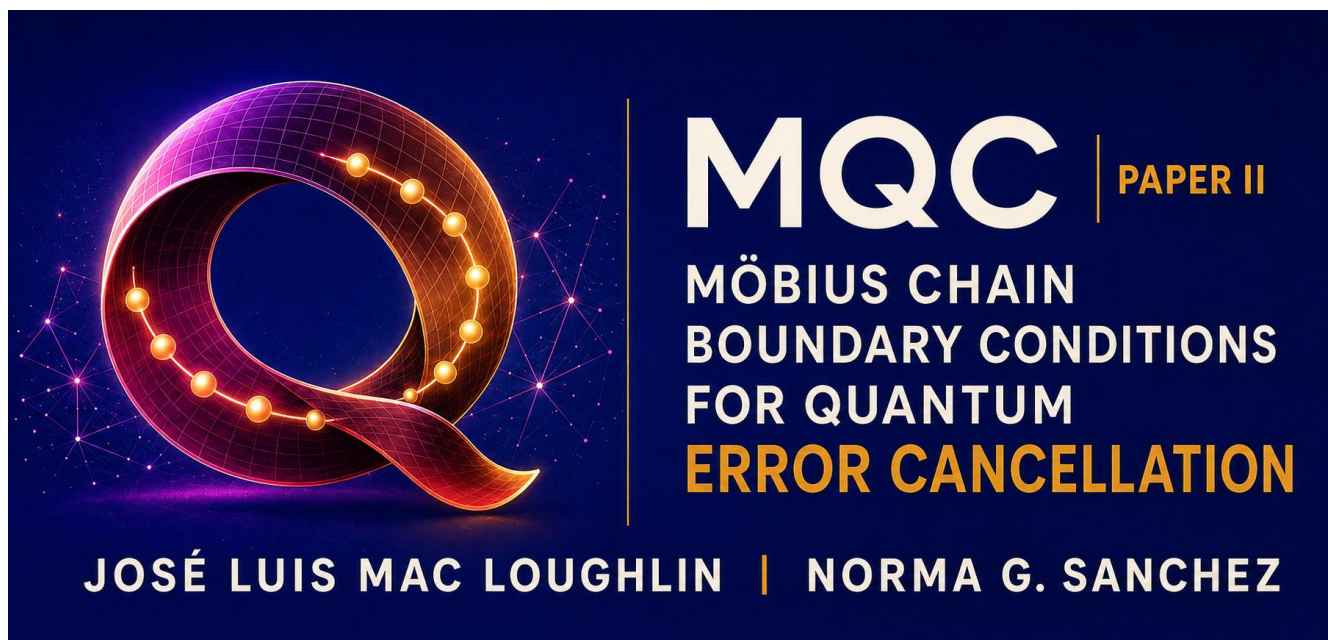


RELEASE

RELEASE | September 2026



Möbius Quantum Computation: A New Topological Resource for Quantum Error Cancellation

The Möbius Quantum Computation (MQC) Research Programme, French-Argentinian Collaboration, conducted by José Luis Mac Loughlin and Norma G. Sanchez shows how twisted boundary conditions can globally and geometrically cancel coherent quantum errors, a crucial problem in today quantum computation.

José Luis Mac Loughlin¹

¹ School of Arts and Sciences, Museum House and Quantum Laboratory, La Plata city 1900, Provincia de Buenos Aires, Argentina

Norma G. Sanchez²

² International School and Institute of Astro-Physics Daniel Chalonge-Hector de Vega, CNRS, INSU-Institut National des Sciences de l'Univers, Sorbonne Université, 75014 Paris, France

