So what can you do with Quantum Computing?

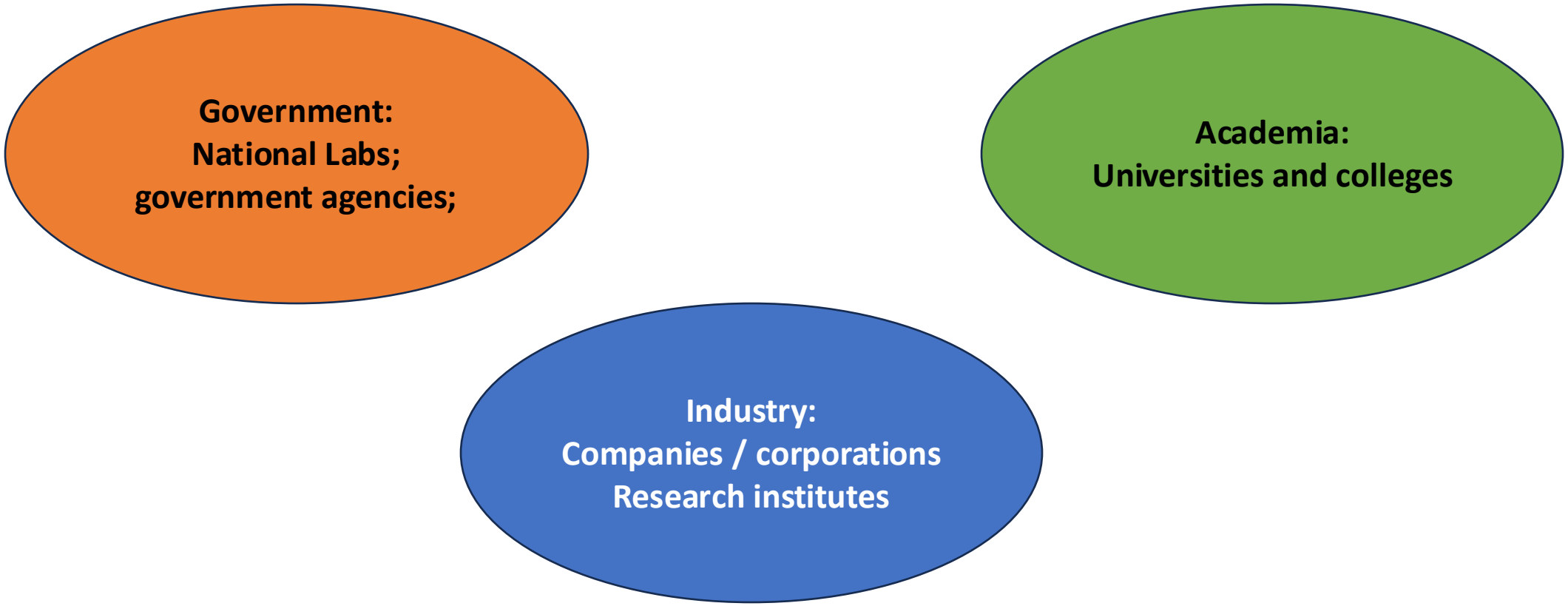
Erik Gustafson

You're probably feeling overwhelmed

Quantum Computing is rapidly developing

- Break even with fault tolerant computers
- A quantum winter
- Demonstrations of quantum advantage
- Quantum utility

