# Bosonic Error Mitigation and Suppression with Linear Optics

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Bosonic modes, though promising candidates for quantum computation, are susceptible to noise. In our latest work [1], we propose linear-optical schemes to mitigate bosonic thermal and displacement noise, and suppress bosonic dephasing noise. With photon subtraction gadgets (PSG) endowed with linear attenuation/amplification and constrained statistics, we show that thermal/displacement error cancellation (PSG-PEC) is possible with sufficient amplification gain. On the other hand, with linear optics, vacuum measurements (the vacuum Mach–Zehnder or VMZ) and linear amplification, we prove that arbitrary dephasing noise is *coherently* invertible using infinitely-large interferometers at nonvanishing success rates. No high-order nonlinearities such as Kerr's effect are needed as presumed. Finite-size interferometers are also proven to effectively and *coherently suppress* weak Gaussian-dephasing errors, with the suppression fidelity increasing with the interferometer mode number most optimally using Hadamard interferometers. Although PSG and VMZ do not correct dephasing and thermal/displacement errors respectively, they mutually commute in operation and we show that such compatibility between PSG-PEC and VMZ permits the mitigation of composite noise channels, such as thermal-dephasing and displacement-dephasing channels. While all theoretical proofs pertain to idling (storage) noise, numerical evidence also supports the mitigation and suppression of gate errors using these techniques.

## References

[1] Y S Teo, S U Shringarpure, S Cho and H Jeong, Quantum Sci. Technol. **10**, 035003 (2025); DOI: 10.1088/2058-9565/adc82c