Quantum spin chains are important in **quantum computing** and **optics**. Driven and dissipative chains can **split a pulse into two**.

Quantum Transport in Driven Spin Chains

Gabrielle Olinger, Eric Bittner

University of Houston
Deparment of Chemistry

Initial Question: How does the addition of a cavity affect transport of an excitation?

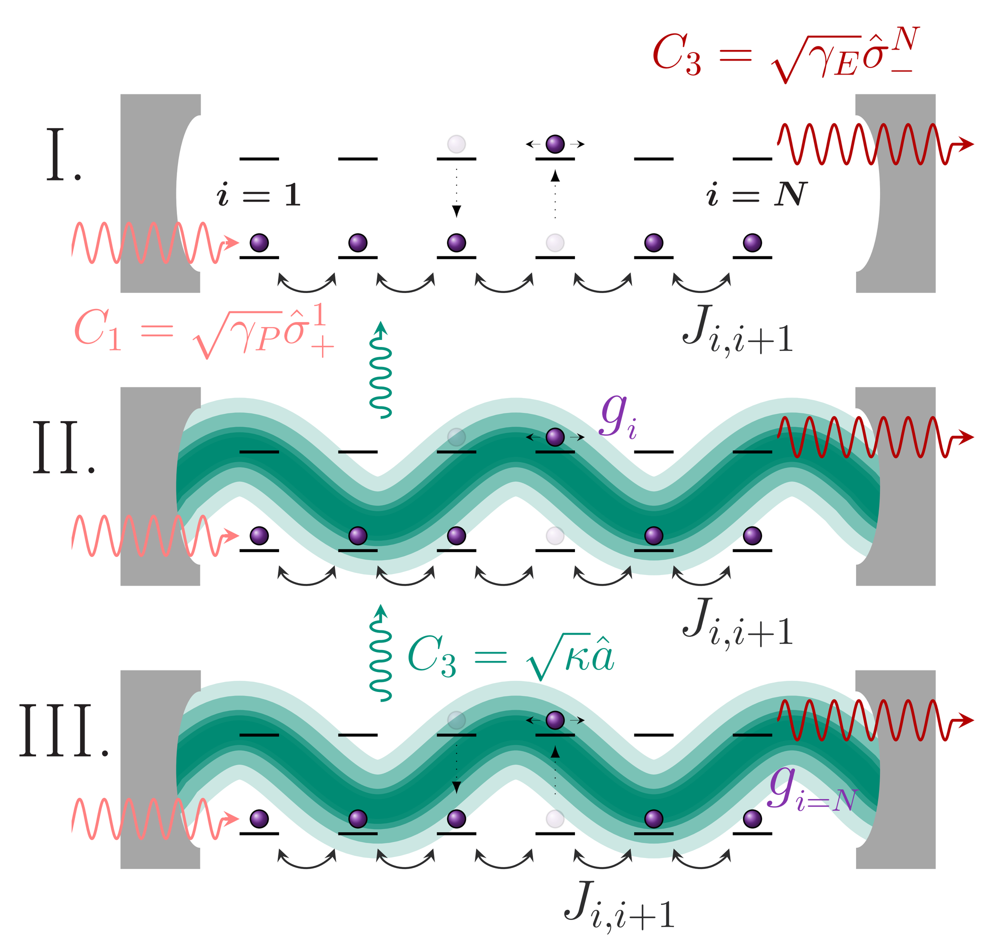
