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Heisenberg scaling of time-limited quantum metrology with realistic decoherence MAXIME HARDY, WILLIAM A. COISH, Department of Physics, McGill University, Montreal, Quebec, Canada H3A 2T8 — The prospect of using entanglement to improve various metrology tasks is one of the most promising avenues for a near-term real-world benefit from genuine quantum phenomena [1]. However, in the standard scenario, history-independent Markovian dephasing removes the quantum advantage [2]. We revisit the problem of quantum metrology using the model of trapped ions subject to non-Markovian phase damping decoherence caused by Gaussian noise with finite correlation length and time (a slight generalization of the model used in Ref. [3]). Assuming a fixed available measurement time shorter than the noise correlation time (the non-Markovian limit) and a noise source that is local in space, we recover Heisenberg scaling ($\sim$1/N). This allows one to measure an "instantaneous" frequency to a higher precision than the time-averaged noise amplitude and moreover to a higher precision than classically allowed. Interestingly, for this protocol we show that the optimal number of measurements to be performed within the measurement time is three.

[1] V. Giovannetti, S. Lloyd, and L. Maccone Nature Photonics 5, 222 (2011)
[2] S. F. Huelga et al. Phys. Rev. Lett. 79, 3865 (1997
[3] T. Monz et al. Phys. Rev. Lett. 106, 130506 (2011)

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