

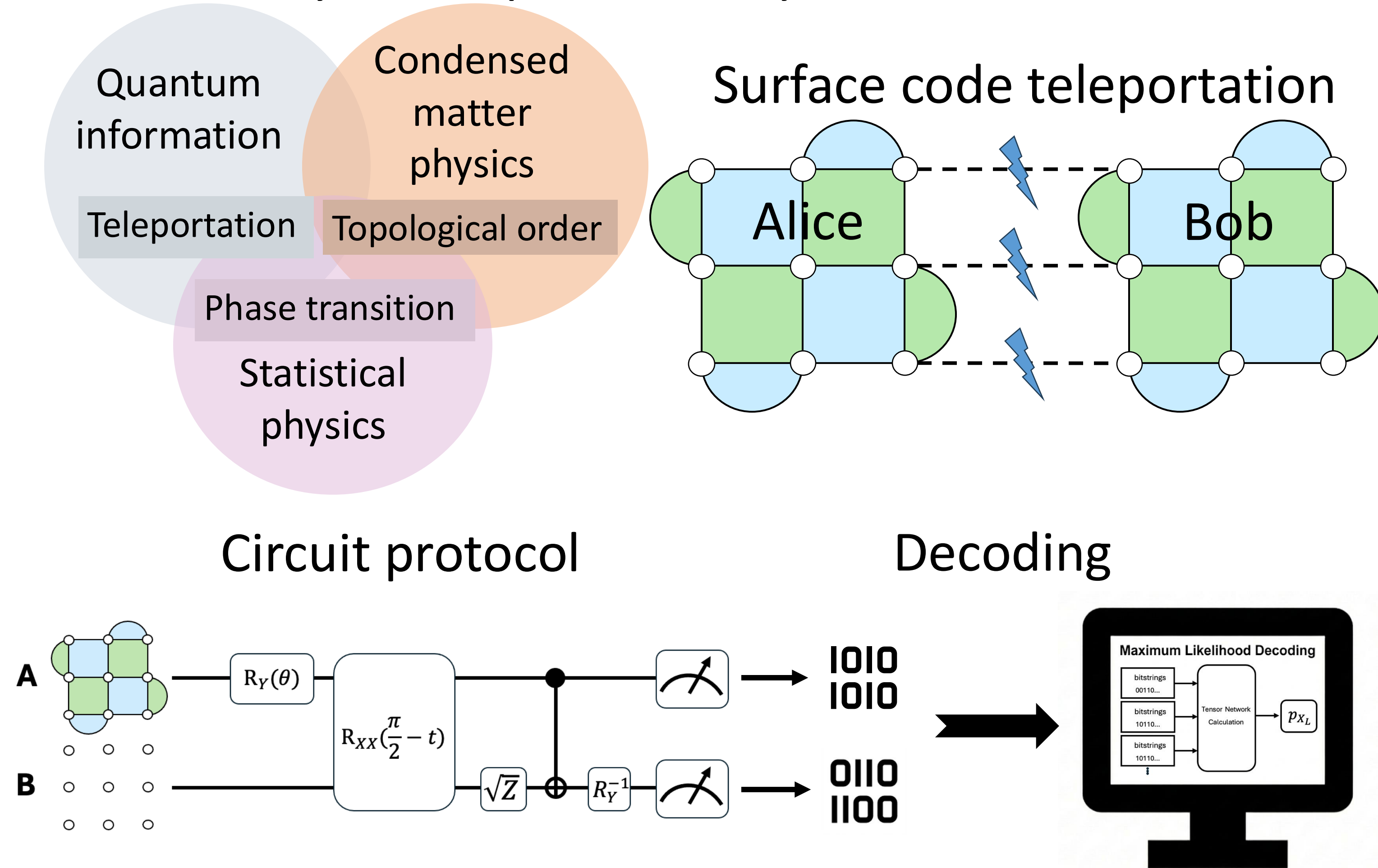
Decoding teleportation transition of long-range entangled state