Research spans a wide range of fields



Lots of options

Hardware

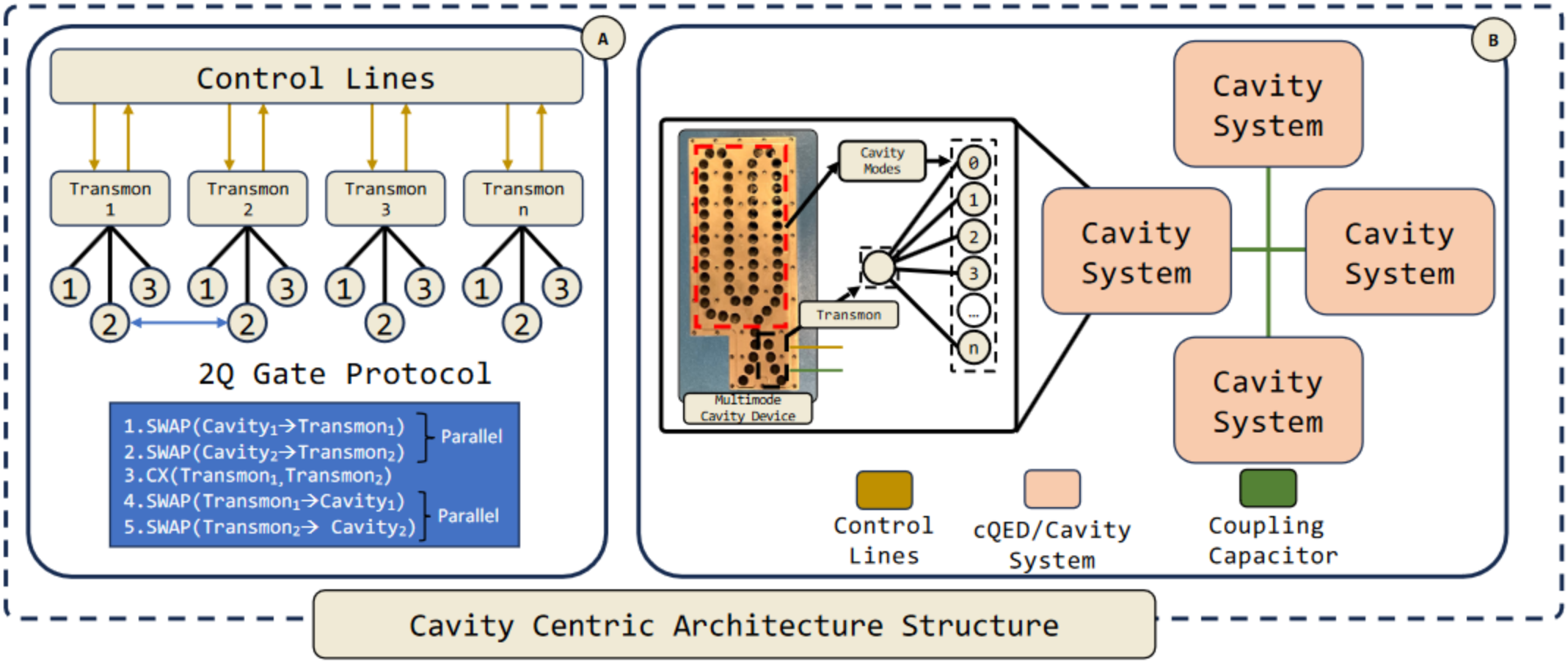
- Actual designing of qubits / qudits
- Middle and control stack for utilizing qpus
- Materials characterization
- Experiments to your hearts delight

Software

- Development of upper stack
  - Algorithms
  - Error correcting codes
  - How tos of quantum simulation

