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Heisenberg-limited Rabi spectroscopy in decoherence free subspaces TOM MANOVITZ, RAVID SHANIV, NITZAN AKERMAN, YOTAM SHAPIRA, ROEE OZERI, Weizmann Institute of Science — One of the techniques for suppressing noise in quantum systems is through the use of decoherence free subspaces (DFSs). A quantum state can be engineered so that it resides in a subspace which is degenerate with respect to the primary noise operators. Any operation performed on the qubits which remains within this subspace is immune to the damages of decoherence. In this work we entangled two ions in a Paul trap in order to create a correlated measurement of their internal atomic transition while in a DFS. We generate an effective $\sigma_x\sigma_x + \delta\sum\sigma_z$ Hamiltonian and scan the detuning δ through the transition resonance, observing a Rabi-spectroscopy peak twice as narrow as the single-ion case. Such an interaction Hamiltonian acts separately on two orthogonal subspaces corresponding to the mean and differential transition frequency of the ions, separating the Hilbert space into two DFSs. Hence, one can measure the differential frequency while remaining immune to decohering mean frequency noise, and vice versa. Furthermore, the narrowing we observed due to the entangling Hamiltonian produces a Rabi spectroscopy measurement which is limited by the energy-time Heisenberg uncertainty relation, previously only demonstrated using Ramsey spectroscopy.

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