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Accelerating quantum control of spins in semiconductors with superadiabatic dynamics[1]

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Adiabatic processes are widely used tools in quantum science, providing robust control of spin or motional states and enabling adiabatic quantum simulation. However, the long evolution time required to maintain adiabaticity exacerbates the effect of quantum decoherence. A general strategy termed shortcuts to adiabaticity (STA) aims to remedy this vulnerability by designing judicious fast dynamics to reproduce the results of slow, adiabatic evolutions. Recently, an STA technique known as superadiabatic transitionless driving (SATD) was proposed to provide a flexible set of dressed-state shortcuts [1]. In this talk, I discuss the demonstration of SATD to speed up stimulated Raman adiabatic passage in a solid-state lambda system based on the spin of a single nitrogen-vacancy center in diamond [2]. Driving optical transitions to a dissipative excited state with resonant laser pulses shaped on nanosecond timescales, I characterize the accelerated performance of different SATD shortcuts for the initialization and transfer of quantum states, including coherent superpositions. SATD protocols exhibit robustness to dissipation and experimental uncertainty, and can be optimized when these effects are present. This realization of superadiabatic dynamics in a three-level system suggests useful applications of STA to a variety of dissipative settings, including hybrid quantum systems of spins linked by intermediary couplings.

[1] A. Baksic, H. Ribeiro, and A. A. Clerk, Phys. Rev. Lett. 116, 230503 (2016).
[2] B. B. Zhou, et al., arXiv:1607.06503 (2016). Accepted in Nature Phys.

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