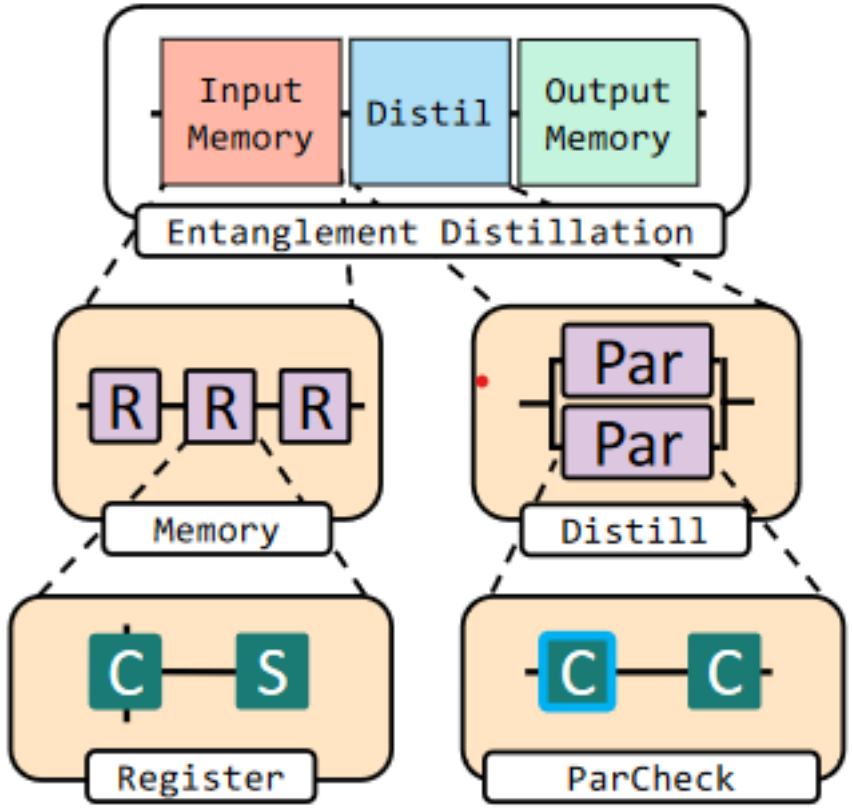
Things to study for Hardware

How we might utilize types of hardware effectively



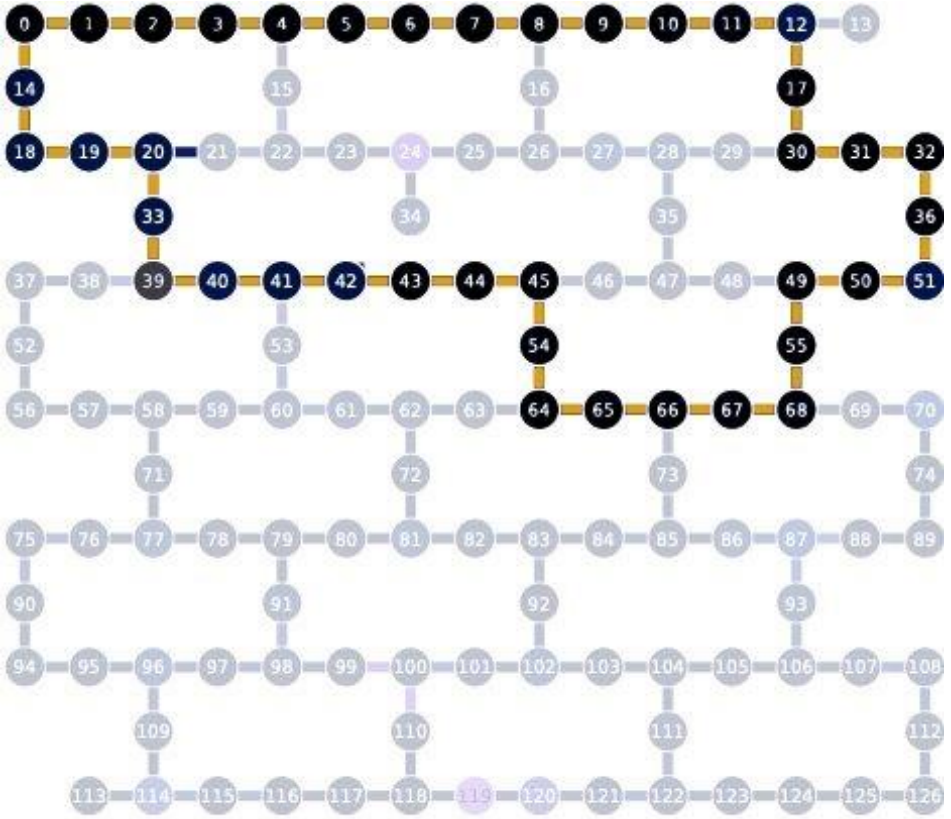
Used with permsion from Samuel Stein et al. ArXiv:2309.15994

