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NTU Q

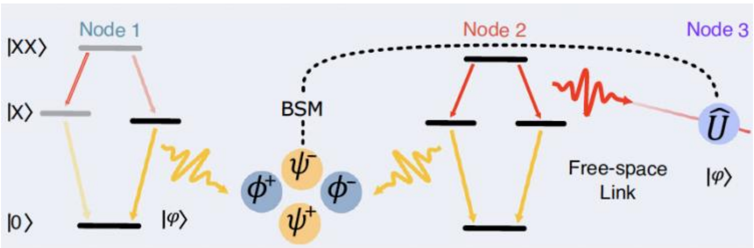
HIGHLIGHTING NEWS

QUANTUM TELEPORTATION WITH DISSIMILAR QUANTUM DOTS OVER A HYBRID QUANTUM NETWORK

A team from Rome has demonstrated the first successful all-photonic quantum teleportation using two independent and dissimilar semiconductor quantum dots (QDs) operating as separate nodes within a realistic quantum network. They engineered the electronic and optical properties of both emitters by using nanophotonic circular Bragg resonators, multi-axial strain tuning, and magnetic-field control. These techniques enable one QD to act as a highly entangled photon-pair source with a Bell-state fidelity $F=0.94\pm0.01$, while the other provides tunable single photons to carry the input state for teleportation.

The teleportation protocol is implemented across a hybrid urban quantum network spanning multiple buildings on the Sapienza University campus. Their schematic diagram is excerpted below. A single-photon qubit generated at Node 1 is sent via optical fiber to Node 2, where it interferes with a photon from an emitted entangled pair. A Bell-state measurement is then performed to project the state onto the partner entangled photon, which is transmitted through a 270 m free-space optical link to Node 3.

A central experimental challenge, the low intrinsic indistinguishability between photons from dissimilar QDs, is addressed through spectral tuning and ultrafast superconducting nanowire detectors that facilitate temporal post-selection with ~24 ps system resolution. This approach yields Hong–Ou–Mandel (HOM) interference visibilities up to 60% for a 20 ps window. Despite imperfect spectral and temporal overlap, the combination of high entanglement fidelity and controlled post-selection produces robust teleportation. The authors report teleportation fidelities of 0.82 ± 0.01 in a fiber-only configuration and 0.80 ± 0.04 over the full hybrid link, both significantly exceeding the classical limit of 2/3. Their work paves the way toward practical quantum relays and future quantum repeaters based on semiconductor technologies. The realization of metropolitan quantum networks is now more promising than ever.



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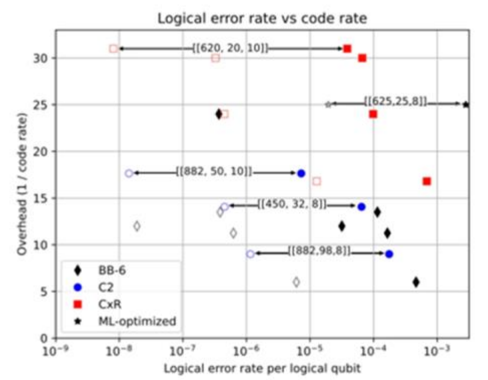
IONQ RESEARCHERS REPORT SIMPLE, SYMMETRY-BASED ERROR-CORRECTING CODES THAT OUTPERFORM STATE-OF-THE-ART DESIGNS

Quantum error-correcting codes (QECCs) are techniques used to protect fragile quantum information from noise, decoherence, and operational errors by encoding a single qubit into a larger system of physical qubits. Recently, researchers at IonQ introduced a novel class of symmetry-based QECCs known as cyclic hypergraph product (HGP) codes. Unlike machine-optimized HGP codes that rely on extensive numerical searches, these codes impose global rotational symmetry on the code structure, drastically simplifying their construction while still producing high-distance, high-rate codes. The required combinatorial design space is also reduced, resulting in codes that are easier to analyze, implement, and scale.



A major practical advantage of cyclic HGP codes lies in their constant-depth stabilizer measurement circuits, which naturally arise from its repeating two-line structure. This feature allows large-scale implementations without increasing circuit depth, making these codes particularly advantageous for hardware platforms where qubits can be transported, such as trapped ions, photonic qubits, and neutral atoms. Benchmarking results indicate that several cyclic HGP codes significantly surpass leading optimized codes under realistic circuit-level noise. For physical error rates around 10^{-3}, the researchers report logical error rates as low as 2×10^{-8} for a [[882, 50, 10]] C2 code. Other cyclic variants, such as a [[450, 32, 8]] C2 code, achieve similar advantages with smaller block lengths. In sum, their new cyclic codes rival or even outperform recently proposed bicycle codes across multiple scenarios, demonstrating broad robustness for a single noise model.

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IBM Quantum Computer Hub at National Taiwan University

Rm.711, Dept. of Physics /Center for Condensed Building

No. 1, Sec.4 Roosevelt Rd., Da’an Dist. Taipei City 106319,

ntuq2018@gmail.com :+886 2-33669928 http://quantum.ntu.edu.tw/