Contribution ID: **13** Type: **Poster contribution**

Noise classification in small quantum networks by Machine learning

Tuesday, 7 May 2024 17:30 (1h 30m)

Characterizing the effects of the interaction between quantum systems and their environment is a key challenge in the development of Quantum Technologies. Among the several possibilities, classifying whether the noise is correlated and Markovian has important implications on the dynamics of the system. In this work we consider the simplest quantum network in which correlations can be identified: the three level system. In particular we consider the position eigenbasis of three quantum dots with time-dependent tunneling rates $\Omega_p(t)$ and $\Omega_s(t)$ and employ the Coherent Tunneling by Adiabatic Passage (CTAP) protocol for system control. We focus on distinguishing among five distinct types of noise: three non-Markovian (quasistatic correlated, anti-correlated, and uncorrelated) and two Markovian (correlated and anti-correlated) through supervised learning. Using different pulse configurations as inputs, we train a feedforward neural network to classify these noise types. Our results show that, while the correlations of the non-Markovian noises can be readily distinguished from each other and from Markovian noise, achieving approximately 99% classification accuracy, the correlations in Markovian noise cannot be classified with our method. Moreover, our approach proves robust against statistical measurement errors, maintaining its efficacy even with a limited number of measurements.

Abstract category

Other

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Session Classification: Poster session