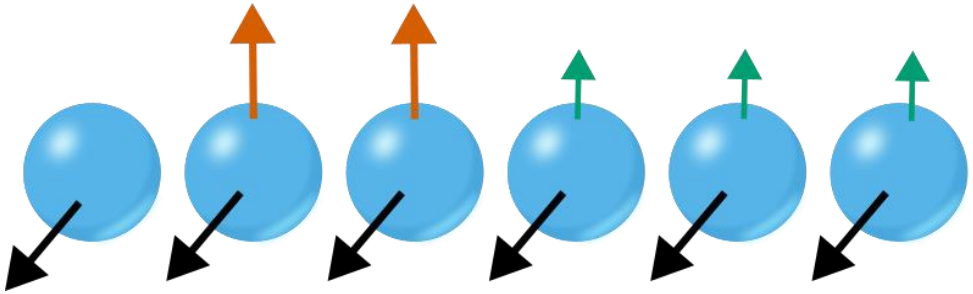
How do we design computers



Used with permission from: Stein et al. arXiv:2305.03243v

How we might utilize hardware effectively





Collaborators

Elizabeth Hardt:
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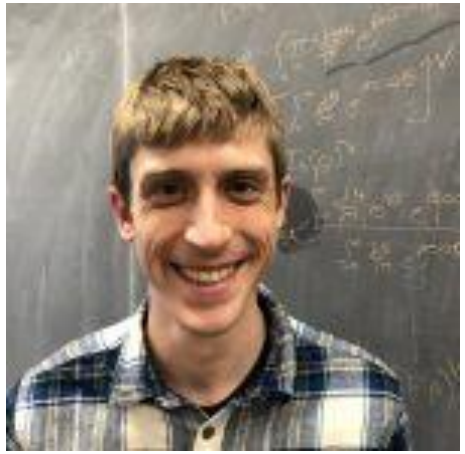
Sara Staracheski:
Sarah Lawrence College

Hank Lamm

Ruth van Der Water

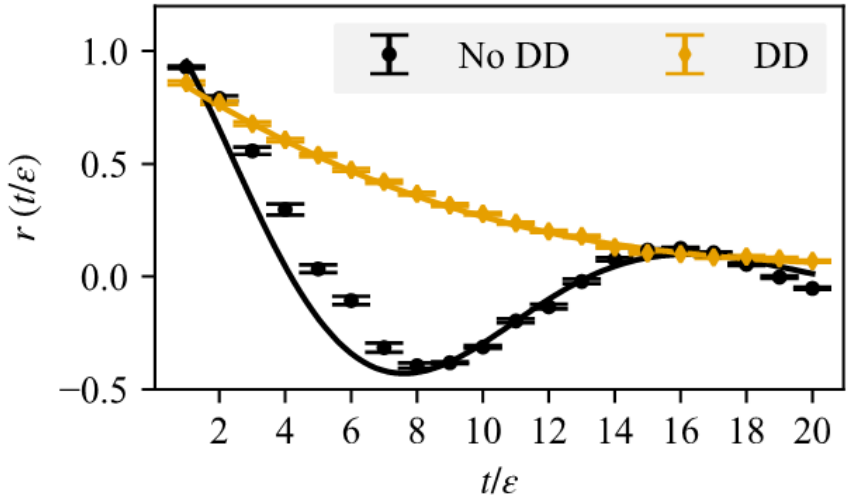
Clement Charles
University of the West Indies

