

Call 2021
Final Evaluation



DQUANT

Dissipative Quantum Chaos Perspective on Near-Term Quantum Computing

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5 partners · PT · SI · DE · NO · PL · April 2022 – September 2025

Website:

sites.google.com/tecnico.ulisboa.pt/dquant/

COLLABORATION

THE ORIGIN. Before DQUANT we were competitors. Ribeiro & Prosen and Denysov & Życzkowski were racing each other on the spectra of random Lindbladians. Luitz was reaching the same physics from error mitigation. DQUANT put the competing groups in one team.



GEOGRAPHICAL BREADTH. 5 partners, 5 countries
Academic consortium
3 widening (PT, SI, PL) plus DE and NO.



INTERDISCIPLINARITY – Random Matrices; Non-Equilibrium; Open Quantum Systems; Many-Body Systems; Quantum Information;



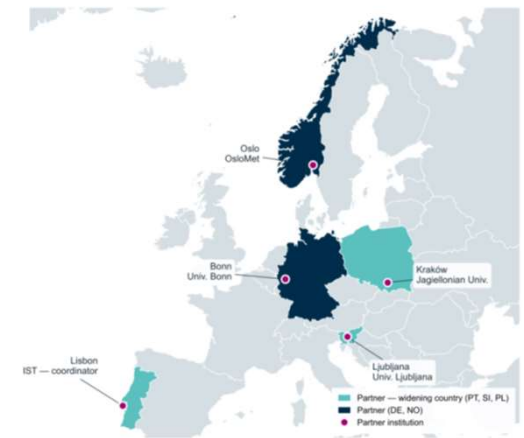
QUALITY OF COOPERATION. Weekly online work-package meetings for 3.5 years; 10 consortium meetings (Lisbon, Évora x2, Nordita Stockholm); PhD and MSc students co-supervised across sites. Many two- and three-group papers. Two papers with all five groups.



INFRASTRUCTURE. Theory consortium: shared code and cluster time. Hardware through IBM Quantum cloud, a contracted VTT device.



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SUCCESS STORY



CHALLENGE. Every NISQ processor is an open quantum system. The field's answer is to fight decoherence. We asked the opposite question: what if you model the noise as physics and use it?



SOLUTION. Dissipative quantum chaos: random-matrix descriptions of noisy many-qubit dynamics. Each former rival group brought one strand; the project merged them.



OUTCOME 1 — a periodic table for dissipative dynamics (symmetry classification of Lindbladians, PRX).

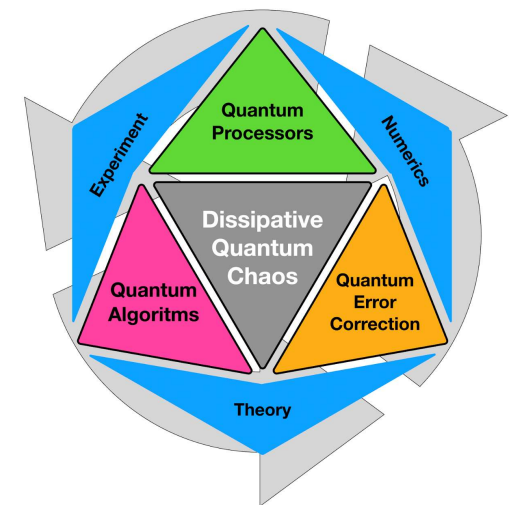
OUTCOME 2 — algorithms that read the noise model off real hardware, jump operators and non-Markovian rates included.

OUTCOME 3 — universal laws for error accumulation, and noise-aware algorithm design that follows from them.

UNPLANNED. An experiment we proposed (Zhejiang); two industrial users (VTT, Ruter); a COST Action, QOpen, that now carries the network; two ERC Advanced Grants to consortium PIs.



