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Title:	Stabilizing Quatam Simulators of gauge Theories Against 1/f Noise
Authors:	Kumar, Bhavik
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Abstract:	This work investigates the application of quantum simulation in the ongoing ”second” quantum revolution, which employs various synthetic quantum matter platforms, such as ultracold atoms in optical lattices, Rydberg atoms, and superconducting qubits, to realize exotic condensed matter and particle physics phenomena with high precision and control. Gauge theories are of particular interest in modern quantum simulators as they offer a new probe of high-energy physics on low-energy tabletop devices. However, to accurately model gauge-theory phenomena on a quantum simulator, stabilizing the underlying gauge symmetry is crucial. Through this thesis we demonstrate that a recently developed ex- perimentally feasible scheme based on linear gauge protection, initially devised to protect against coherent gauge breaking errors, can also be used to suppress incoherent errors arising from 1/f β noise prominent in various quantum simulation platforms. The Bloch- Redfield formalism is introduced to model gauge violations arising due to these incoherent errors given the noise power spectrum of the environment. The efficacy of linear gauge protection in stabilizing salient features of gauge theories in quantum simulators, such as gauge invariance and exotic far from equilibrium phenomenon focusing on disorder- free localization, and quantum many-body scars against 1/f β noise sources, is illustrated. These results are immediately applicable in modern analog quantum simulators and digital NISQ devices, paving the way for further development in the field of quantum simulation of lattice gauge theories.
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