Quantum Control for Quantum Computation, Sensing and Imaging

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In this talk recent results from quantum control experiments with trapped ions, doped solids, and superconducting qubits are reported. They include demonstration of broadband composite pulses – trains of pulses with well-defined relative phases – for complete (X gates) and partial (Hadamard and general rotation gates), which cancel the experimental errors to an arbitrary order [1-3]. Alternatively, narrowband composite pulses which squeeze excitation to an arbitrarily narrow parameter range, are used for spatial localization in doped solids and accurate phonon counting in trapped ions [3-6]. The composite idea is extended to new, very efficient dynamical decoupling sequences [7,8]. Another example is the newly proposed quantum control technique of polychromatic pulse trains – sequences of pulses of appropriately chosen different frequencies [9]. In another set of experiments, we have observed the counterintuitive phenomenon of power narrowing with driving pulses of Lorentzian shape – the squeezing of the excitation line profile when the Rabi frequency increases – by as much as a factor of 10 [10], potentially enabling new quantum sensing tools.

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