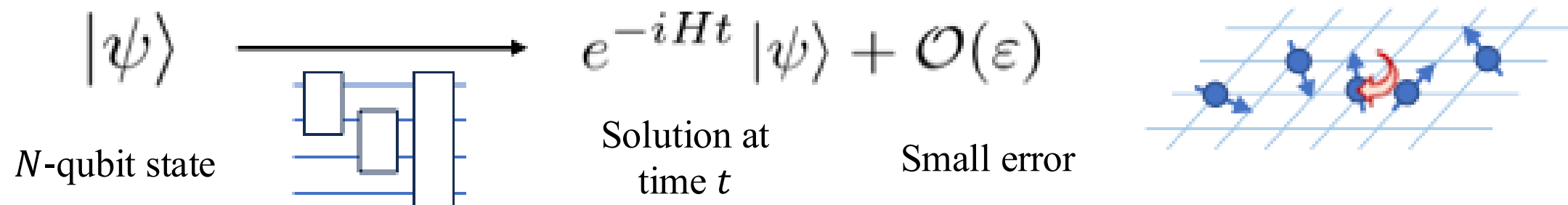


1. Intro: Hamiltonian simulation

■ **Hamiltonian simulation** Solve Schrodinger equation with quantum computers



- Potential exp. speedup

- Application to physics & chemistry

Goal: What is the **fastest** quantum algorithm achieving the best scaling in size N , time t , and error ϵ ?

■ Various quantum algorithms

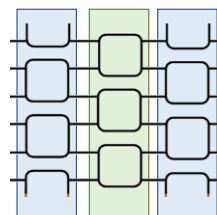
[Product formula (PF)] or Trotterization

$$T_p(\tau) = e^{-iH\tau} + \mathcal{O}(\tau^{p+1})$$

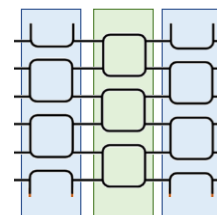
e.g. $T_1(\tau) = e^{-iH_2\tau} e^{-iH_1\tau}$

$$T_2(\tau) = e^{-iH_1\tau/2} e^{-iH_2\tau} e^{-iH_1\tau/2}$$

S. Lloyd, Science 273, 1073 (1996)



...



[Linear combination of unitaries (LCU)]

/ **[Quantum singular value transform (QSVT)]**

$$e^{-iHt} = \sum_{n=0}^q \frac{(-iHt)^n}{n!} + \mathcal{O}\left(\frac{(\|H\|t)^{n+1}}{n!}\right)$$

D. W. Berry, et al.,
PRL 114, 090502 (2015).

A. Gilyén, et al., STOC 2019