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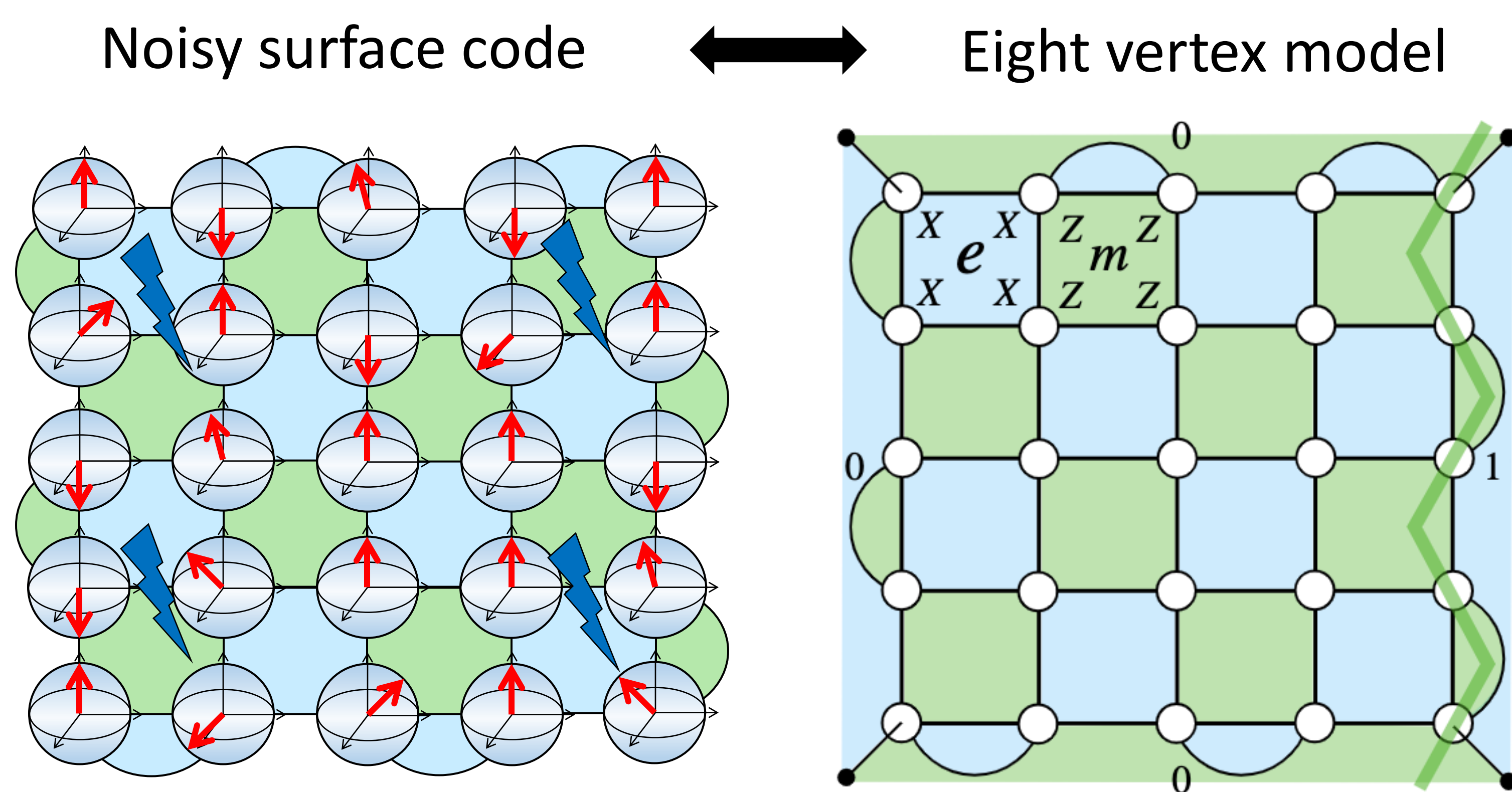
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Introduction

