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Utilizing the Noise: Quantum Simulation of an Open System

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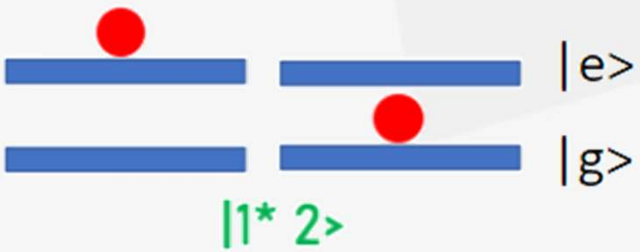
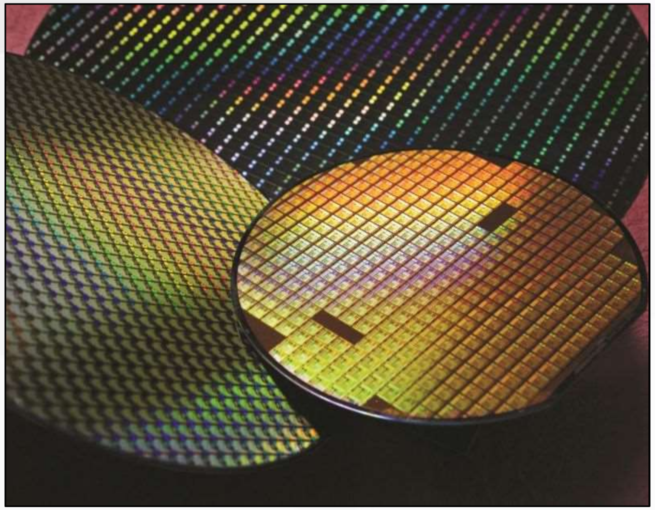
Model System: Simple Symmetric Dimer Model





https://www.ks.uiuc.edu/Research/fmo/

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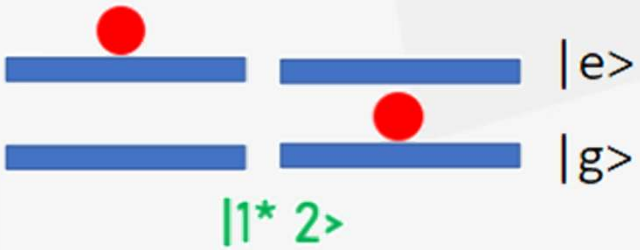
Model System: Simple Symmetric Dimer Model



$$H = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \qquad H = a_1^{+} a_2 + a_1\, a_2^{+}$$

$$a_n^{+} = \frac{1}{2}(X_n - iY_n) \qquad a_n = \frac{1}{2}(X_n + iY_n)$$

$$\widetilde{H} = \frac{1}{2}(X_1X_2 + Y_1Y_2)$$

Map the system to a two-qubit system with qubit Hamiltonian.

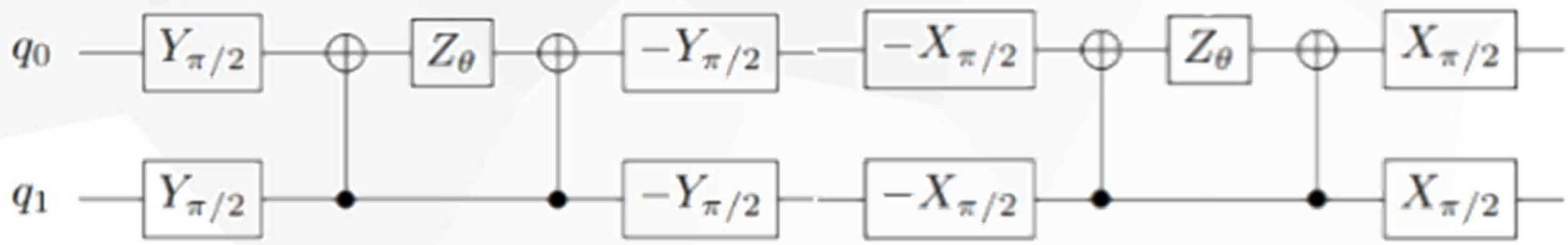
Trotterization and Quantum Evolution Circuit

Use local quantum gates by the a Jordan-Wigner-like transformation.

