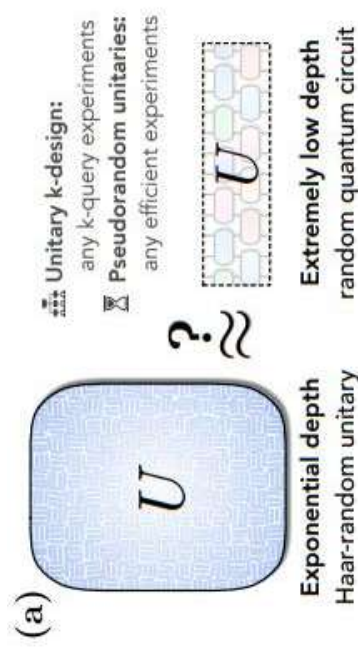


Prof. Dr. Jonas Haferkamp (Saarland University)

Random unitaries from random quantum circuits

Random unitaries are central to quantum technologies and the study of complex quantum many-body physics. However, existing protocols for generating random unitaries require long evolution times and deep circuits. In this work, we prove that local quantum circuits can form random unitaries in extremely low depth on any geometry. These shallow circuits have low complexity and create only short-range correlations, yet are indistinguishable from random unitaries with exponential complexity. This finding contrasts sharply with classical systems, in which a long evolution time is required to appear random. Our results have widespread applications across quantum science, from device benchmarking to quantum advantages. Moreover, they reveal that fundamental physical properties—including evolution time, causal structure, and phases of matter—are provably hard to learn.



Monday, December 8th, 2025
At 12:00 PM
Building E2 6, Room E.04