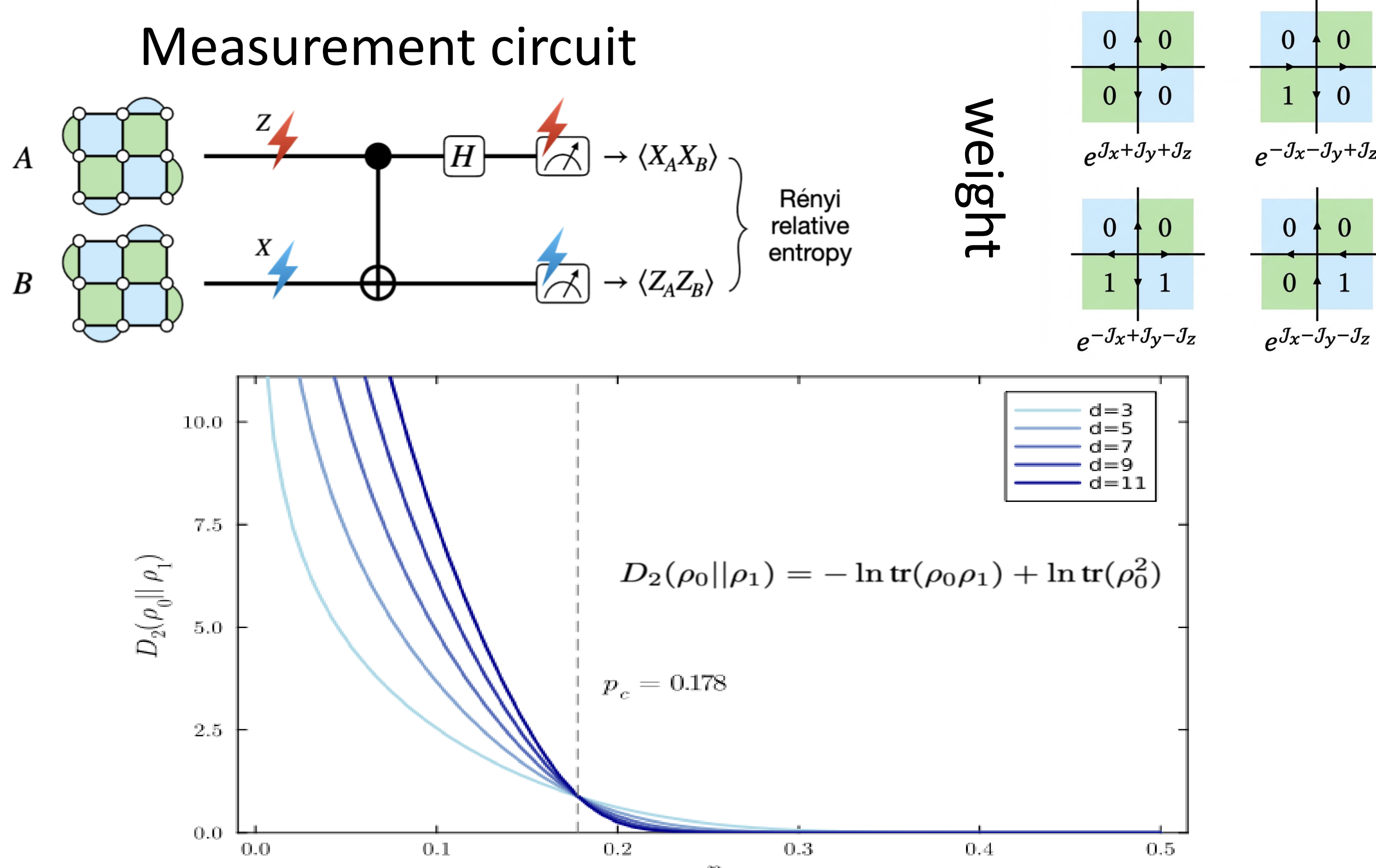
Surface code teleportation enables fault-tolerant distributed quantum computation. However, in realistic experiments, the noise level of the entangled resource determines the success of surface code teleportation. The transition threshold is of significant interest, both theoretically and experimentally.