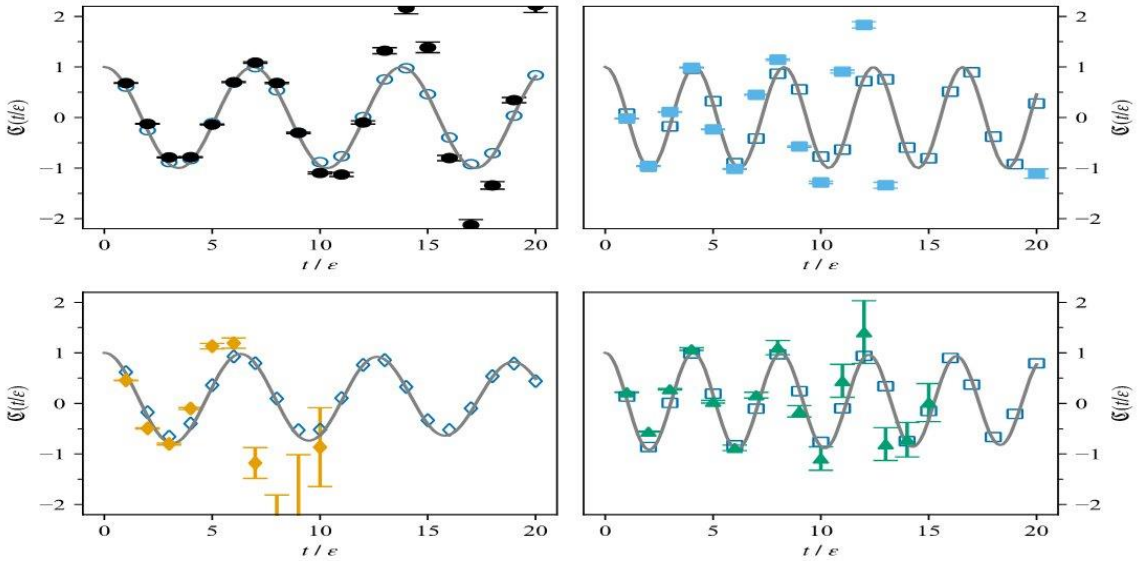
Norman Hogan:
North Caroline State University

