

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

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

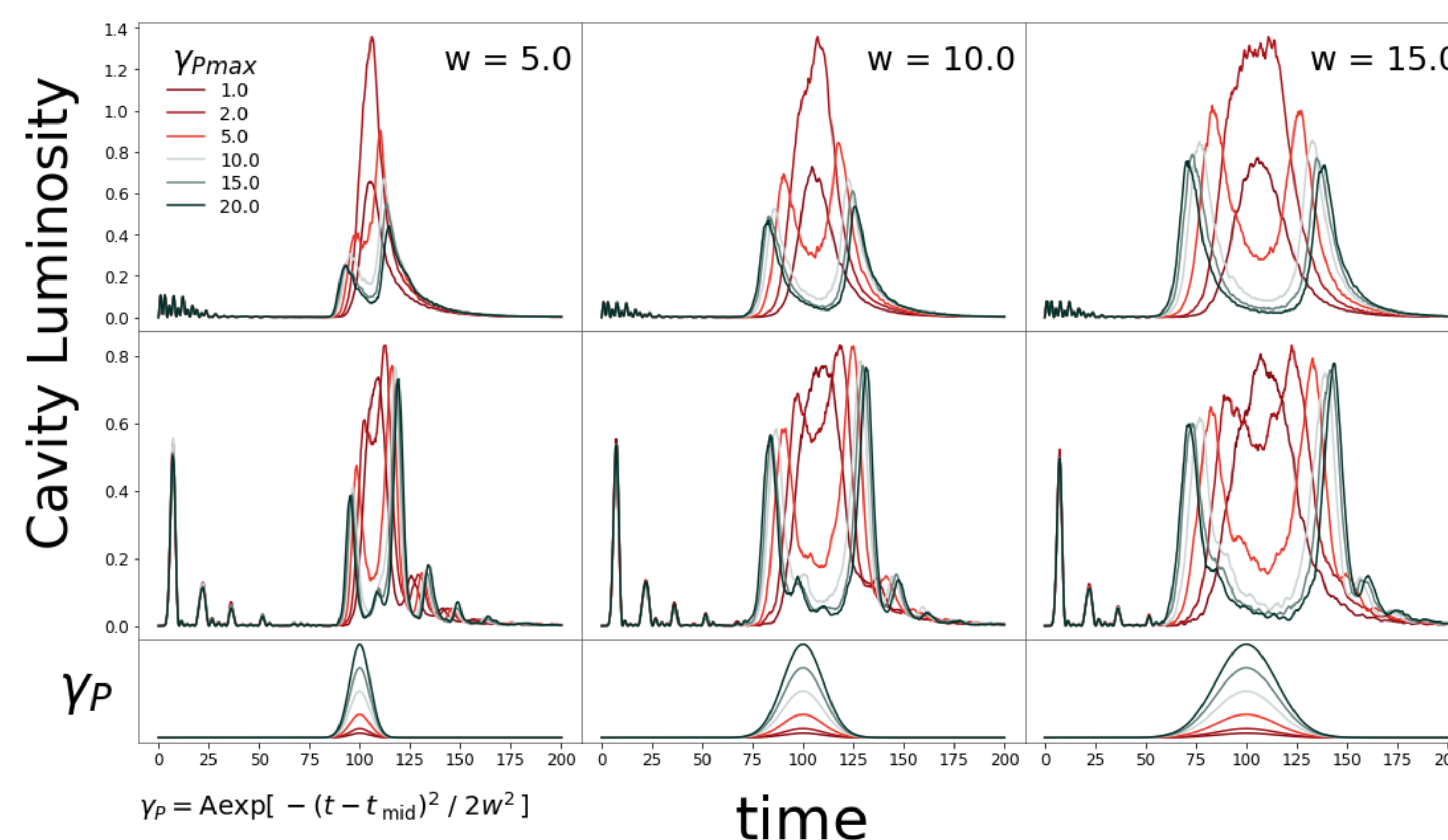