Model

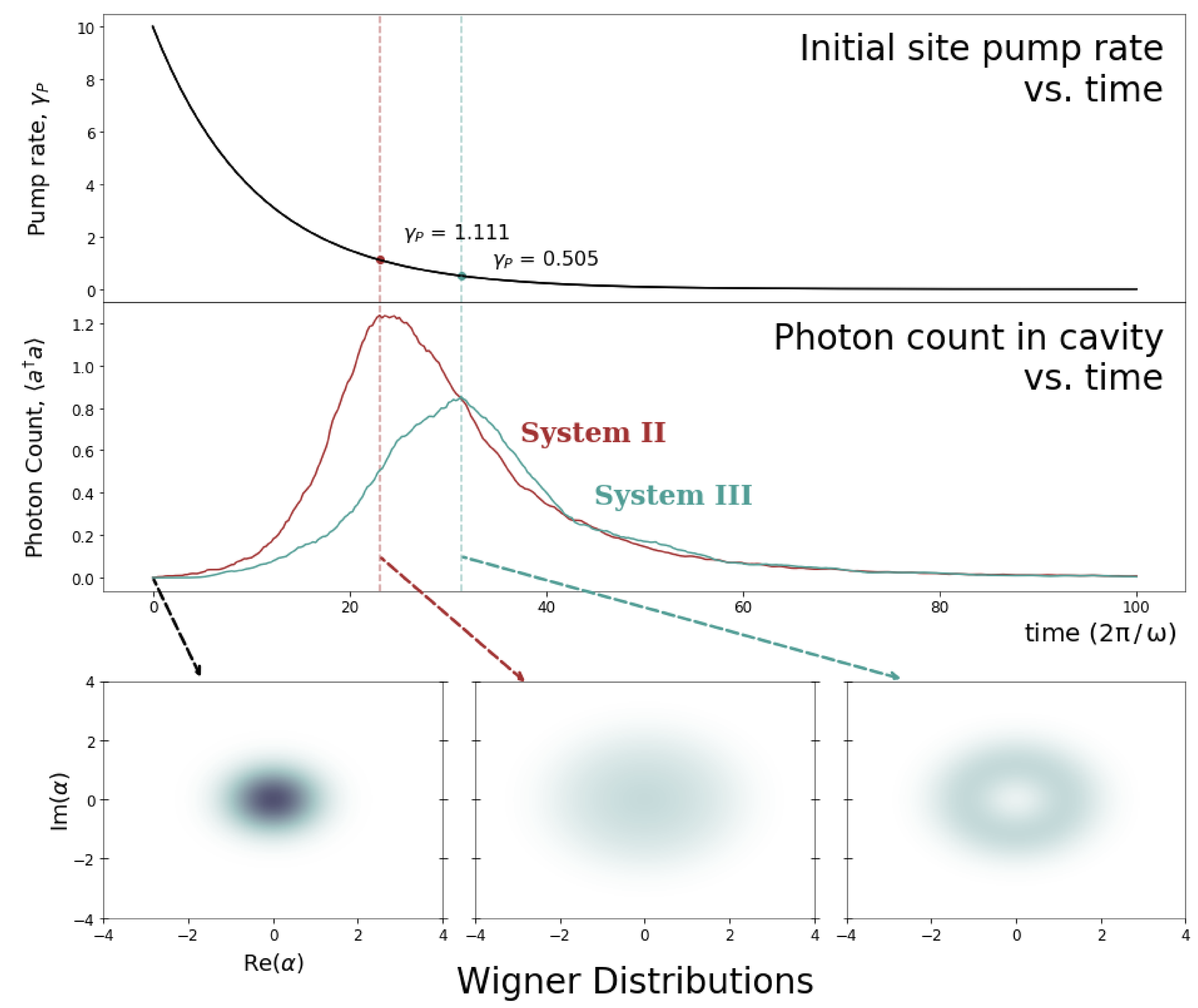
- 1D array of dipole-dipole interacting spins (spin chain) can transport excitations
- Hamiltonians: spin chain and spin chain with cavity $\hbar = 1$

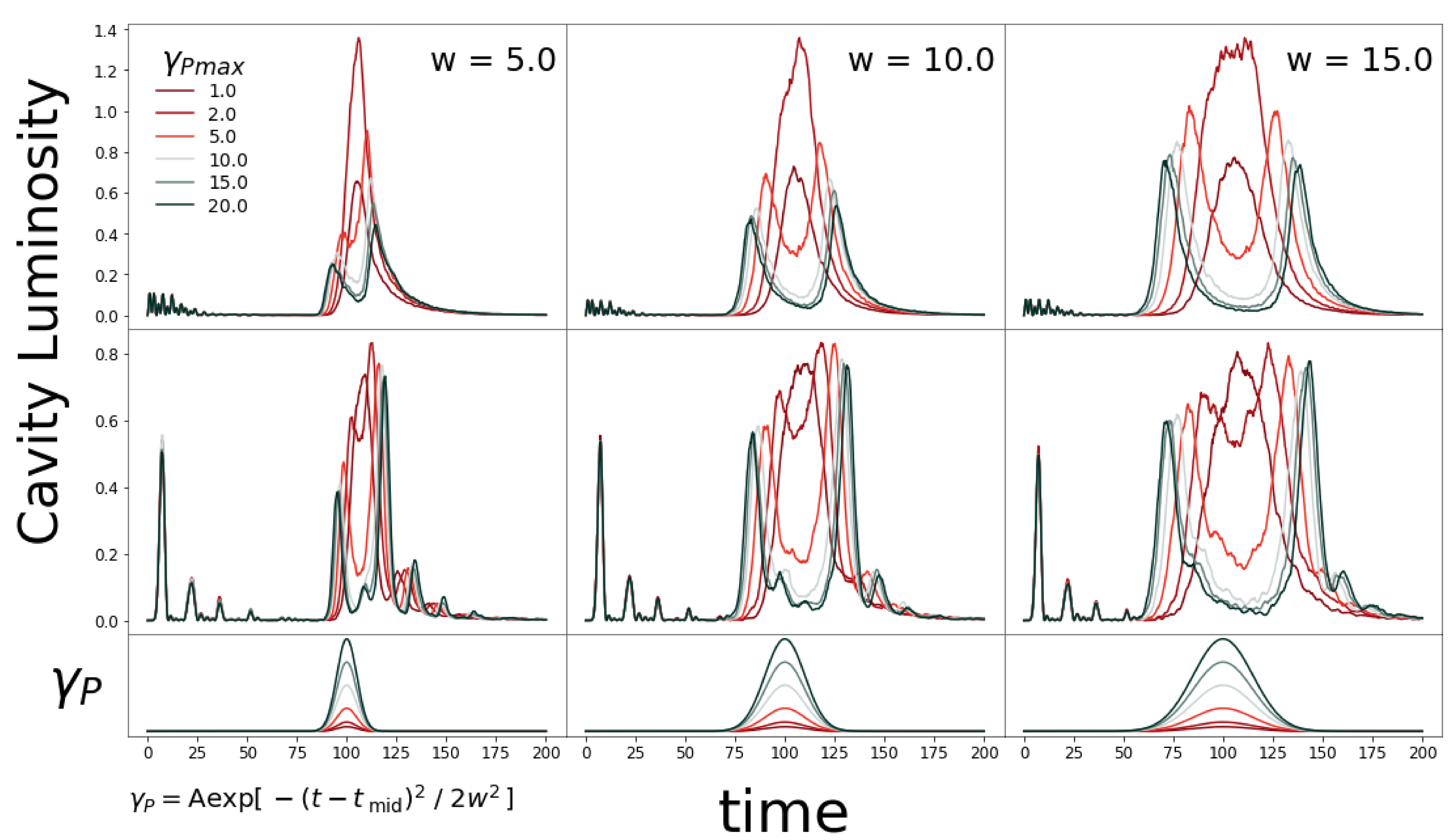
$$H_1 = \sum^{N} \frac{\omega_s}{2}\sigma_i^+\sigma_i^- + \sum^{N-1} \frac{J}{2}(\sigma_i^+\sigma_{i+1}^- + \sigma_{i+1}^+\sigma_i^-)$$

