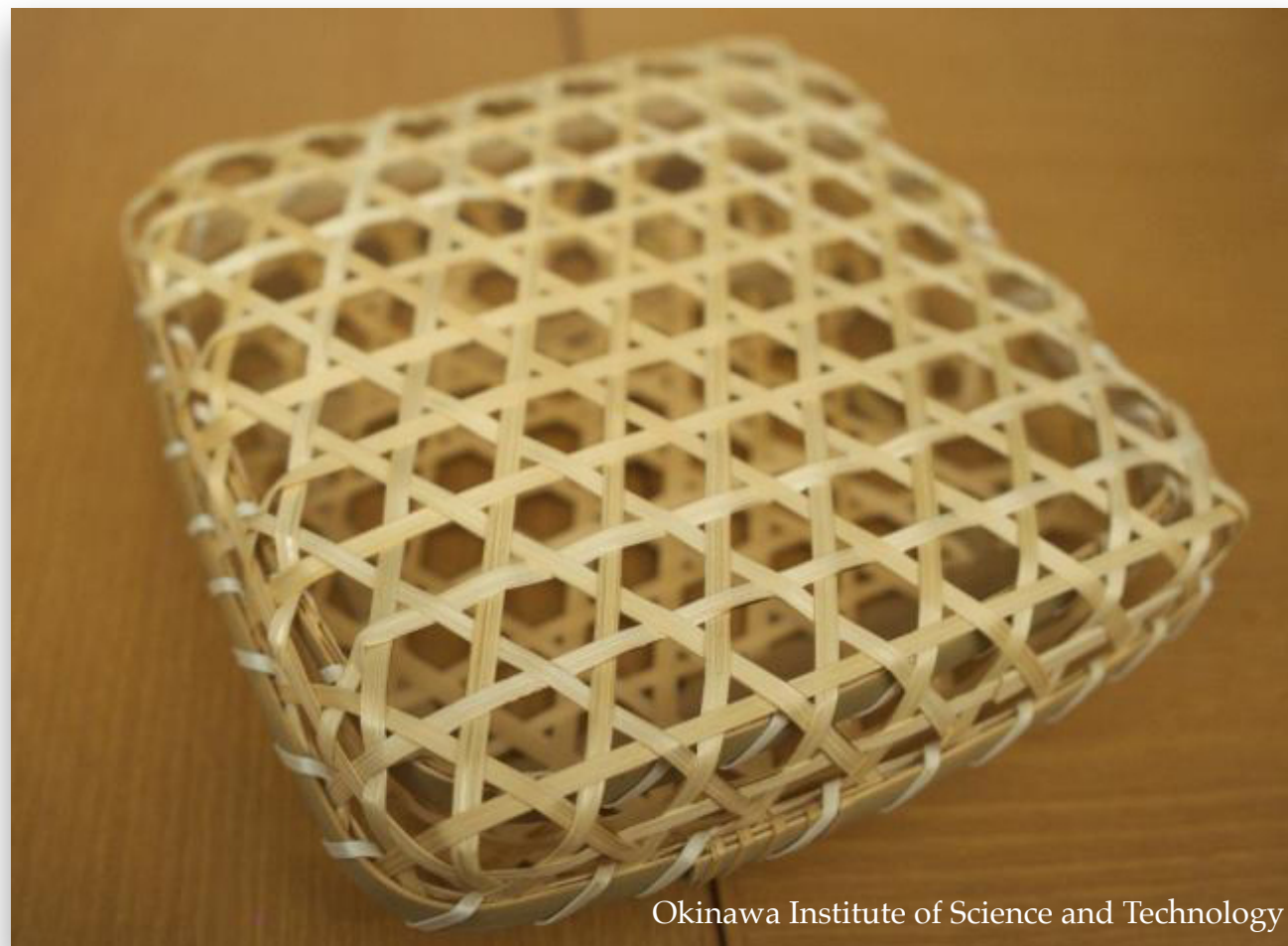

What is topological quantum computing

How does it work, what are the advantages and how will it be realized?