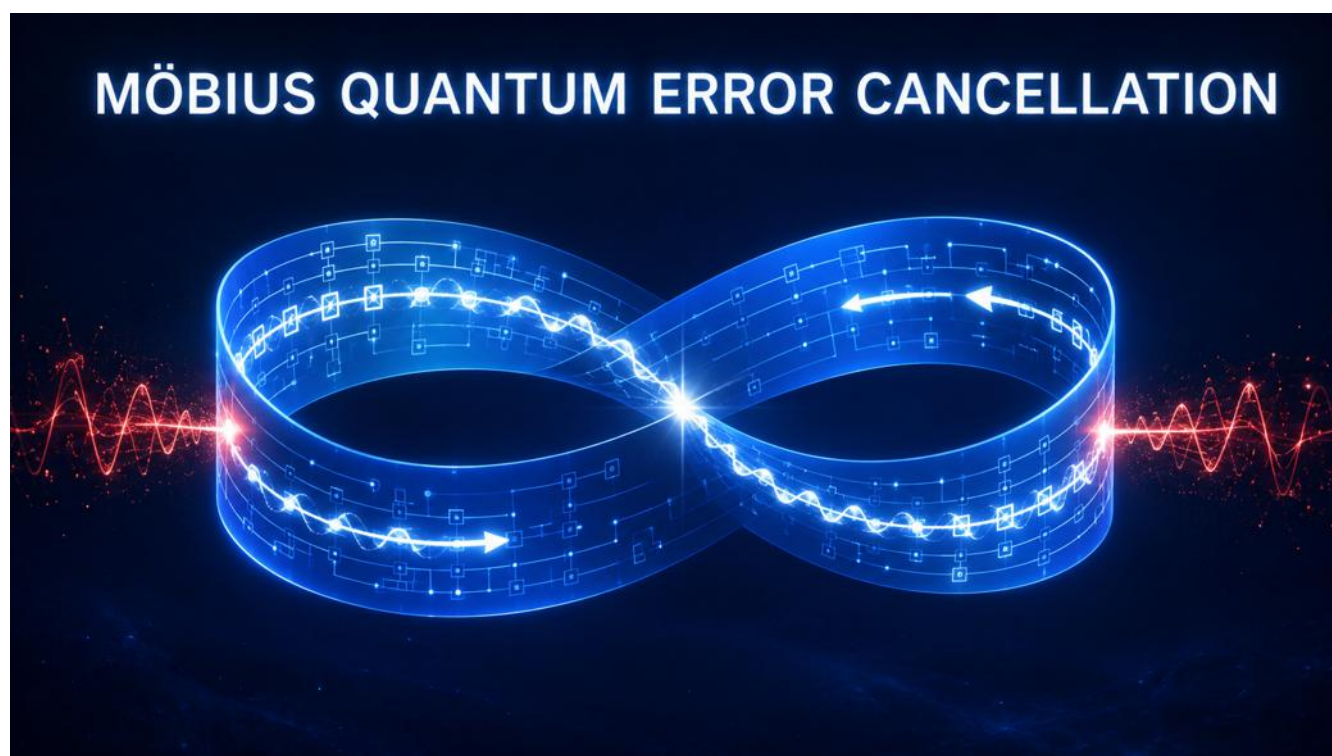
Contact: chalonge.ecoleATchalonge-devega.fr | <https://chalonge-devega.fr>

A new theoretical study proposes that Möbius boundary topology can serve as a passive resource for suppressing coherent errors in quantum computation. This is a crucial item for quantum computation today. The paper A New Topological Resource for Quantum Error Cancellation is the second study of the Möbius Quantum Computation (MQC) research programme.

