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Semiconductor quantum simulator for lattice gauge theories

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Semiconductor spin qubits are ideal for scalable quantum computing due to their long coherence times and compatibility with existing semiconductor fabrication technology. For quantum simulation of lattice gauge theories, the encoding of fermionic d.o.f. into qubits becomes complicated in higher dimensions. Furthermore, encoding with bosonic d.o.f. in a digital scheme introduces additional qubit and gate costs. In a semiconductor platform, the presence of both electrons and (large) nuclear spins provides readily available fermionic and bosonic degrees of freedom, respectively. Moreover, parameters such as tunneling coefficients, chemical potentials, hyperfine couplings, and global magnetic fields are highly tunable. This tunability allows periodic driving of the parameters, which can potentially be used to engineer interactions that simulate gauge dynamics on a lattice.

In this poster, I'll present our ongoing work on implementing an analog simulation scheme for Z2 lattice gauge theory in (1+1)D. The Floquet-Magnus expansion is used to analyze the behavior of the system under high-frequency periodic drives of the parameters involved. Future research will explore the feasibility of implementing an analog or hybrid simulation of gauge theories in (2+1)D on this platform.

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