Phase-flip repetition code with realistic noise

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During computation on a quantum hardware the data is subject to noise hence its lifetime is limited.
To preserve information, quantum error correction must be implemented [1]. QEC relies on encoding of data into specific multi-qubit states and stabilizer measurements.
Specific code-stabilizer operators are chosen whose eigenstate is the preferred encoded state. Thus the post measurement state remains identical.
By syndrome extraction we are able to detect errors by kind and apply an appropriate recovery operation to re-establish the noise-free state.
The simplest QEC code is repetition code [2] which consists of data-qubits in row and ancillary-qubits are plugged in between them. If an error occurs in any of the data qubits, it will be indicated by ancillas.
We investigate the optimal code-length by considering a realistic noise such that relaxation, dephasing. Noises are charaterized by coherence times. Our theoretical results would support the quantum computer engineers by what the reasonable code-length is as a function of engineering parameters.

References

[1] Joschka Roffe. “Quantum error correction: an introductory guide”. In: Contemporary Physics
[2] Manuel Rispler et al. “Towards a realistic GaAs-spin qubit device for a classical error-corrected quantum memory”. In: Phys. Rev.

Figures

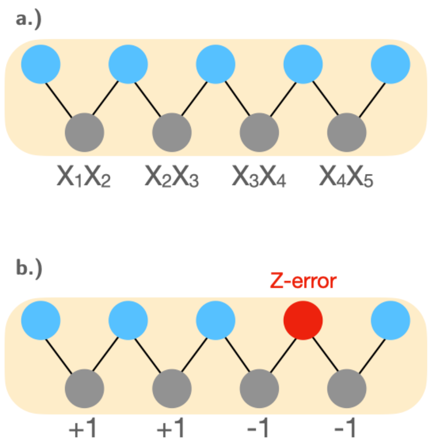

Figure 1: Schematic model of phase-flip repetition code for code distance d=5. In the chain of qubits the blue and grey dots are representing the data and ancillary qubits respectively. Under the ancillary qubits a.) the corresponding measuring operators b.) yielded syndrome are subscribed.

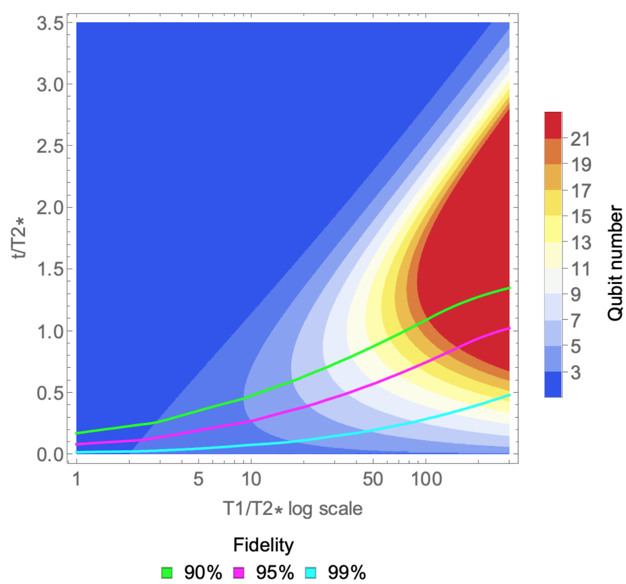

Figure 2: Optimal code-length diagram as a function of the T1,T2* coherence times and t idling time.