**Noisy Quantum Computing**

Wei-Min Zhang

Department of Physics, National Cheng Kung University, Tainan, 70101 Taiwan

Email: wzhang@mail.ncku.edu.tw

**Abstract:**

Based on the general theory of quantum devices as an open quantum system we developed for electronic systems, photonic systems and topological systems, we find that no unitary operations or manipulations could be performed for any realistic quantum systems, no matter it is a superconducting qubit system, or a photonic quantum circuit or a superconductor-semiconductor hybrid system of Majorana zero modes for topological quantum computer. Quantum manipulations are all noisy, not only for intermediate-size but for all kind of size quantum algorithms. No practical unitary evolution (operation) exists for subparts of multi-qubit systems. The thermalization of multi-qubit systems is universal and probability is intrinsic, therefore probably only quantum simulation is reliable.

**References:**

1. H. L. Lai, and Wei-Min Zhang\*, *Decoherence dynamics of Majorana qubits under braiding operations*, [Phys. Rev. B **101**, 195428 (2020)](https://journals.aps.org/prb/pdf/10.1103/PhysRevB.101.195428).

2. Y. W. Huang, P. Y. Yang and Wei-Min Zhang\*, *Quantum theory of* *dissipative topological systems*, [arXiv: 1909.10188](https://arxiv.org/abs/1909.10188) , [Phys. Rev. B **102**, 165116 (2020)](https://journals.aps.org/prb/pdf/10.1103/PhysRevB.102.165116).

3. F. L. Xiong and Wei-Min Zhang\*, *Exact dynamics and thermalization of open quantum systems coupled to reservoirs through particle exchanges* [arXiv:2003.09598](https://arxiv.org/abs/2003.09598), [Phys. Rev. A **102**, 022215 (2020)](https://journals.aps.org/pra/pdf/10.1103/PhysRevA.102.022215).

4. C. Z. Yao and Wei-Min Zhang\*, *Probing topological states through the exact non-Markovian decoherence dynamics of a spin coupled to a spin bath in real-time domain,* [arXiv:2004.04380](https://arxiv.org/abs/2004.04380), [Phys. Rev. B 102, 035133 (2020)](https://journals.aps.org/prb/pdf/10.1103/PhysRevB.102.035133).

5. Md M. Ali, W. M. Huang and Wei-Min Zhang\*, *Quantum Thermodynamics of single particle systems*, [Scientific Reports **10**, 13500 (2020)](https://www.nature.com/articles/s41598-020-70450-y.pdf?origin=ppub).

6. K. T. Chaing and W. M. Zhang\*, *Non-Markovian decoherence dynamics of strong-coupling hybrid quantum systems: A master-equation approach*, [arXiv:2006.16064](https://arxiv.org/abs/2006.16064), [Phys. Rev. A **103**, 013714 (2021)](https://journals.aps.org/pra/abstract/10.1103/PhysRevA.103.013714).

7. Y. J. Sun and W. M. Zhang\*, Modeling neuronal system as an open quantum system, [arXiv:2104.09424](https://arxiv.org/abs/2104.09424), [Symmetry **13**, 1603 (2021)](https://www.mdpi.com/2073-8994/13/9/1603) (for Special Issue: Quantum Information Applied in Neuroscience).

8. F. L. Xiong, H. L. Lai, and Wei-Min Zhang\*, Generating Majorana qubit coherence without braiding, [arXiv: 2102.10586](https://arxiv.org/abs/2102.10586), [Phys. Rev. B **104**, 205417 (2021)](https://journals.aps.org/prb/pdf/10.1103/PhysRevB.104.205417).

9. F. L. Xiong and Wei-Min Zhang\*, Controlling the dynamics of dissipationless localized bound states in open quantum systems with periodic driving fields, [arXiv: 2106.03446](https://arxiv.org/abs/2106.03446), [Phys. Rev. A **104**, 062206 (2021)](https://journals.aps.org/pra/pdf/10.1103/PhysRevA.104.062206)

10. W. M. Huang and Wei-Min Zhang\*, Nonperturbative renormalization of quantum thermodynamics from weak to strong coupling, [arXiv:2205.08114](https://arxiv.org/pdf/2205.08114.pdf), [Phys. Rev. Research, **4**, 023141 (2022)](https://journals.aps.org/prresearch/pdf/10.1103/PhysRevResearch.4.023141).

11. C. Z. Yao1 and Wei-Min Zhang\*, The differential conductance tunnel spectroscopy in an analytical solvable two-terminal Majorana device, [arXiv:2112.13554](https://arxiv.org/pdf/2112.13554.pdf), [New J. Phys. **24**, 073015 (2022)](https://iopscience.iop.org/article/10.1088/1367-2630/ac7c85/pdf).

12. Y. W. Huang and W. M. Zhang\*, Exact master equation for generalized Quantum Brownian motion with momentum-dependent system-environment couplings, [arXiv:2204.09965 (2022)](https://arxiv.org/pdf/2204.09965.pdf), Phys. Rev. Research (accepted, 2022).

13. W. M. Huang and W. M. Zhang\*, Strong Coupling Quantum Thermodynamics far away from Equilibrium: Non-Markovian Transient Quantum Heat and Work. [arXiv:2206.05772 (2022)](https://arxiv.org/pdf/2206.05722.pdf), Phys. Rev. A (submitted, 2022).