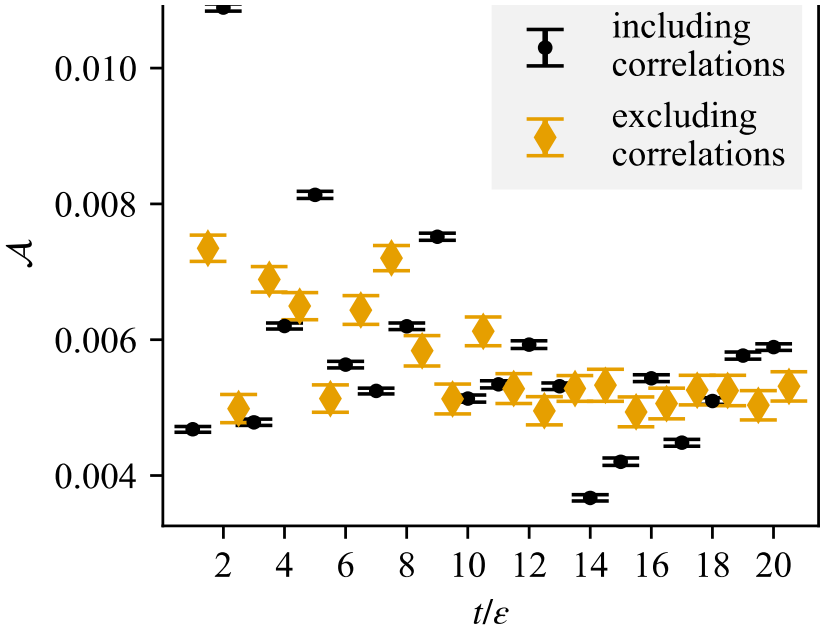


Mike Wagman

Characterizing Noise



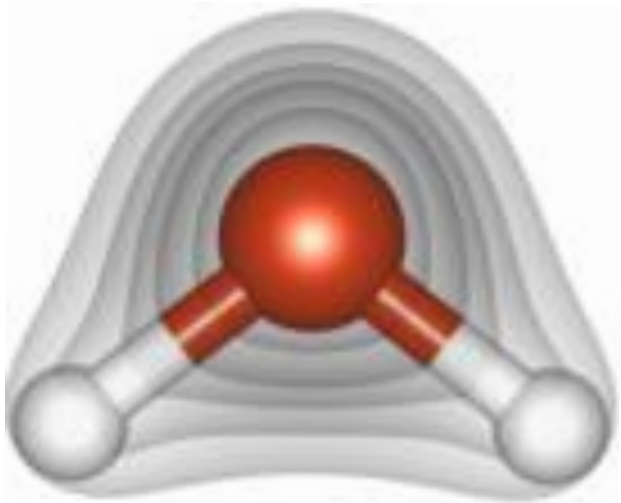


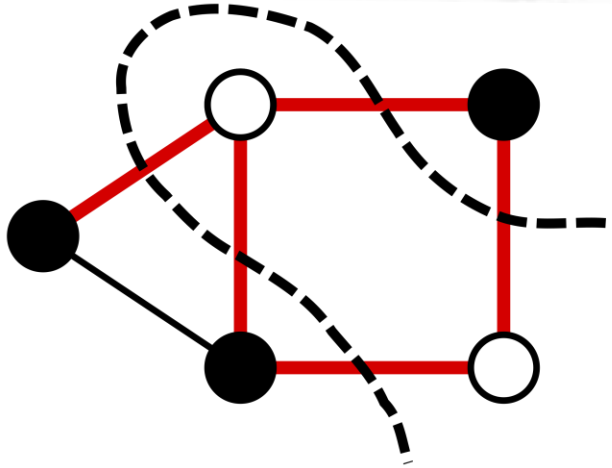


Results from: Charles et al. "Simulating Z_2 Lattice gauge theory on a quantum computer" arXiv:2305.02361

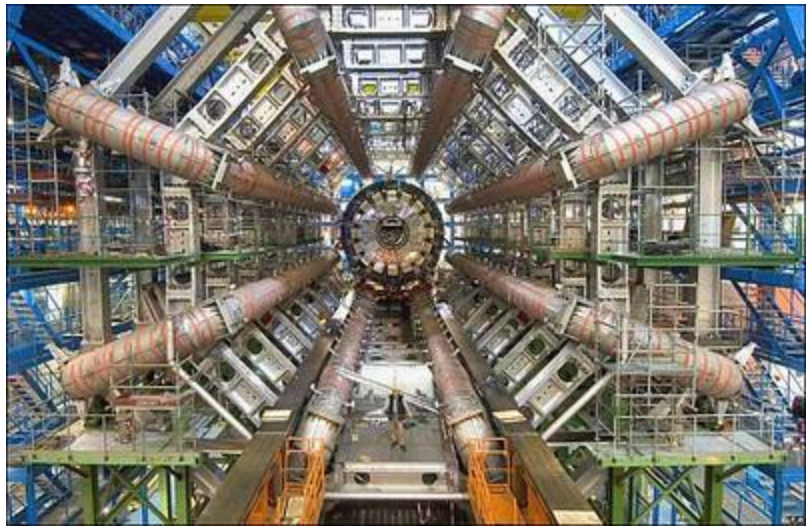
Theory side

What sort of problems do algorithms people look at?

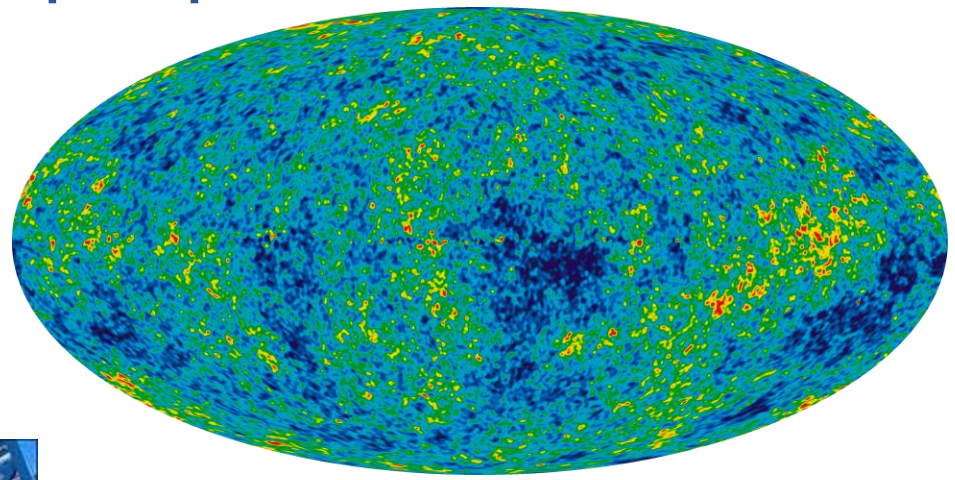




Max Cut: Author Miym: Used under CC-BY-SA-3.0 https://en.wikipedia.org/wiki/Maximum_cut#/media/File:Max-cut.svg