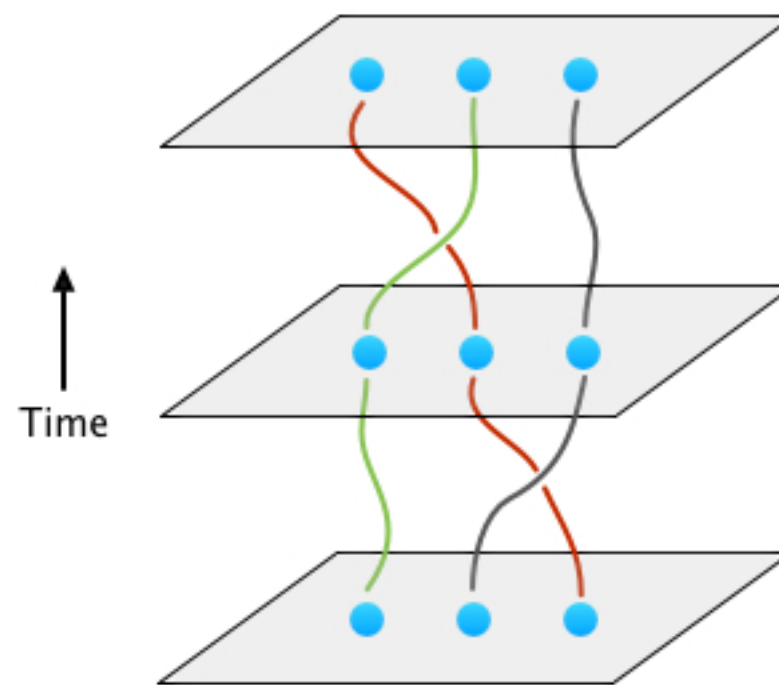
Topological matter is like a woven basket

- ❖ The qubits are stretched out and entangled like strands in a basket, **protecting and stabilizing** each other
- ❖ This means **less error correction** needed and **better scalability**



Computation is performed by “braiding” qubits

- ❖ Luckily, the qubits do not need to be *physically* moved
- ❖ Instead, one can use sequences of *measurements* to implement quantum gates (Measurement Based Quantum Computing*)