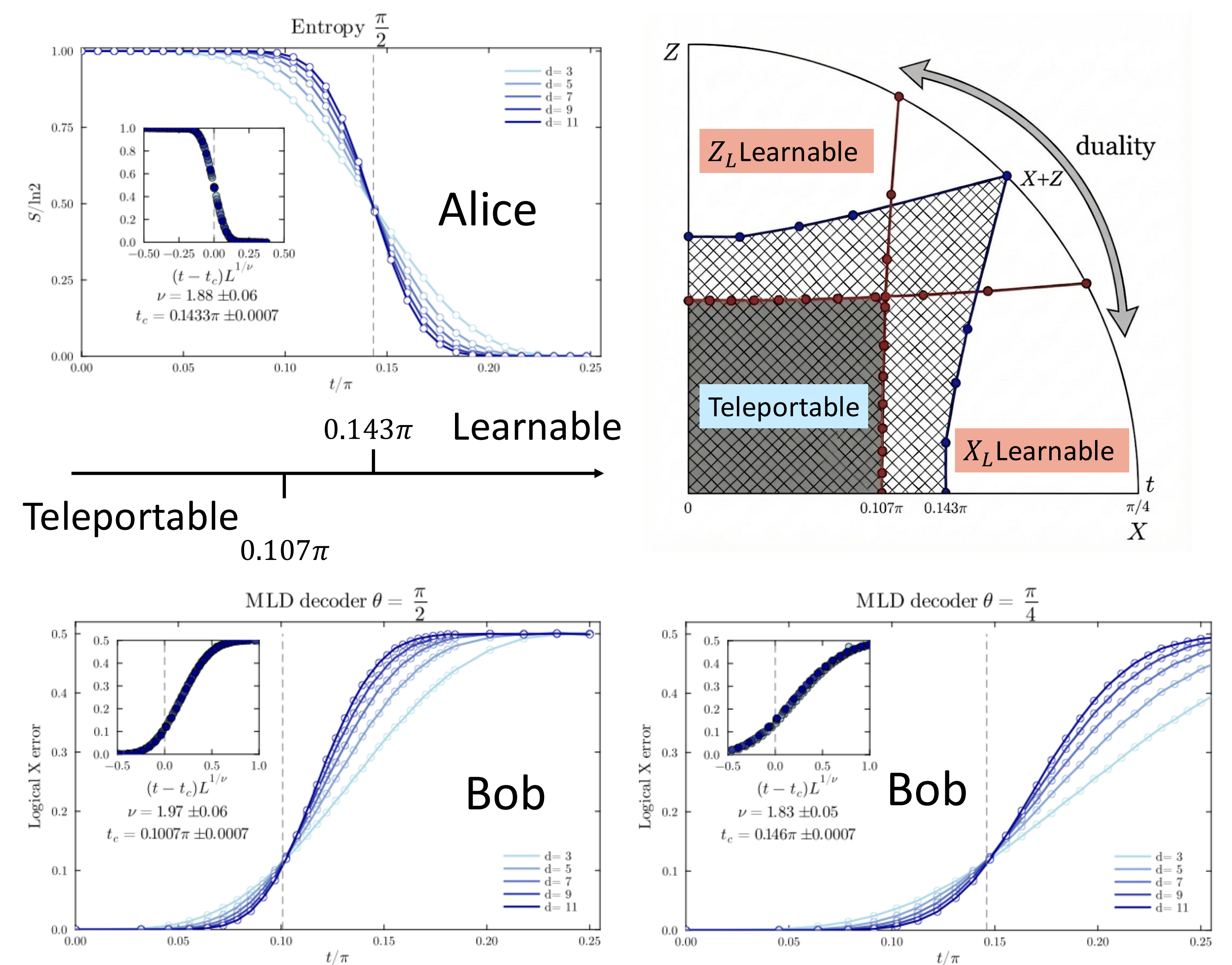
Statistical model



Relative entropy



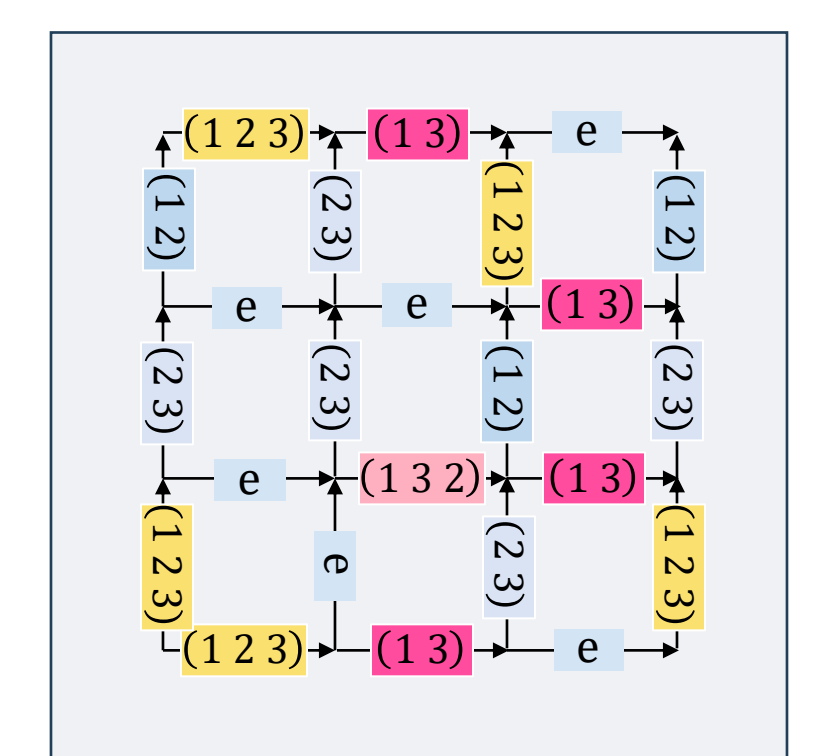
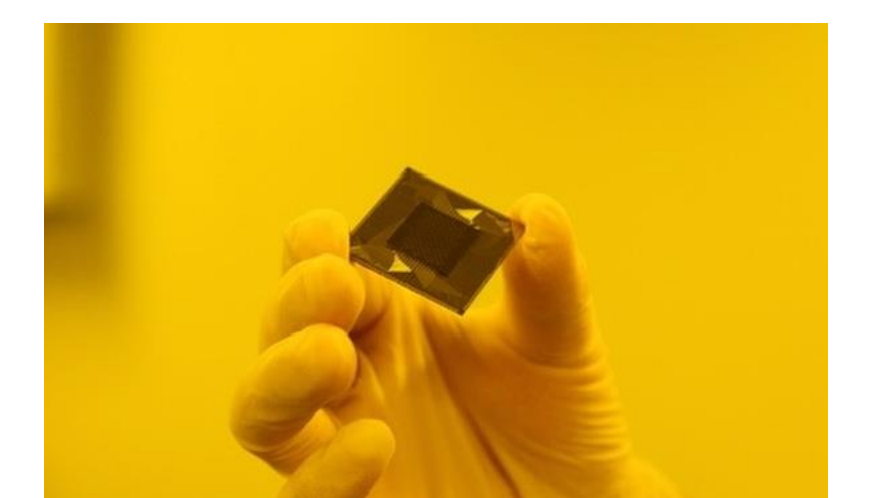
Teleportable and learnable threshold



By tuning the parameter t , Alice and Bob represent learnable and teleportable transition respectively, both belong to Nishimori universality class.

Summary and outlook

In this work, we characterize the statistical physics of the teleportation transition for \mathbb{Z}_2 topological order, while a corresponding experiment on superconducting processors is in preparation. Furthermore, we plan to investigate non-Abelian orders like the S_3 quantum double, which host exotic anyon physics and enable fault-tolerant universal quantum computation.



Reference

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- [2] F. Eckstein, B. Han, S. Trebst, and G.-Y. Zhu, Robust teleportation of a surface code and cascade of topological quantum phase transitions, PRX Quantum 5, 040313 (2024).
- [3] E. Dennis, A. Kitaev, A. Landahl, and J. Preskill, Topological quantum memory, J. Math. Phys. 43, 4452 (2002).