Prolonging Coherence in Trapped Ions

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Abstract: We study pulse sequences that dynamically decouple $^9Be^+$ ions from their decohering environment. The noise environment the ions see is artificially synthesized to emulate a variety of physical systems. By incorporating measurement feedback, our locally optimized dynamical decoupling sequences (LODD) attain an order of magnitude improved suppression of noise in certain noise environments compared to known sequences.

1. Summary

Efficient suppression of decoherence is a key challenge in many experiments aiming to exploit features of quantum mechanics. Many techniques to this end were developed, and are today widely employed, in the nuclear magnetic resonance community. Improving these capabilities are becoming increasingly relevant in the field of quantum information science, in which stringent fidelity requirements exist for the implementation of fault-tolerant quantum computing.

Here we report the implementation of new techniques for the suppression of decoherence [1]. In particular we use adaptive measurement feedback to optimize the delay times between applied decoupling pulses. We find that the pulse sequences so obtained outperform known sequences in certain noise environments [2,3]. This study hints at the potential power of using adaptive feedback in the context of noise suppression.

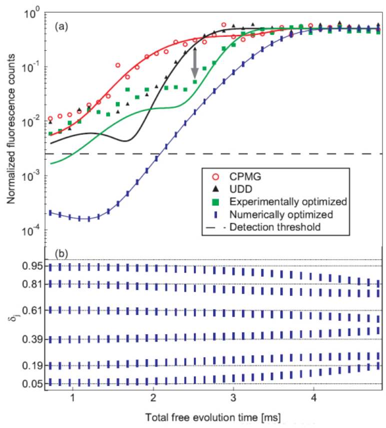

Figure 1: (a) Comparison of 6π-pulse CPMG (open circles), UDD (black triangles) and a sequence optimized via measurement feedback (green squares) at a free evolution time of $\tau = 2.4$ ms. The gray arrow indicates the improvement gained over UDD at that time. Note the log scale. The blue line with vertical dashes represents a LODD simulation adjusting the pulse timings to give optimum error suppression at each point along the curve. It shows an improvement of at least an order of magnitude over UDD at most times. The timing of each pulse sequence (relative to each corresponding total free evolution time) is shown in (b) on the same time axis. The dotted lines in (b) show the pulse timings of the UDD sequence. The horizontal dashed line in (a) indicates the current detection threshold of our system. In all cases the same ohmic spectrum with a sharp cutoff around 500 Hz was used.

2. References

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