurement based feedback control methods have been proposed to achieve various objectives such as entanglement preservation, state preparation, and error correction. An alternative control mechanism, called coherent feedback control, has been proposed recently where measurement is not necessarily involved; instead, quantum information may flow directionally as a (possibly non-commutative) signal (such as a quantum optical electromagnetic field or an injected laser), or directly via a bidirectional physical coupling. The benefits of coherent feedback include (i) preservation of quantum coherence, and (ii) high speed (a coherent controller would have similar time scale to the plant, and likely is much faster than classical signal processing). Notwithstanding the early recognition of the development of the general principles of quantum control theory as an essential requirement for the future applications of quantum technologies, the quest for integrated, first principles discipline of quantum control for quantum optics is rather challenging. In this project we aim to develop a set of advanced coherent feedback control methods for quantum optical systems by following two closely related directions: 1) optimal control via squeezing and direct coupling, which will reveal a general picture of how to utilize squeezing components and direct coupling to design physically realizable quantum controllers to meet prescribed control performance; 2) multi-objective control, which will provide more flexibility to manipulate quantum optical systems to meet ever demanding design performance and complexity. The outcome of this project will deliver a set of systematic, first principles control methods for quantum optical systems, which will be of benefit to the successful practice of quantum optical engineering in the near future.