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1 — A periodic table for open dissipative dynamics

Symmetry classification of many-body Lindbladians

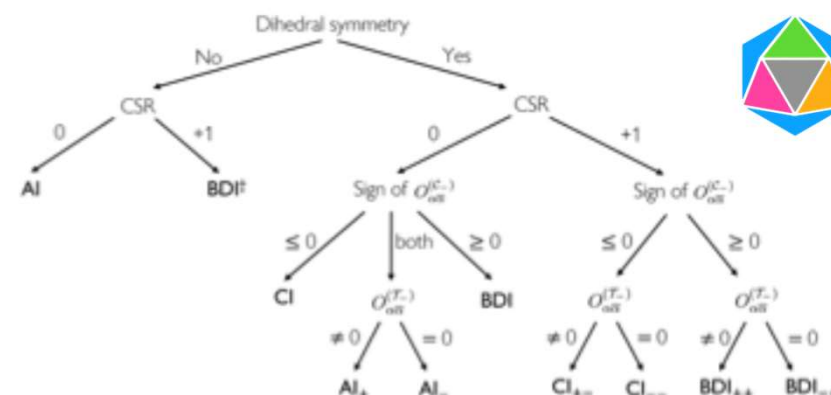
Phys. Rev. X 13, 031019 (2023) — IST + Ljubljana

Altland–Zirnbauer symmetry classification, carried over to open systems: classes differ not only in their spectra but in matrix-element structure and steady states.

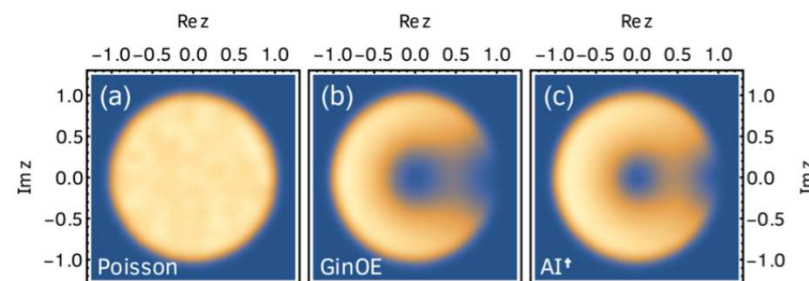
Extended to free-fermion Liouvillians — SciPost Phys. 15, 145 (2023).

And to classical stochastic processes — J. Stat. Phys. 192, 41 (2025).

Why this matters: this is characterizes generic features of dissipation rather than how it acts in one particular noisy device.



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2 — Reading the noise model off the chip

From measurement data to the generator of the dynamics

IST + OsloMet, with H. Wang's group (Zhejiang)

Machine-learning reconstruction of the quantum map from Pauli data — arXiv:2405.11625. On IBM devices the spectrum fills a single ring, and the support turns from ring to disk as depth grows.

Quantum Liouvillian tomography — arXiv:2504.10393: the time-dependent generator itself, including jump operators and non-Markovian rates.

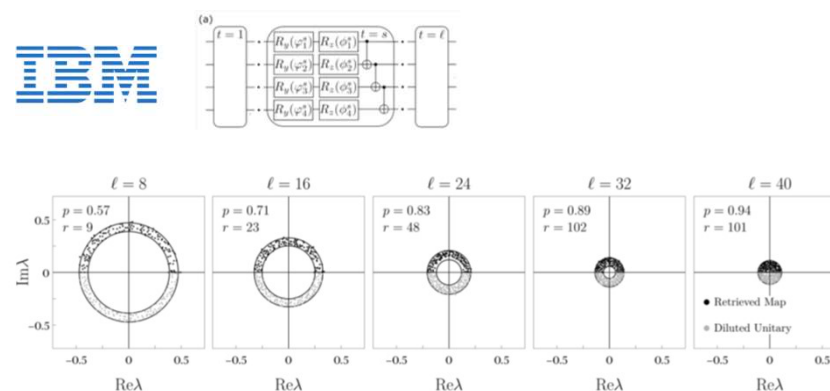
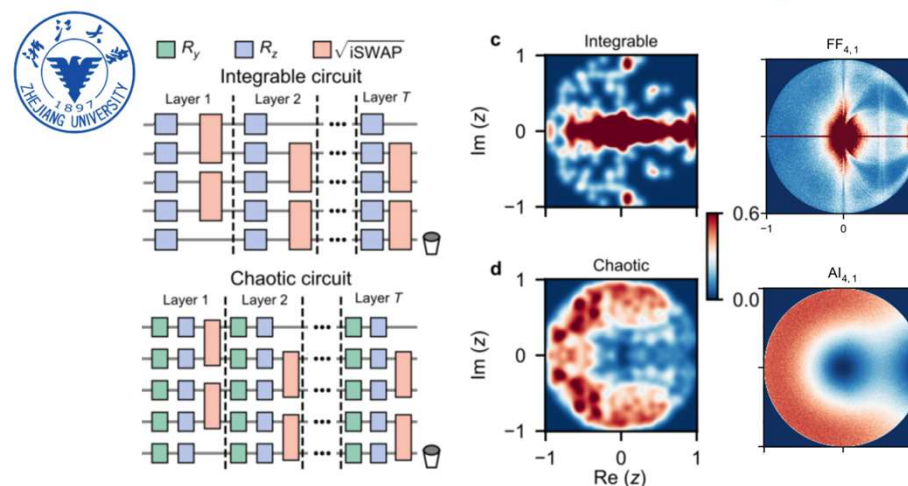
Experimental detection of dissipative quantum chaos — arXiv:2506.04325. Not in the work plan; it came out of the collaboration.