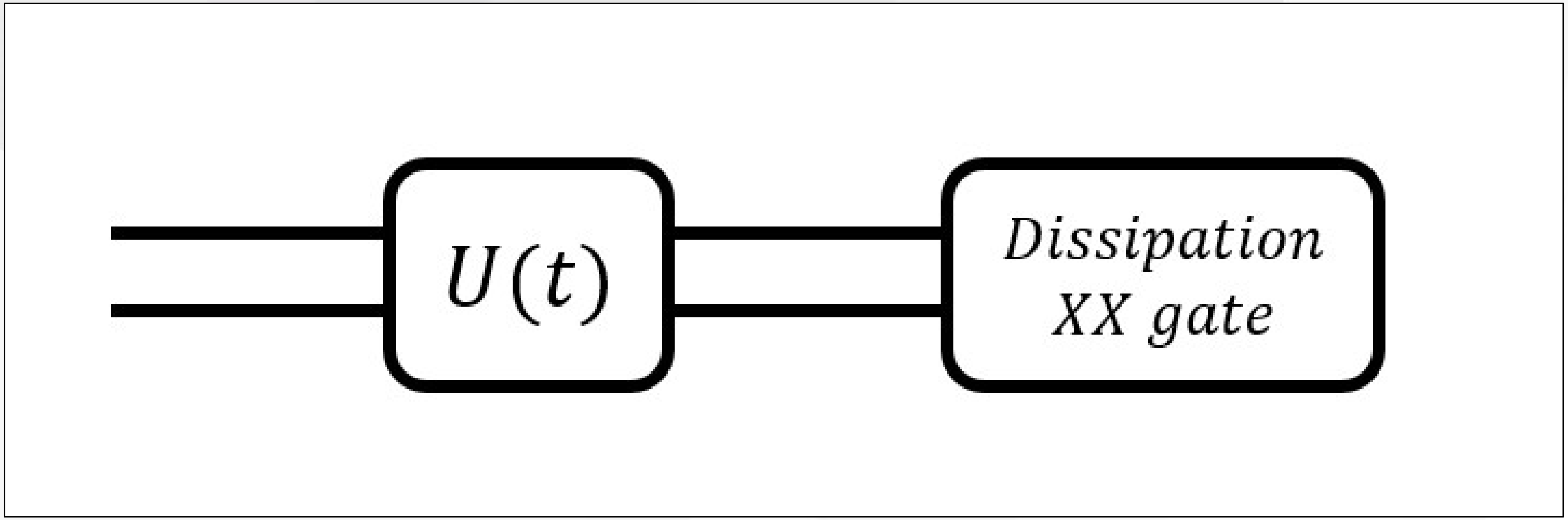
Use trotter expansion to propagate the dynamics.

$$e^{i(A+B)t} = \lim_{n\to\infty}(e^{iAt/n}e^{iBt/n})^n \qquad |\Psi(t+\delta t)> \approx e^{-iA\delta t}e^{-iB\delta t}|\Psi(t)>$$

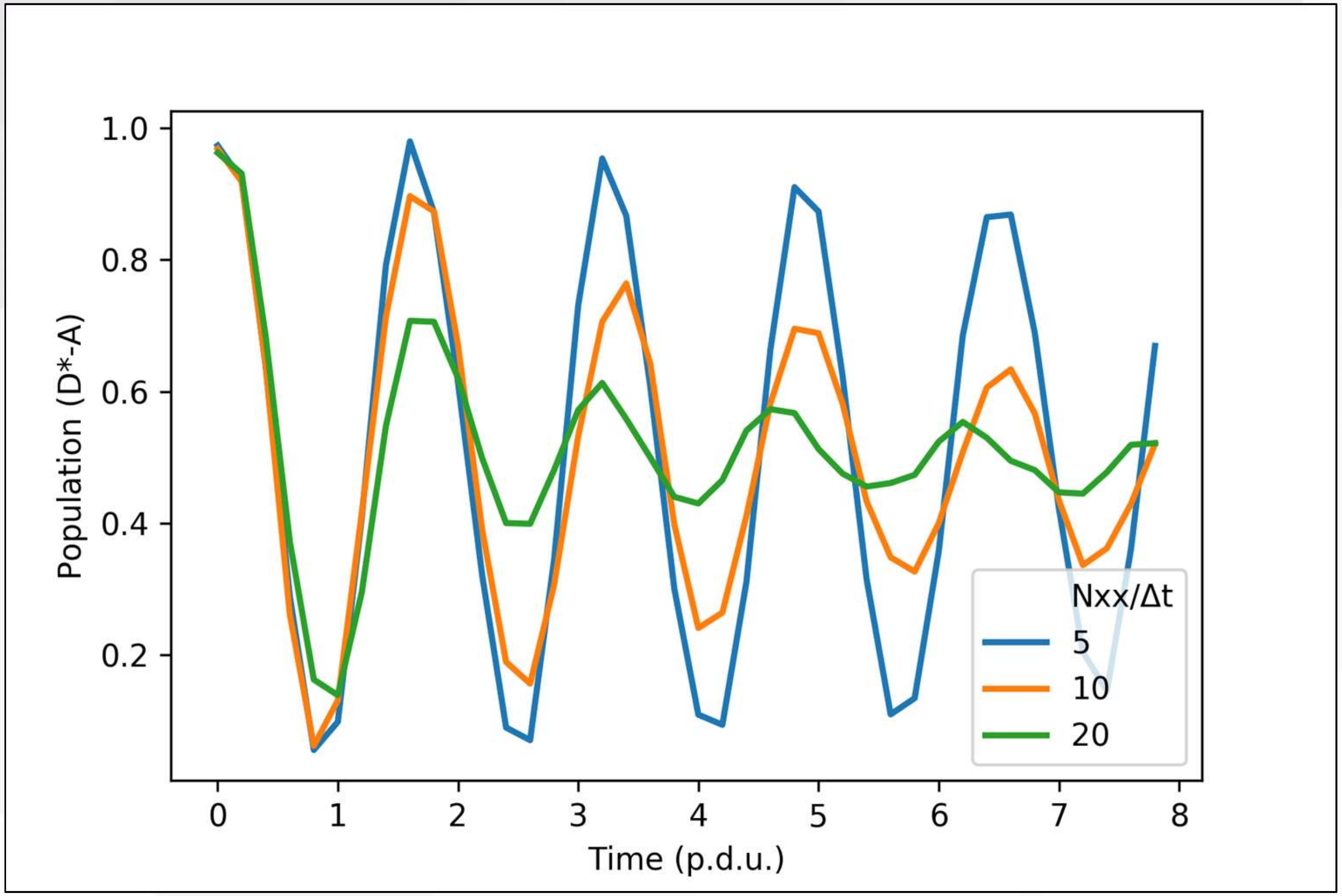
Quantum circuits for time evolution:



