



Ph.D. DISSERTATION DEFENSE

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Degree:	Doctor of Philosophy
School/Department:	Charles V. Schaefer, Jr. School of Engineering and Science / Physics
Date:	May 1st, 2026
Time/Location:	12:00 pm - 1:30 pm / Babbio 304
Title:	Dissipative Structure in Gaussian Open Systems: Symmetry, Detuning, and Environmental Memory
Chairperson:	Dr. Ting Yu, Department of Physics, School of Engineering & Science
Committee Members:	Dr. Chunlei Qu, Department of Physics, School of Engineering & Science Dr. Knut Stamnes, Department of Physics, School of Engineering & Science Dr. Michael Zabaranin, Department of Mathematical Sciences, School of Engineering and Science

ABSTRACT

Dissipation is typically treated as an obstacle to coherent quantum information processing. This dissertation asks whether structured system–environment coupling can instead support useful dynamical mechanisms in continuous-variable Gaussian systems. The central thesis is that three levers organize these dynamics: collective coupling symmetry, static spectral detuning, and finite environmental correlation time.

Three dissipative primitives are analyzed. First, for two bosonic modes coupled to a common reservoir, collective symmetry fixes the channel structure while detuning and memory reshape resonant pathways and effective decay. Parameter maps and trajectories identify entanglement generation, freezing, revival, and suppression, with robustness tested against symmetry breaking, detuning mismatch, and finite temperature. Second, fixed-time Gaussian state reconstruction is established under autonomous collective dissipation. In a bright–dark decomposition, the dynamics close analytically and yield a prescribed readout time set by symmetry and spectral alignment; finite memory primarily renormalizes effective rates and phases without altering the reconstruction condition. Third, coherent-state transfer and two-mode π -swap are compared within a common framework, in which ensemble fidelity statistics reveal distinct sensitivities to detuning, asymmetry, temperature, and memory-modified operating windows.

Together, these results classify dissipative Gaussian primitives under autonomy constraints through effective-rate dressing, stability analysis, and backaction diagnostics across a variety of quantum primitives.