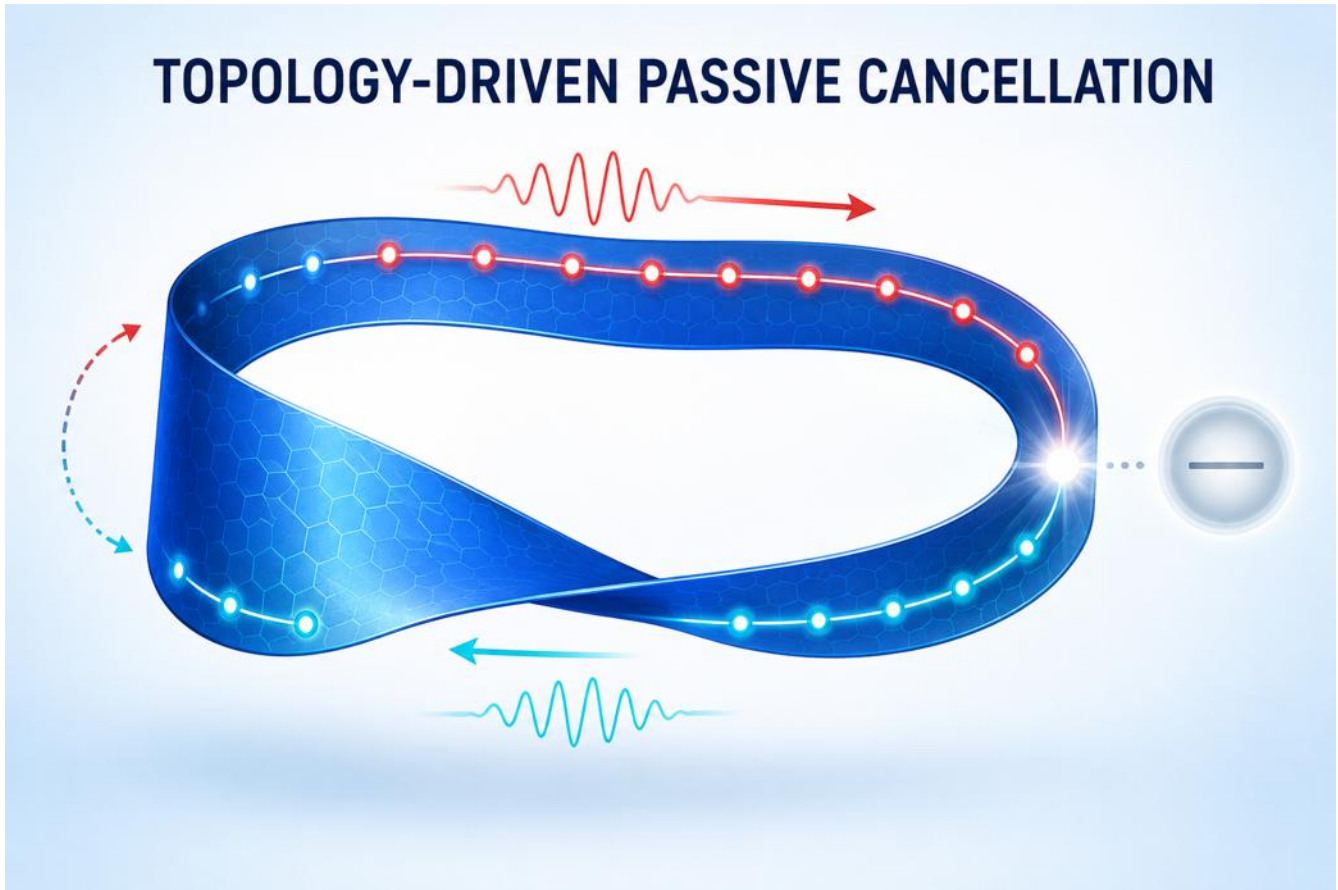
Quantum processors are affected not only by random decoherence but also by coherent and systematic errors, such as phase drifts, imperfect calibrations, repeated over-rotations and slowly varying control errors. Because these perturbations can accumulate constructively over many operations, they can become especially damaging in long quantum circuits.

The new proposed mechanism replaces an ordinary closed-chain return condition with an effective Möbius identification. After one complete traversal, a quantum amplitude is compared with a twisted copy of itself. For symmetric coherent perturbations, the phase accumulated along one branch is opposed by its topologically reflected contribution, producing geometric cancellation.

Unlike conventional quantum error correction, the cancellation does not rely on redundant logical encoding, syndrome measurements or active recovery. It is boundary-driven, topology-driven and passive. The approach is therefore presented as a efficient complement to established error-mitigation and fault-tolerant architectures, not necessarily a replacement for them. And it is a much more economical and sustainable resource, with less consumption.