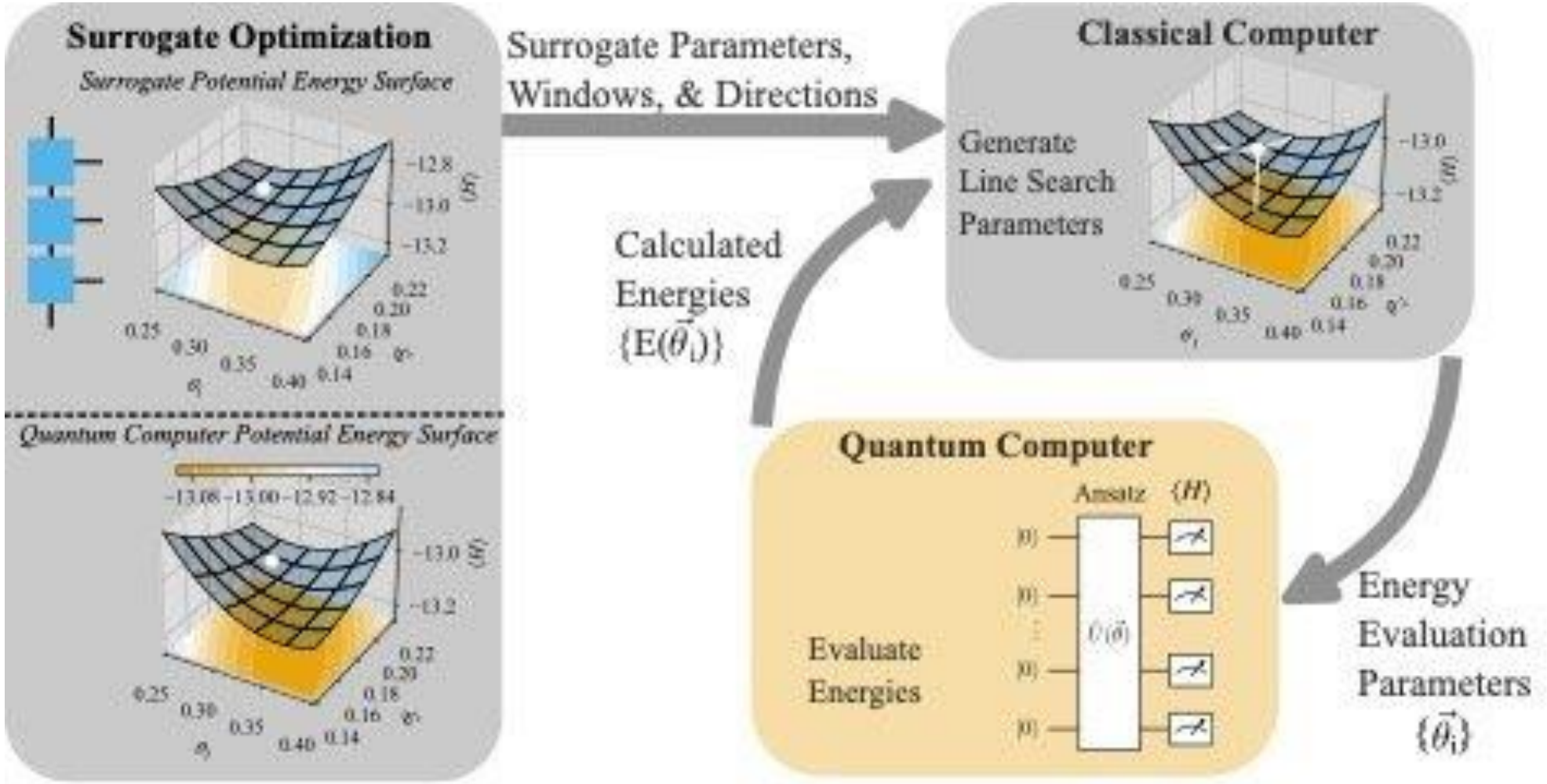
The Large Hadron Collider/ATLAS at CERN cc-by-2.0