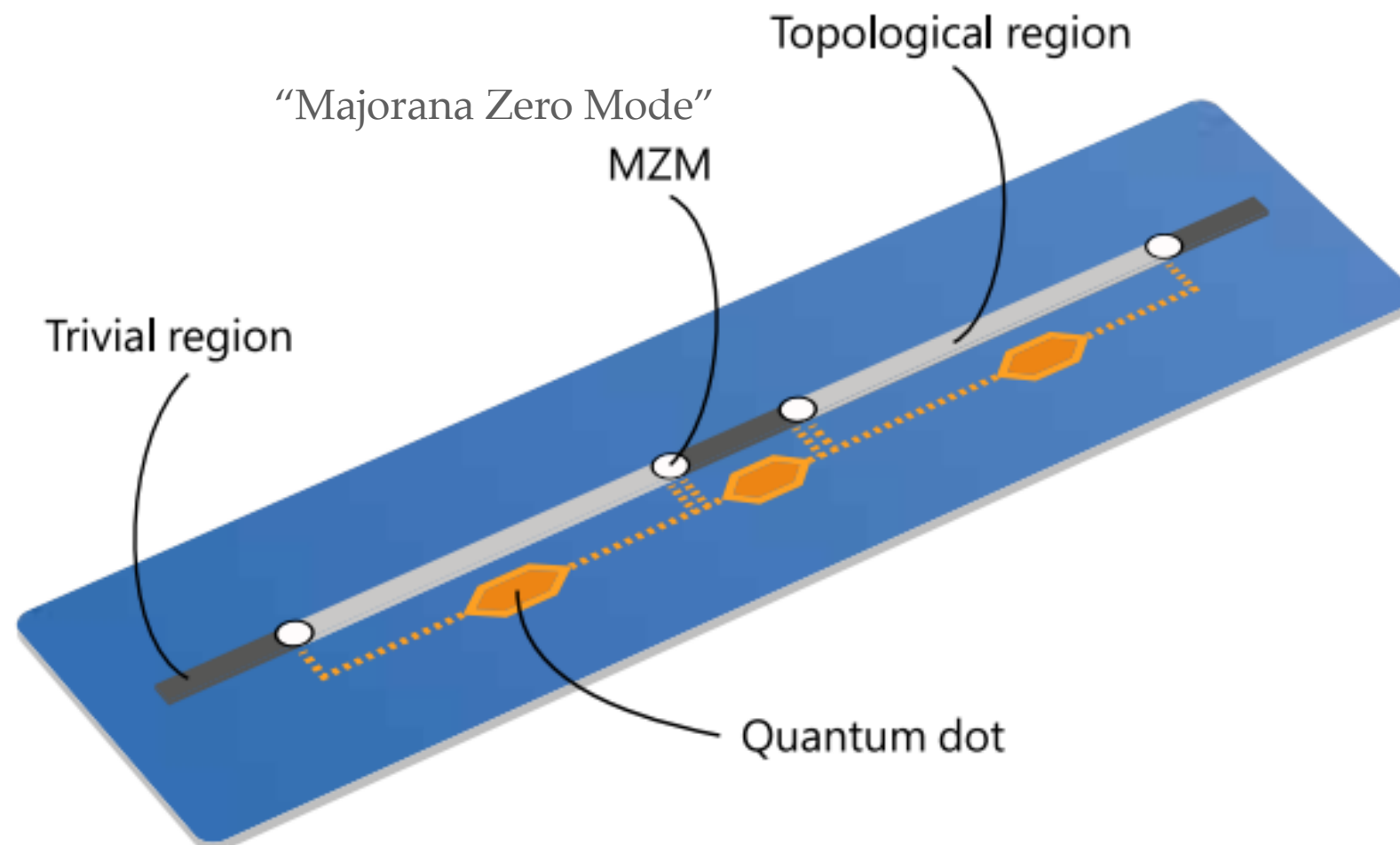


Quanta Magazine

* Raussendorf & Briegel ('01). Measurements in this context typically rely on quantum interference

Some roadmaps are well advanced: Microsoft

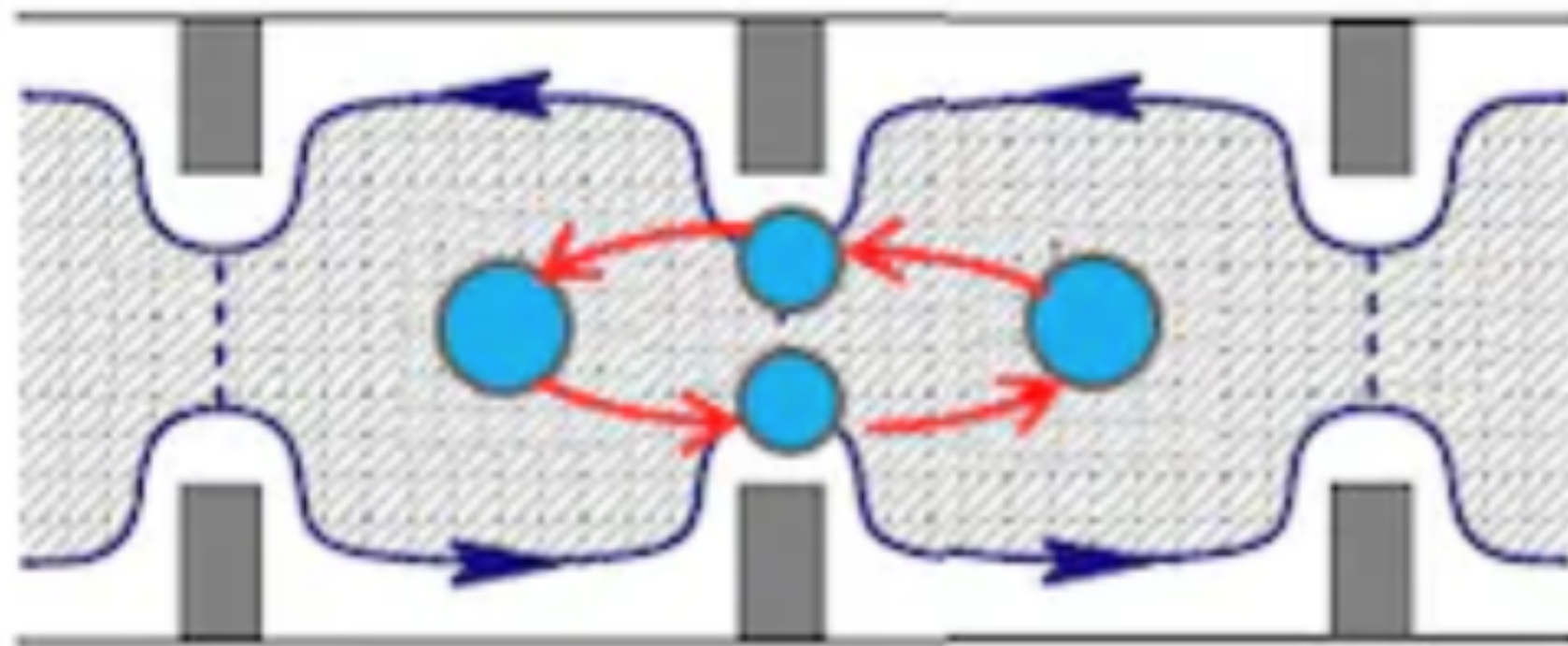
❖ 1-dimensional wires



Read & Green ('00), Kitaev ('00), Nayak et al ('08), Lutchyn et al ('10), Oreg et al ('10), Microsoft ('24)