Open source: github.com/KristianWold/experimental-quantum-spectrum



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Experimental Observation of DQC



3 — Beyond quantum volume: how errors accumulate

Universal laws, and the algorithm design that follows

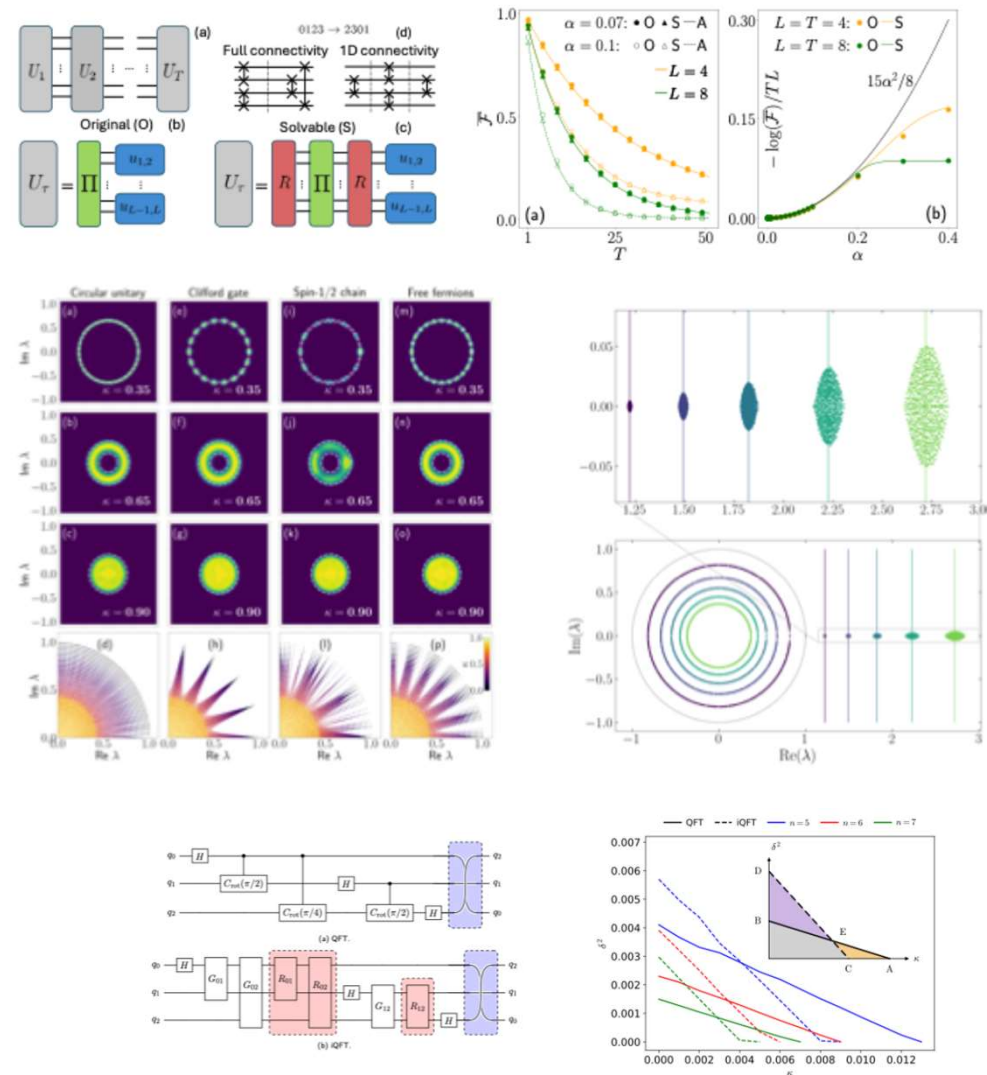
All five partners

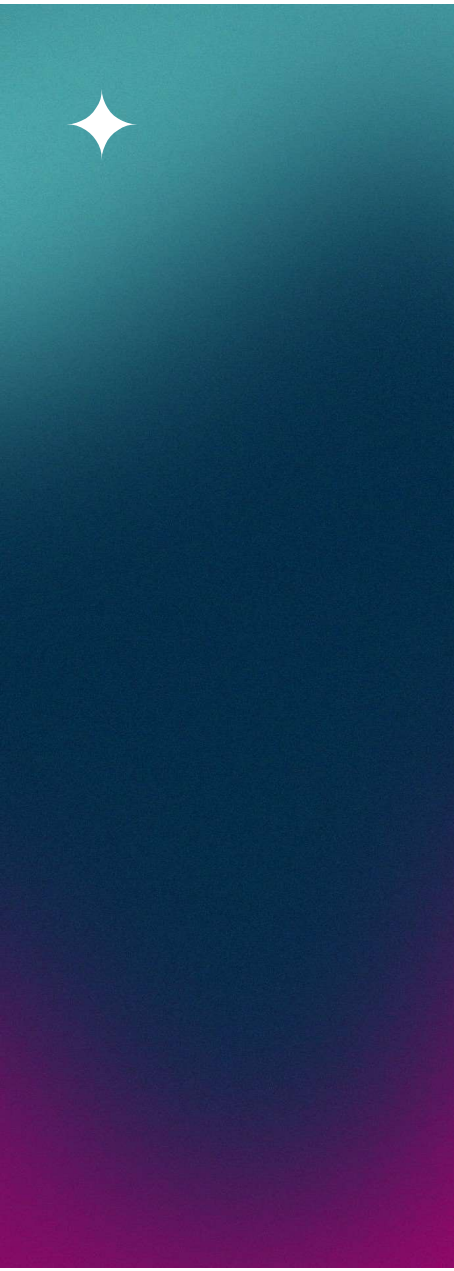
Fidelity decay and error accumulation in random circuits — SciPost Phys. 19, 013 (2025); dissipation-induced threshold on integrability footprints — arXiv:2504.10255.

Universal error accumulation in dissipative circuits: fidelity follows one curve, independent of Kraus rank — dissipation folds into an effective noisy unitary.

Random-matrix theory of probabilistic error cancellation (all five groups) — PRA 114, 012442 (2026); denoiser spectra inherit random-Lindblad structure, with a locality-induced hierarchy of time scales.

Dissipative quantum Fourier transform (all five groups): reshuffling the gate order pays off under mixed unitary + dissipative noise, not under dissipation alone.





SCIENTIFIC OUTPUTS



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PUBLICATIONS. ~50 papers, all in open access on arXiv.

Highlights: PRX 13, 031019 · SciPost Phys. 15, 145 · PRE 108, 014102 · Quantum 8, 1234 · J. Stat. Phys. 192, 41.



PRESENTATIONS. 26 conference contributions, more than 10 of them invited, across all five partners. Two workshops and two schools organised.



