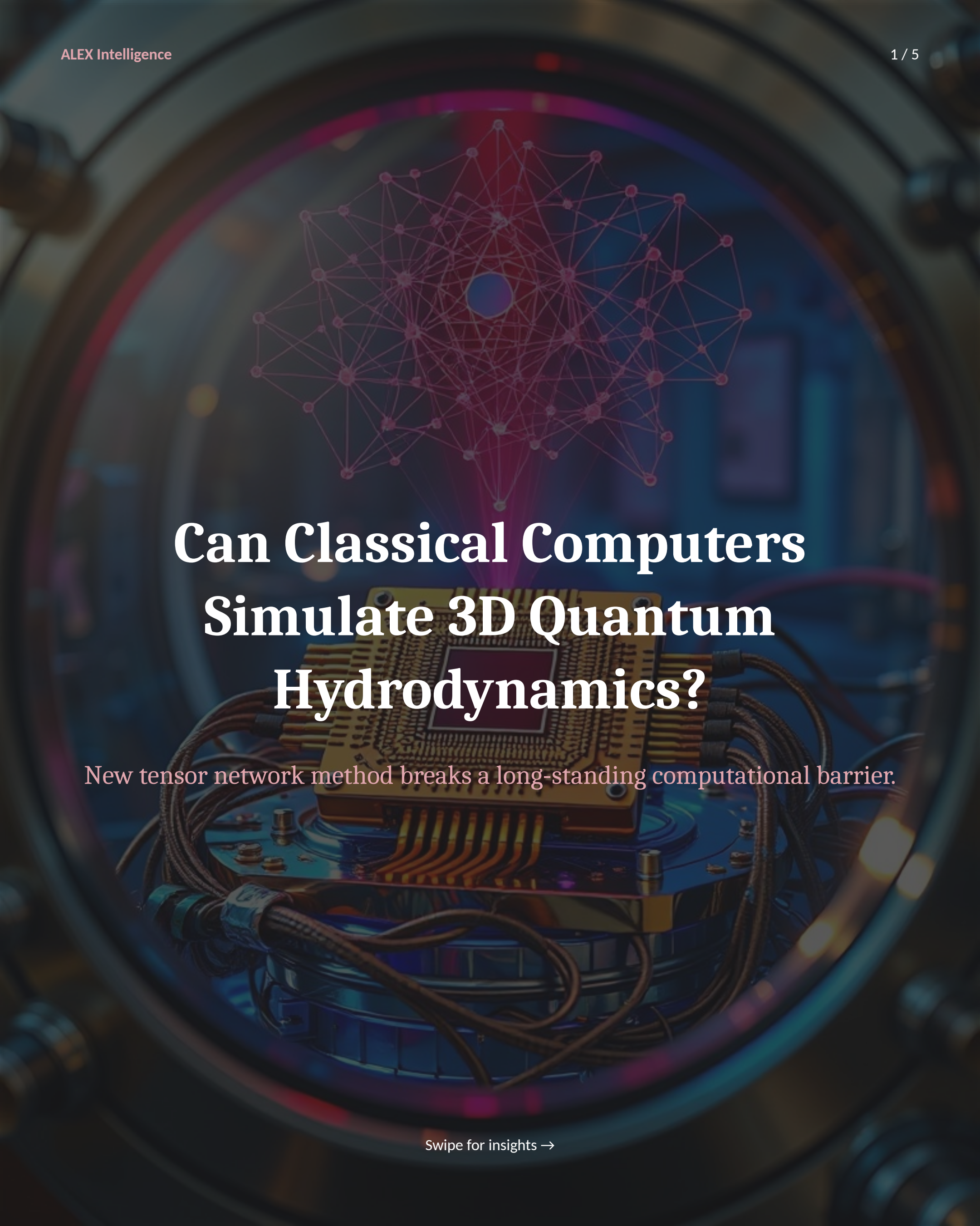


Can Classical Computers Simulate 3D Quantum Hydrodynamics?

New tensor network method breaks a long-standing computational barrier.

