

Q@TN COLLOQUIUM

Observation of Universal Quantum Chaos at Shallow Depths



SPEAKER

Prof. Jacopo De Nardis

Laboratoire de Physique Théorique et Modélisation (LPTM)

 CY Cergy Paris Université & Collège de France 3 December 2026 14:00 Aula A109

ABSTRACT

Universal statistical laws are a hallmark of quantum chaos. A natural route to probing them in quantum circuits is offered by the statistics of output probabilities, which for sufficiently deep chaotic circuits approach the Porter–Thomas distribution. Here we show, theoretically and experimentally, that the approach to this limit is itself universal, and is organized into geometry-dependent universality classes. At shallow depths, growing only logarithmically with system size, we derive universal output-probability distributions that differ markedly from Porter–Thomas statistics, and we test them on a programmable superconducting processor. Two-dimensional lattices, open one-dimensional chains, and periodic rings exhibit distinct universal forms, retaining signatures of geometry and boundary topology within the same logarithmic-depth regime. Within each class, the distributions depend on only two parameters: an effective many-body Thouless scale and the accumulated number of incoherent errors. Extracting these directly from measured bitstring frequencies provides access to scrambling, entanglement growth of the target state, and global fidelity, without reconstructing or classically simulating the implemented circuit. We also identify a noise-driven transition between output statistics retaining system-wide quantum correlations and those reproducible by independent small patches. Our results establish universality beyond Porter–Thomas statistics as a quantitative tool for characterizing noisy quantum processors.

Reference: arxiv.org/pdf/2609.28623

Contacts

Staff Dipartimento di Fisica

 +39 0461 281219 info.qtn@unitn.it

Scientific Coordinators

Prof. P. H. J. Hauke

Prof. S. Mazzucchi

Dr. G. Pucker

With the financial support of

FONDAZIONE
CARITRO

CASSA DI RISPARMIO DI TRENTO E ROVERETO