Spin dephasing in a silicon double quantum dot and its implications for spin qubit shuttling

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I will discuss spin dephasing in two scenarios that arise in the context of coherent shuttling of an electron spin qubit. In the first one, an electron is shuttled through a chain of tunnel-coupled quantum dots [1] via adiabatic sweeps of interdot detunings. It turns out that in presence of realistic inhomogeneity of spin splittings in neighbouring quantum dots, both high- and low-frequency noise in detuning determines the dephasing of the electron shuttled between the two dots at low shuttling velocities [2]. In the second scenario, we consider dynamics of a spatially separated spin singlet S in a double quantum dot, in a setup in which one of the dots can also be moved to a distance *d* from the stationary one (and back) with the use of conveyer-belt shuttler [3,4,5]. In such a shuttling experiment, dephasing of S-T_0 superposition is suppressed, compared to the case of stationary dots, due to motional narrowing of the influence of quasi-static local noises in spin splitting [4]. For single-spin Zeeman splitting close to valley splitting in each of the dots, spin-valley coupling leads to mixing of S and T_0 states with one of polarized triplets [5,6,7]. This mixing leads to a very large relative renormalization of S-T_0 precession frequency [5,7] that can be harnessed for measurement of valley splittings in the two dots, and thus for mapping of valley splitting along the shuttling path [5]. I will discuss how the spin-valley mixing modifies the way in which spin-splitting fluctuations in each dot affect the S-T_0 coherence, and how valley splitting fluctuations become active at dephasing of spatially separated singlet near the spin-valley hotspot [8].

[1] A. Milles et al., Nat. Commun. **10**, 1063 (2019); A. M. J. Zwerver et al, PRX Quantum **4**, 030303 (2023).
[2] J. A. Krzywda and Ł. Cywiński, arXiv:2405.12185 (2024).
[3] V. Langrock, J. A. Krzywda et al., PRX Quantum **4**, 020305 (2023).
[4] T. Struck et al., Nat. Comm. **15**, 1325 (2024).
[5] M. Volmer, T. Struck at al., npj Quantum Information **10**, 61 (2024).
[6] X. Cai et al, Nat. Phys. **19**, 386 (2023).
[7] R. M. Jock et al., Nat. Comm. **13**, 641 (2022).
[8] Ł. Cywiński, M. Volmer, T. Struck, and L. R. Schreiber, coming soon.