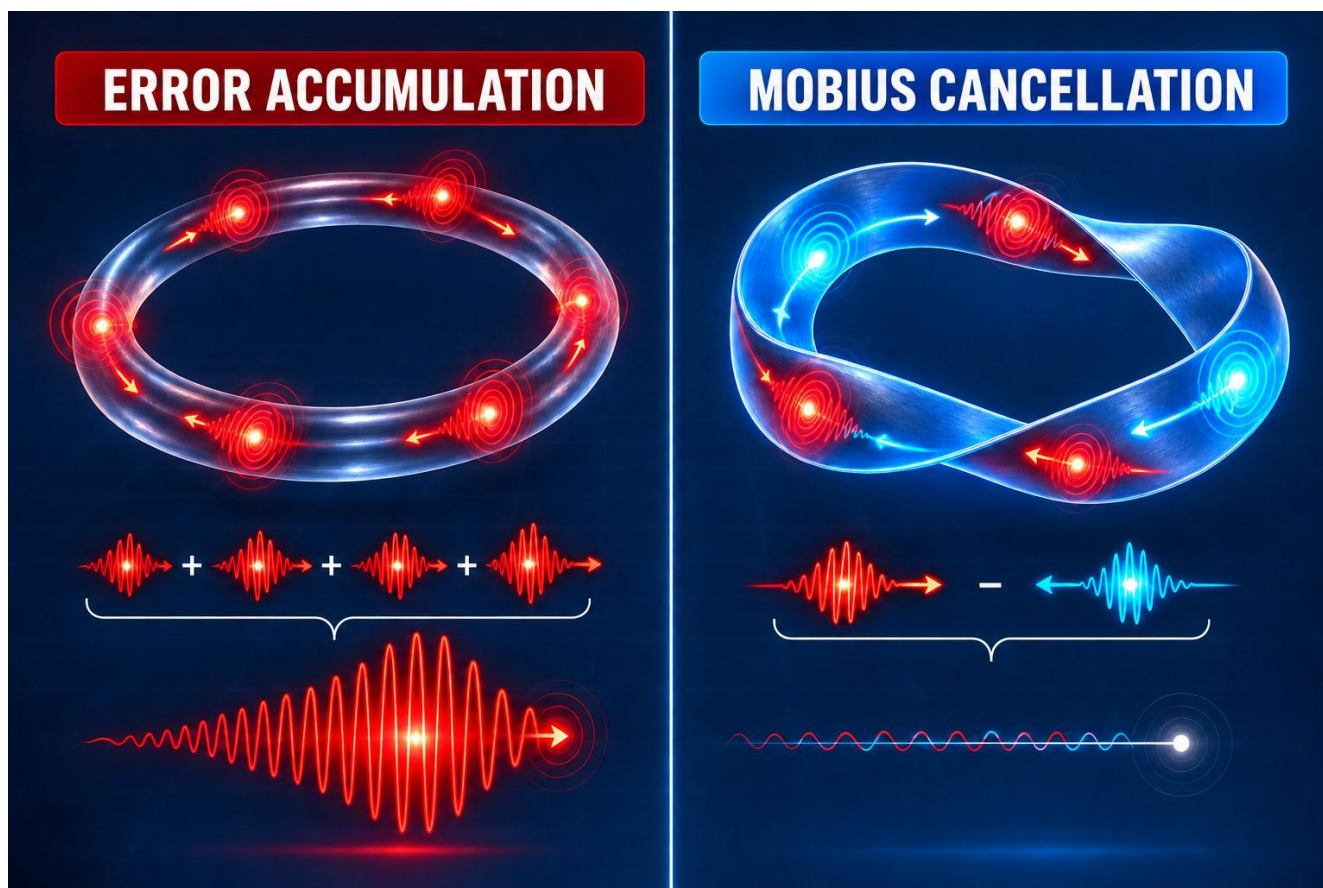
TOPOLOGY-DRIVEN PASSIVE CANCELLATION



Passive Error Cancellation: By mapping information qubits onto a non-orientable Möbius topology, quantum states undergo a logical inversion upon completing a computational cycle. This generates a "topological echo" effect that naturally cancels first-order coherent errors, without the need for cumbersome error-correction codes.

The study also identifies its limit of the proposal: imperfect symmetry leaves a residual error governed by the mismatch between the ordinary and twisted branches. The mechanism is expected to be most relevant to slowly varying, systematic and spatially correlated coherent errors; it is not intended to cancel arbitrary local stochastic noise.

Possible future implementations include photonic waveguide arrays, superconducting circuits with synthetic boundary conditions, cold atoms, trapped-ion systems and quantum materials. The essential requirement is not a literal Möbius strip, but an effective non-orientable boundary rule engineered in the quantum dynamics.



KEY POINTS

- A global Möbius boundary condition converts accumulated coherent phase error into a difference between two topologically related branches.
- For symmetric coherent perturbations, the leading phase contributions cancel after one complete traversal.
- The mechanism is passive and uses no measurement, nor redundancy nor active recovery operation.
- The work is a proof of principle and motivates numerical, circuit-level and experimental tests.

IMPACT

- Topology can make quantum errors cancel themselves
- A Möbius twist becomes an operational resource for quantum control.
- Passive error suppression could work before or alongside active quantum error correction.
- From mathematical non-orientability to experimentally engineerable quantum boundary rules.

• WHY THIS RESULT MATTERS NOW

Quantum error control is one of the decisive obstacles to useful large-scale quantum computing. The present result introduces a different design principle: instead of correcting

every coherent error only after it appears, quantum dynamics may be engineered so that a specific class of errors cancels through the global boundary topology itself. Implemented in realistic devices, this passive layer could reduce the burden placed on active correction and strengthen hybrid fault-tolerant strategies.

