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Robust quantum control using smooth pulses and topological winding[1] EDWIN BARNES, Condensed Matter Theory Center and Joint Quantum Institute, Dept. of Physics, University of Maryland, XIN WANG, Condensed Matter Theory Center, Dept. of Physics, University of Maryland — Perhaps the greatest challenge in achieving control of microscopic quantum systems is the decoherence induced by the environment, a problem which pervades experimental quantum physics and is particularly severe in the context of solid state quantum computing and nanoscale quantum devices because of the inherently strong coupling to the surrounding material. We present an analytical approach to constructing intrinsically robust driving fields which automatically cancel the leading-order noise-induced errors in a qubit's evolution exactly. We address two of the most common types of non-Markovian noise that arise in qubits: slow fluctuations of the qubit energy splitting and fluctuations in the driving field itself. We demonstrate our method by constructing robust quantum gates for several types of spin qubits, including phosphorous donors in silicon and nitrogen-vacancy centers in diamond. Our results constitute an important step toward achieving robust generic control of quantum systems, bringing their novel applications closer to realization.

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