$$H_2 = H_1 + \omega_c a^\dagger a + \frac{1}{\sqrt{N}}\sum_{i=1}^{N} g(a^\dagger\sigma_i^- + a\sigma_i^+)$$

- We define **three photo-detector models**







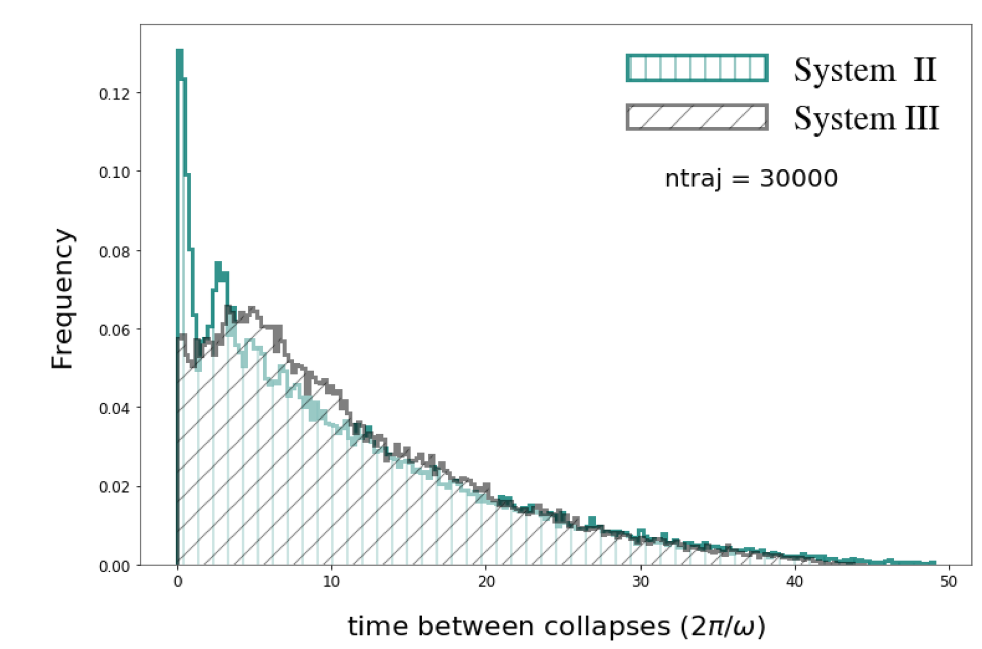
Method

- Quantum Toolbox in Python (QuTiP)
- Monte Carlo Trajectories: average solutions through stochastic collapse procedure
- Collapse operators can have constant or time-dependent coefficients

Results

Time-independent collapse rates

- Wait time distributions
- System II: bunched photon emission
- System III: more random photon emission



Time-dependent driving rate

- Turning the driver off: peak in luminosity
- System III shows population inversion at peak
- Cavity pulse separation dependent on shape of input pulse
  - indication of threshold pump rate before saturation in system
  - System II has less featured output

UNIVERSITY of HOUSTON

NSF

THE Welch FOUNDATION

UNIVERSITY of HOUSTON OFFICE OF UNDERGRADUATE RESEARCH

See code, references, and more info →