SUMMARY

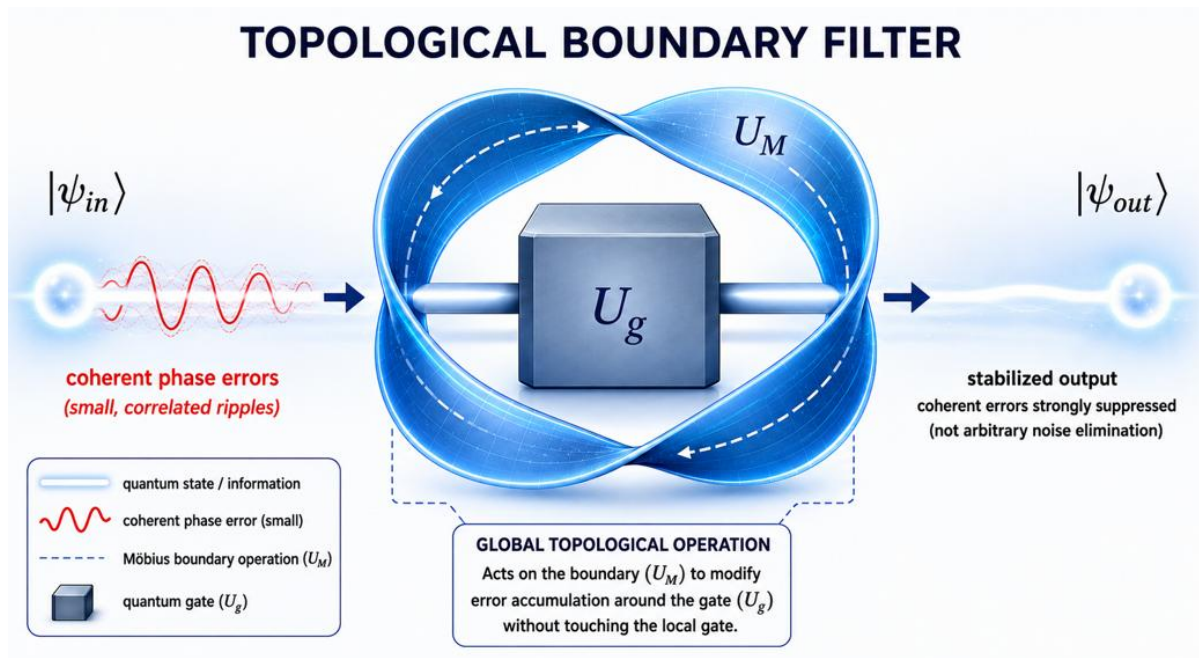
This Paper II of the Möbius Quantum Computation programme proposes a new passive mechanism for cancelling coherent quantum errors. A twisted Möbius boundary makes topologically related phase contributions and opposes one to another, which global result is their cancellation. The theoretical proof of this principle can inspire complementary protection layers for photonic, superconducting, atomic and other quantum platforms.

THE MQC RESEARCH PROGRAMME

The Paper I introduced Möbius topology as a boundary framework for quantum information processing. This Paper II develops one concrete physical consequence of that framework: the passive coherent-error cancellation. Future work will examine topological gate implementations, algorithms and platform-specific realizations.

The central result :

For symmetric coherent perturbations, the leading accumulated phase error cancels after a complete traversal under the Möbius boundary identification.



Möbius boundary condition acting as a **global topological filter** around a local quantum gate U_g . The boundary operation U_M modifies the accumulation of small, correlated coherent phase

errors without altering the gate itself, producing a stabilized output with strongly suppressed coherent errors. The mechanism is complementary to conventional quantum error correction and it appears as an economical and sustainable resource for quantum computation.

This mechanism acts as a complementary quantum error correction

It is designed as a passive complementary layer for particular coherent errors, potentially operating before or alongside active fault-tolerant methods.

The key requirement is an effective non-orientable boundary identification encoded in the quantum dynamics.

What comes next?

Numerical robustness studies, circuit mappings and platform-specific experimental demonstrations.

PAPER AND AUTHORS INFORMATION

Paper:

“Möbius Quantum Computation: A New Topological Resource for Quantum Error Cancellation”

Authors:

José Luis Mac Loughlin¹ and Norma G. Sanchez²

¹ Founder and Director of the School of Arts and Sciences, Museum House and Quantum Laboratory, La Plata city 1900, Provincia de Buenos Aires, Argentina.

² Founder and Director of the International School and Institute of Astro-Physics Daniel Chalonge-Hector de Vega, Research Director at CNRS, INSU-Institut National des Sciences de l'Univers, Sorbonne Université, Paris, France.

Contact: chalonge.ecole@chalonge-devega.fr | <https://chalonge-devega.fr>

https://www.researchgate.net/publication/414594572_MOBIUS_QUANTUM_COMPUTATION_A_NEW_TOPOLOGICAL_RESOURCE_FOR_QUANTUM_ERROR_CANCELLATION

https://chalonge-devega.fr/Mobius_Quantum_Error_Cancellation.pdf