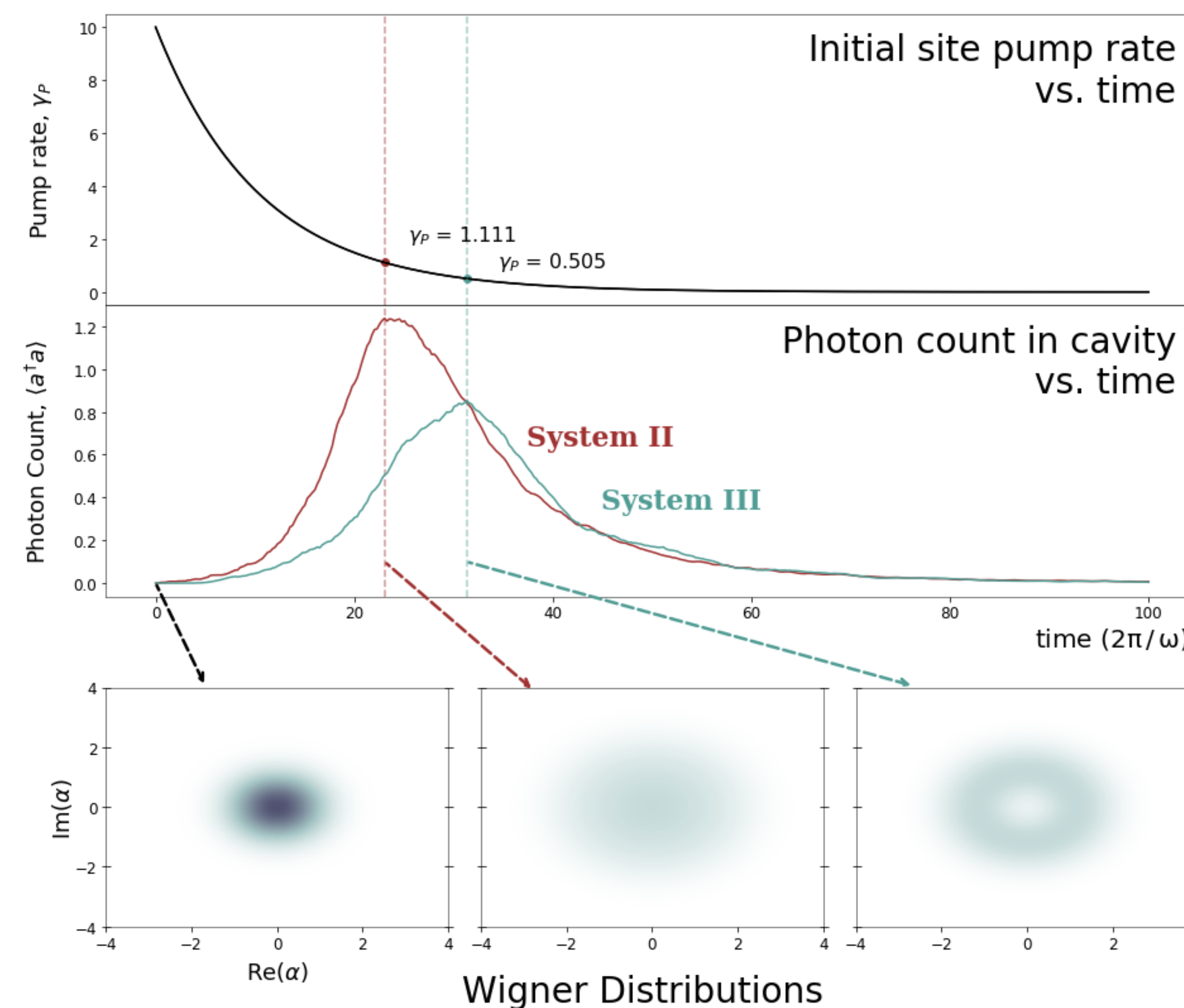
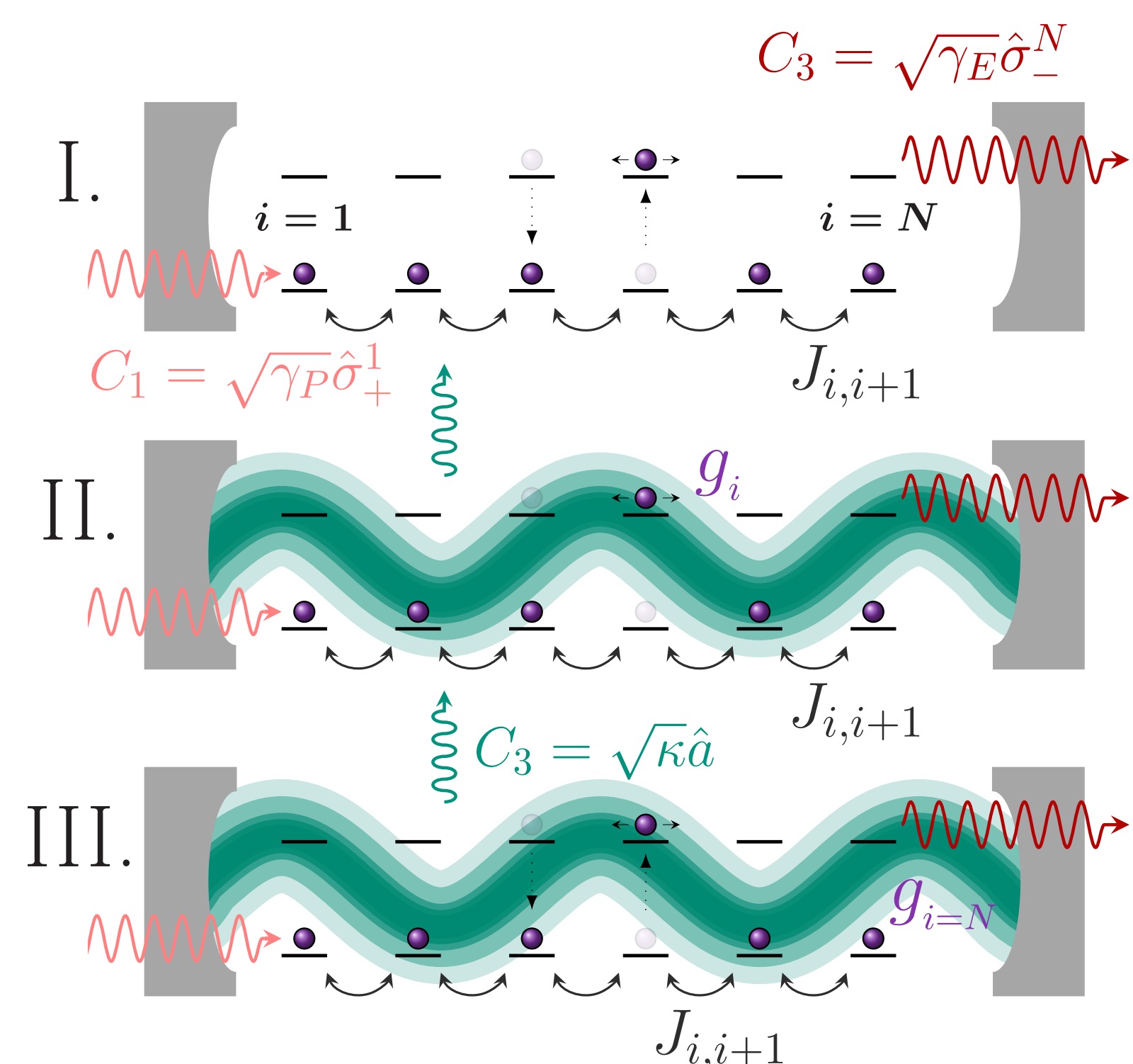
Model