SOFTWARE. Two open releases: DanceQ (danceq.gitlab.io) for number-conserving bases, and the experimental-quantum-spectrum repository for map retrieval and spectral analysis.



THESES. PhD: Lucas Sá (IST, defended 2023); Kristian Wold (OsloMet, expected end 2026); Rafal Bistróń & Marcin Rudziński (Cracow, expected end 2026); MSc: João Costa, Rodrigo Pereira, Diogo Aguiar (IST).



IMPACT — potential users



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QUANTUM INDUSTRY. Quantum hardware providers; quantum software and compiler toolchains;



APPLICATIONS. Device characterisation and drift tracking that go beyond a single quantum-volume number; calibration and benchmarking reports; noise-aware compilation; when error mitigation is worth its cost.



END USERS — VTT (Finland). Contracted access to a 5-qubit transmon to run our characterisation experiments: independent evaluation of the machine, drift and error-channel identification.

END USERS — Ruter (Norway). NISQ-assisted optimisation for public transport in greater Oslo



QUANTUM FLAGSHIP. Ljubljana (P2) is a node of PASQuanS2.



IMPACT — responsible research



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GENDER. Recruitment on merit and open advertising; one woman hired on a 24-month contract at Bonn. The applicant pool for these positions was almost entirely male.



OPEN SCIENCE. Everything on arXiv; open-access journals throughout (PRX, SciPost, PRR, Entropy); analysis code and data public.



SCIENCE EDUCATION. Two workshops, two summer schools, the Bad Honnef school; training spread across all five sites.

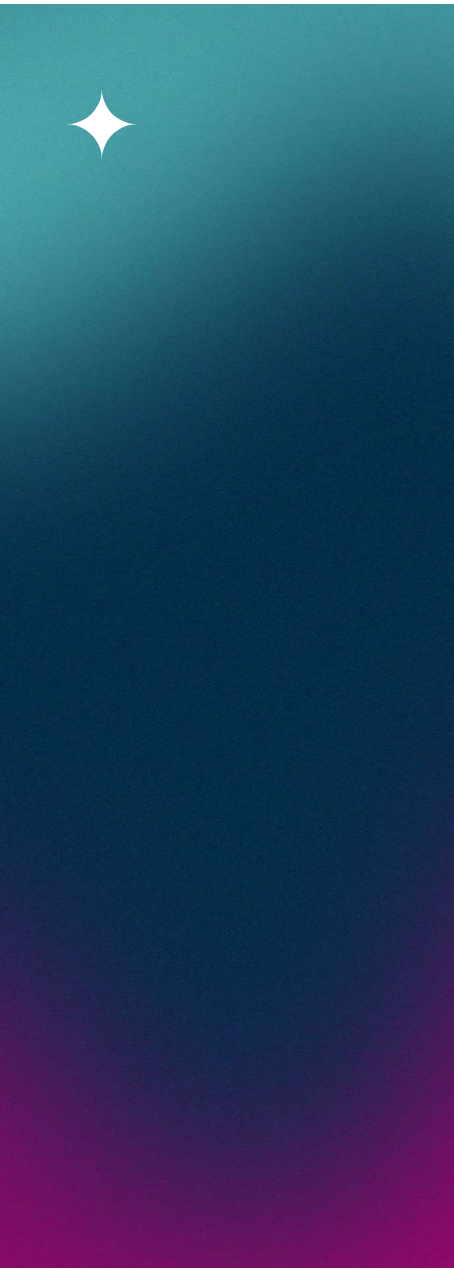


PUBLIC ENGAGEMENT. Karol Życzkowski's lecture 'Chaos in classical and quantum physics' — 46,000 views. OsloMet QuantumHub open days.



ETHICS. No issues arose.





WHAT'S NEXT

THE NETWORK OUTLIVES THE PROJECT. COST Action CA24109 'QOpen — Many-Body Open Quantum Systems', chaired by the coordinator: the DQUANT consortium, opened up to the whole of Europe.

FUNDING. ERC Advanced Grants to Prosen and to Życzkowski; an FCT Exploratory project with Lisbon & Oslo; an MSCA Doctoral Network in preparation.



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the European Union