Swipe for insights →

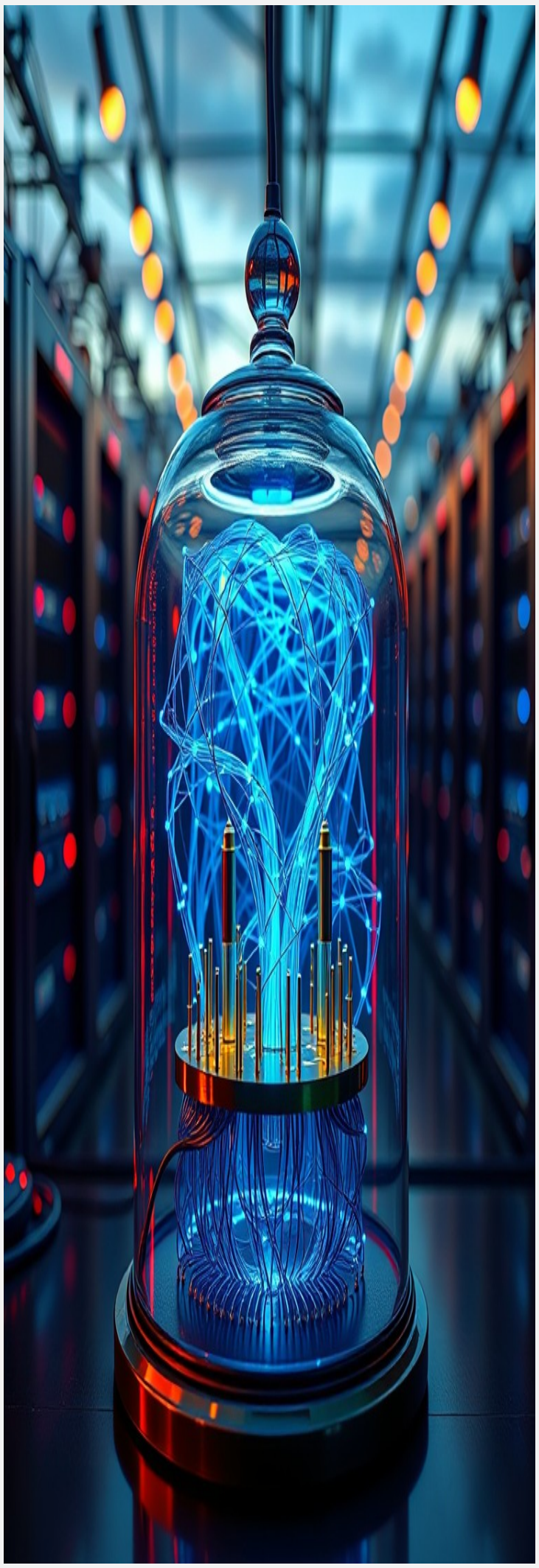
THE DATA

up to three dimensions

Maximum Simulated Dimensions

The new algorithm extends classical simulation capabilities to three-dimensional quantum systems.

This work demonstrates that tensor networks, traditionally limited to one-dimensional systems, can now accurately model hydrodynamic transport in higher-dimensional quantum models. The breakthrough lies in preserving geometric locality during time evolution, even when using a one-dimensional matrix product state ansatz. This enables the prediction of high-temperature transport coefficients like diffusion constants in previously intractable systems.



Source: arXiv.org · Published November 02, 2026
https://arxiv.org/abs/2610.40776

01

Hydrodynamics Now Classically Computable

The extension of the Density Matrix Truncation (DMT) algorithm to three dimensions fundamentally changes what’s classically feasible. It implies that high-temperature, late-time dynamics of quantum simulators—once thought to require quantum computers—can now be benchmarked and validated on classical hardware. This shifts the frontier of quantum simulation from quantum-only to hybrid quantum-classical, accelerating the development of quantum devices and error mitigation strategies.



02

Geometric Locality Is the Hidden Key

The success hinges on preserving geometrically local information during time evolution, despite the ansatz's 1D structure. This reveals that classical simulation fidelity in quantum systems may depend less on entanglement scaling and more on structural fidelity to the physical geometry. It suggests that future tensor network designs should prioritize geometric mapping over pure entanglement handling, a paradigm shift with implications for quantum machine learning and quantum material discovery.

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