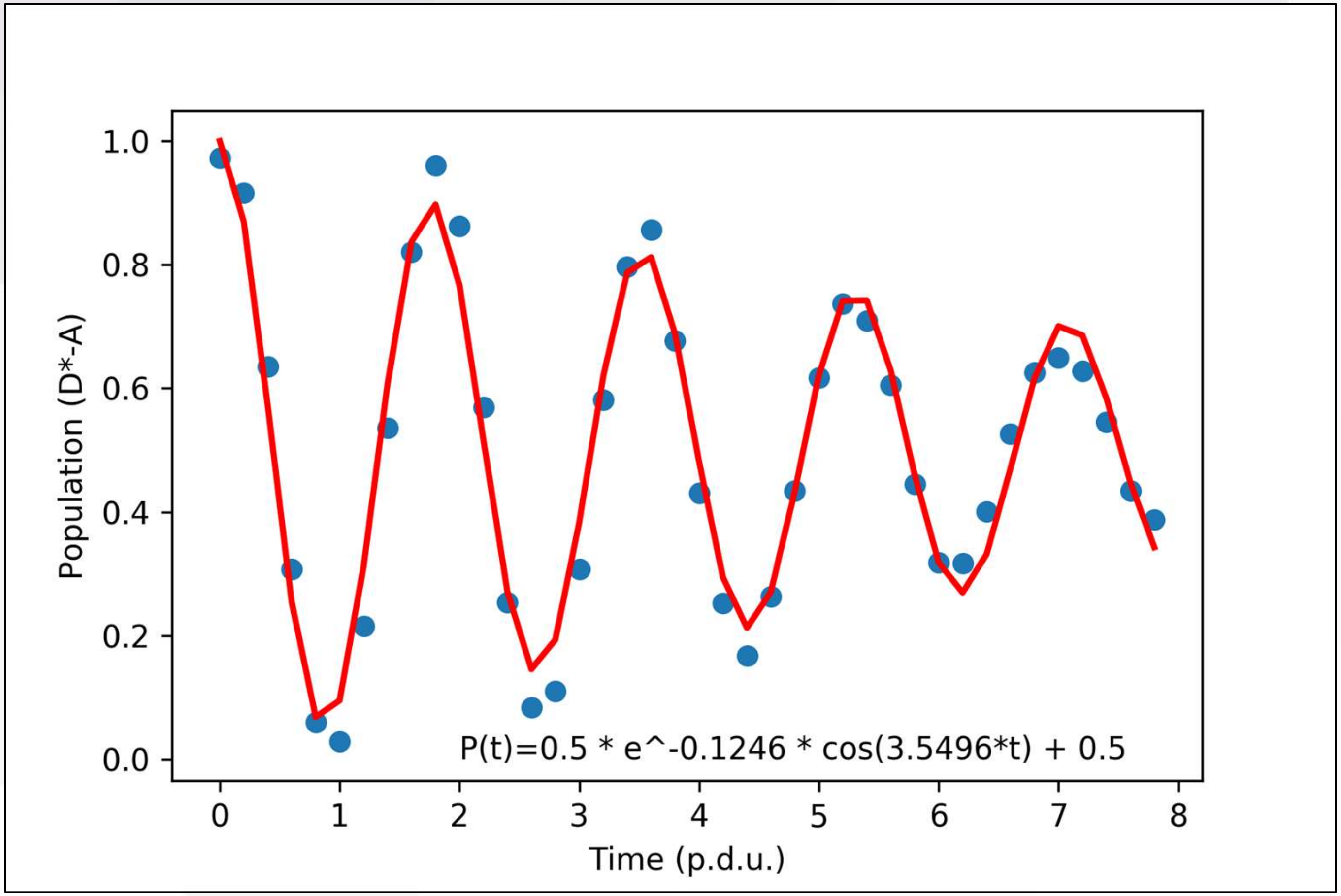
Introduce the Noise



Different Decoherence Rates



Data Fitting



Outlook

A

Extending our methods to asymmetric dimer model

B

More systematic analysis to gain more insight into the dynamics of open quantum system

END

THANK YOU