Boosting Quantum Synchronization

L C Kwek[1,2]

[1] *Nanyang Technological University, Singapore, Singapore*
[2] *Center for Quantum Technologies, National University of Singapore, Singapore, Singapore*
Contact Email: cqtklc@nus.edu.sg

Synchronization is a key focus in nonlinear dynamics, and recent advancements have brought this topic into the quantum realm. However, efficient strategies for enhancing synchronization remain less understood. One promising approach is homodyne measurement, which has shown success primarily in the semiclassical regime. In our study, we investigate the phase synchronization of a harmonic-driven quantum Stuart–Landau oscillator, demonstrating that the benefits of homodyne measurement extend into the quantum domain. Notably, we identify optimal two-photon damping rates that occur when the oscillator and the driving force are in resonance, coupled with a low single-photon damping rate. Additionally, we observe an enhancement in quantum synchronization driven by noise when the single-photon damping rate is sufficiently high. Beyond these findings, we reveal that incorporating a squeezing Hamiltonian can significantly enhance synchronization, particularly in the semiclassical regime. This addition also shifts and aligns the optimal two-photon pumping rates.