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Quantum Control and Entanglement of Spins in Silicon Carbide[1]

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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 29Si and 13C 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).

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