**Quantum simulations of topological phases on superconducting processors**
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Abstract text: Implementing quantum simulators using superconducting qubits has been attracting growing attention due to flexible designs of microchip fabrication, universal controllability, and high-fidelity readouts. Using a dynamic spectroscopy technique from the response of the system given local perturbations, we measure the topological band structures of Chern insulators on a 30-qubit-ladder processor [1] and show the Hofstadter butterfly energy spectrum on a 43-qubit-chain processor [2]. When combining the measured topological band structure and the observation of dynamical localization of edge excitations, the bulk-edge correspondence in topological phases of matter is demonstrated. Moreover, we experimentally simulate various topological states [1,2] that have never been prepared in real materials. In addition, disorder-induced quantum pumps were realized on the 43-qubit-chain processor [3], and two types of 2nd-order topological pumps were simulated on a (4×4)-qubit processor [4]. Our work will inspire further studies on various topological phases on different quantum-simulating platforms with a larger system size.

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[2] Yun-Hao Shi, Yu Liu, Yu-Ran Zhang, et al., *Quantum simulation of topological zero modes on a 41-qubit superconducting processor*, Physical Review Letters **131**, 080401 (2023).

[3] Yu Liu, Yu-Ran Zhang, Yun-Hao Shi, et al., *Interplay between disorder and topology in Thouless pumping on a superconducting quantum processor*, Nature Communications **16**, 108 (2025).

[4] Cheng-Lin Deng, Yu Liu, Yu-Ran Zhang, et al., *High-order topological pumping on a superconducting quantum processor*, Physical Review Letters **133**, 140402 (2024).