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

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

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

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



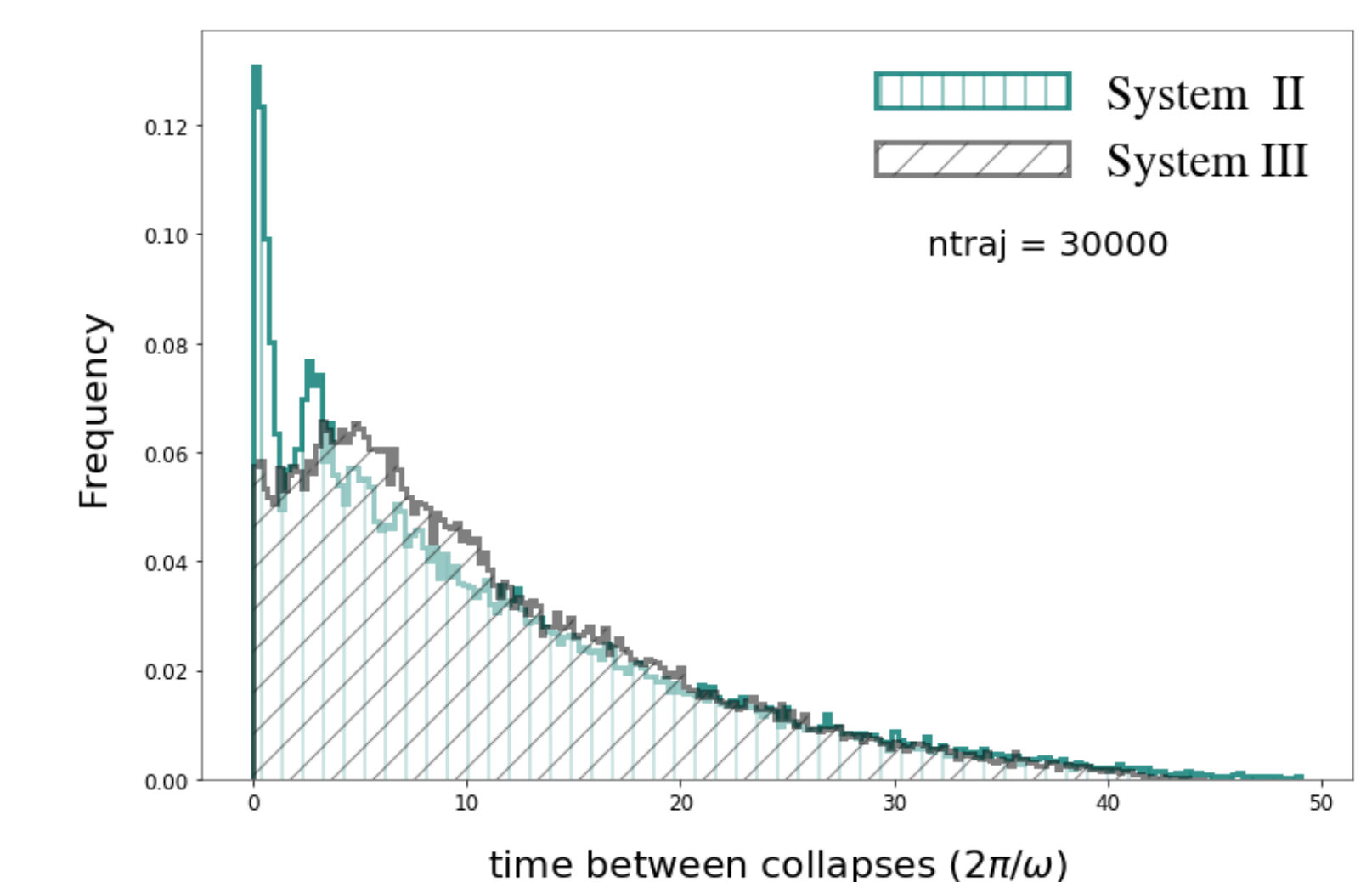
Method

- 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

