Quantum Control and Entanglement of Spins in Silicon Carbide

PAUL KLIMOV, The University of Chicago

Over the past several decades silicon carbide (SiC) has matured into a versatile material platform for high-power electronics and optoelectronic and micromechanical devices. Recent advances have also established SiC as a promising host for quantum technologies based on the spin of intrinsic defects, with the potential of leveraging existing device fabrication protocols alongside solid-state quantum control. Among these defects are the divacancies and related color centers, which have ground-state electron-spin triplets with coherence times as long as one millisecond and built-in optical interfaces operating near the telecommunication wavelengths. This rapidly developing field has prompted research into the SiC material host to understand how defect-bound electron spins interact with their surrounding nuclear spin bath. Although nuclear spins are a major source of decoherence in color-center spin systems [1], they are also a valuable resource since they can have coherence times that are orders of magnitude longer than electron spins. In this talk I will discuss our recent efforts to interface defect-bound electron spins in SiC with the nuclear spins of naturally occurring $^{29}$Si and $^{13}$C isotopic defects. I will discuss how the hyperfine interaction can be used to strongly initialize them [2 – 4], to coherently control them, to read them out, and to produce genuine electron-nuclear ensemble entanglement [5], all at ambient conditions. These demonstrations motivate further research into spins in SiC for prospective quantum technologies. [1] Seo et al., Nat. Commun. 7, 12935 (2016) [2] Falk et al., Phys. Rev. Lett. 114, 247603 (2015). [3] Ivady et al., Phys. Rev. B. 92, 115206 (2015). [4] Ivady et al., arXiv:1605.07931 (2016) [5] Klimov et al., Sci. Adv. 1, e1501015 (2015).

1In collaboration with A. Falk, D. Christle, K. Miao, H. Seo, V. Ivady, A. Gali, G. Galli, and D. D. Awschalom. This research was supported by the AFOSR, the NSF DMR-1306300, and the NSF Materials Research Science and Engineering Center.