Some roadmaps are well advanced: Bell Labs

- ❖ 2-dimensional electron gas

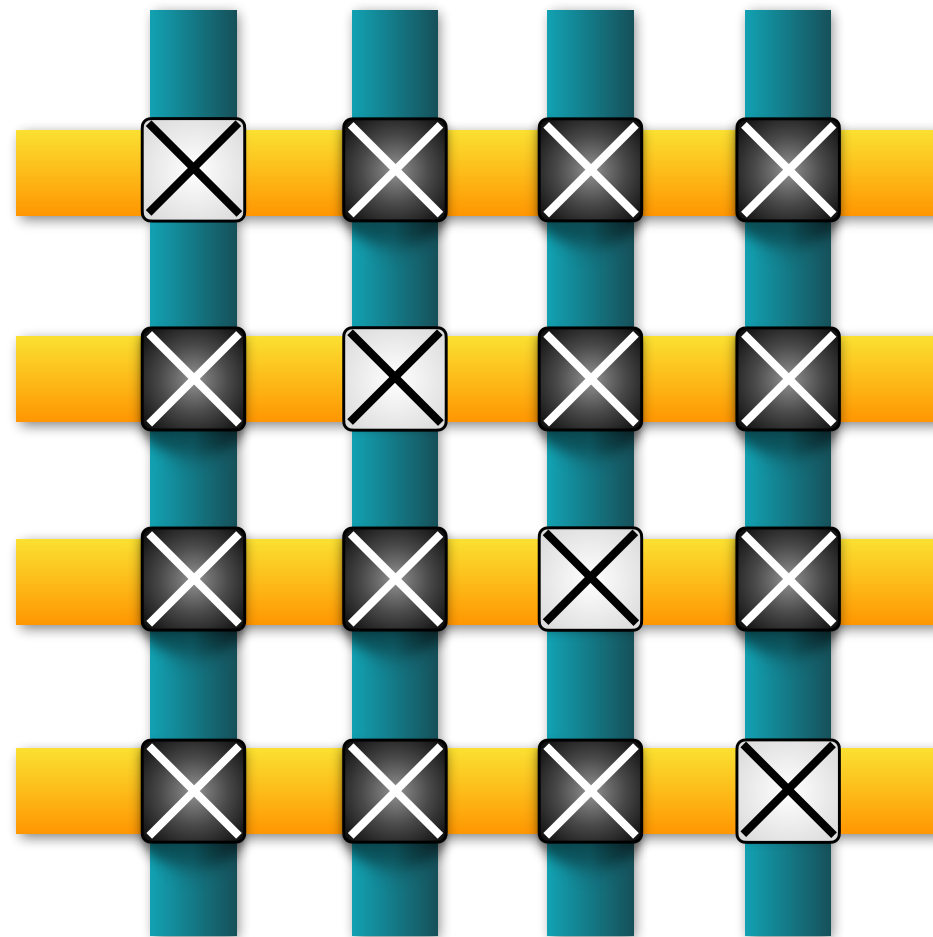


www.nokia.com/bell-labs

Moore & Read ('91), Read & Green ('00), Das Sarma et al ('05) Willett et al ('19, '23)

Some roadmaps are emerging

- ❖ Networks of superconducting wires (my current work with my colleagues)



Recent years have seen relentless progress

- ❖ **Purity** of the materials keeps getting better — a key feature
- ❖ **Interfaces** within the quantum circuitry are increasingly precise
- ❖ *There is nothing in known physics that prohibits topological quantum computing from being realized*
- ❖ As an example of progress, consider that neutral atom platforms had 50 qubits 5 years ago and today have almost 10,000

High barrier to entry

- ❖ The effort to build a topological quantum computer is complex and multi-disciplinary, relying on exquisite materials design. Therefore, few entities are able to work on it.
- ❖ Given the advantage in scaling and error correction, whoever can execute the first topological qubits — plausible within a couple of years in my view — will jump to the front of the quantum computing race.

Views are my own