Quantum Error Suppression Using a Biased GKP Repetition Code

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If scaled, quantum computation has the potential to solve problems which are intractable on current and future classical systems. However to achieve this noise, which is present in any physical realisation, must be suppressed using Quantum Error Correction (QEC). In Continuous Variable (CV) quantum computation, GKP states have emerged as a promising candidate for bosonic error correction [1]. By modifying the GKP lattice structure, one can introduce a noise bias and then concatenate with a qubit level code which exhibits improved performance in the presence of bias [2].

In this work we study the code capacity behaviour of a rectangular lattice, biased GKP mode concatenated with an n-qubit repetition code which benefits from simple encoding, decoding and stabiliser measurements compared to full QEC codes. Under the Gaussian Displacement Channel we find this code suppresses error rates compared to a bare GKP qubit for a channel standard deviation up to $\sigma \approx 0.595$. In a low noise regime ($\sigma < 0.4$) we also find error rates can be effectively suppressed using just three biased modes, potentially allowing for low overhead error suppression in future implementations.

References

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