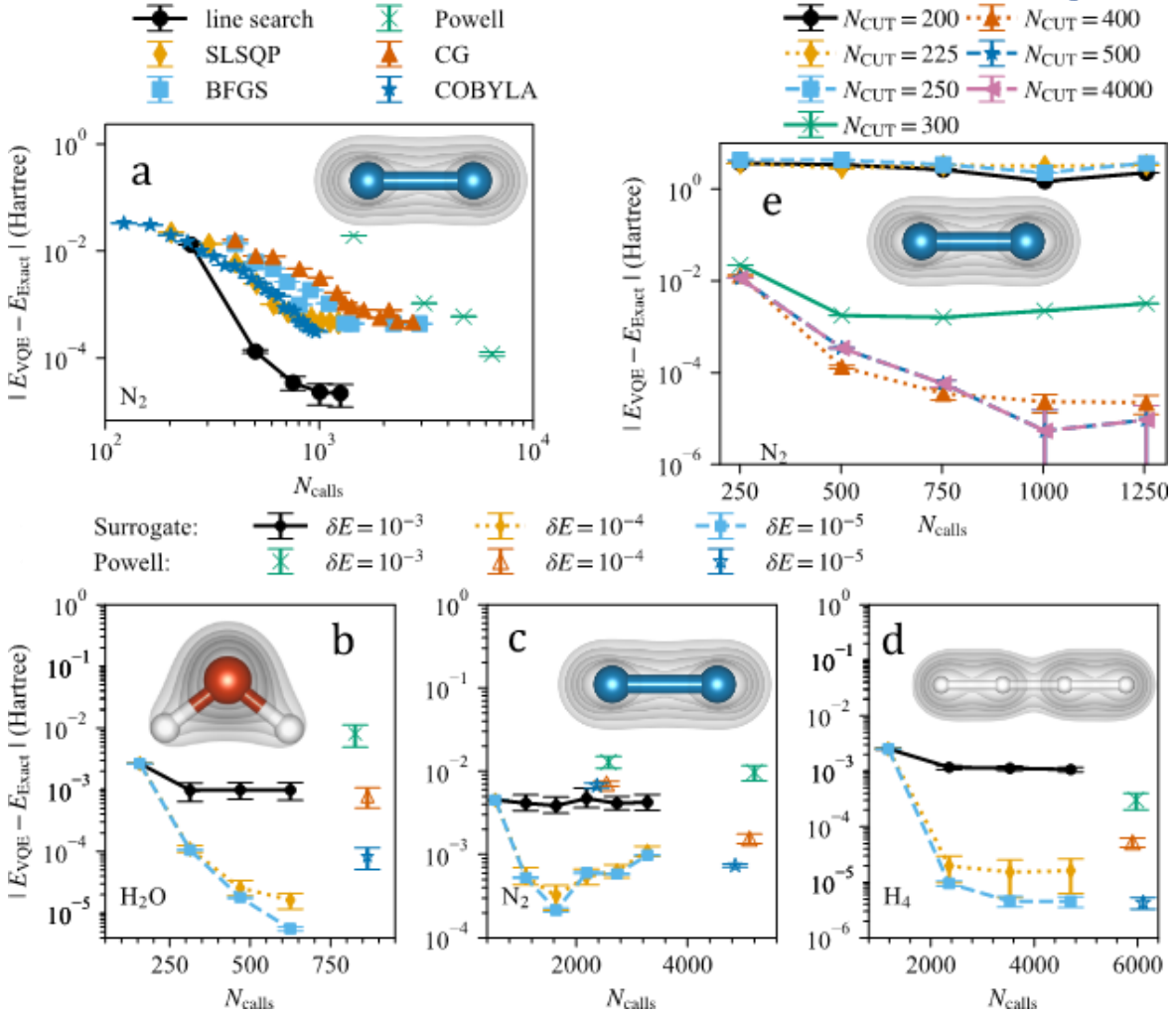
NASA / WMAP Science Team - http://map.gsfc.nasa.gov/media/121238/ilc_9yr_moll4096.png

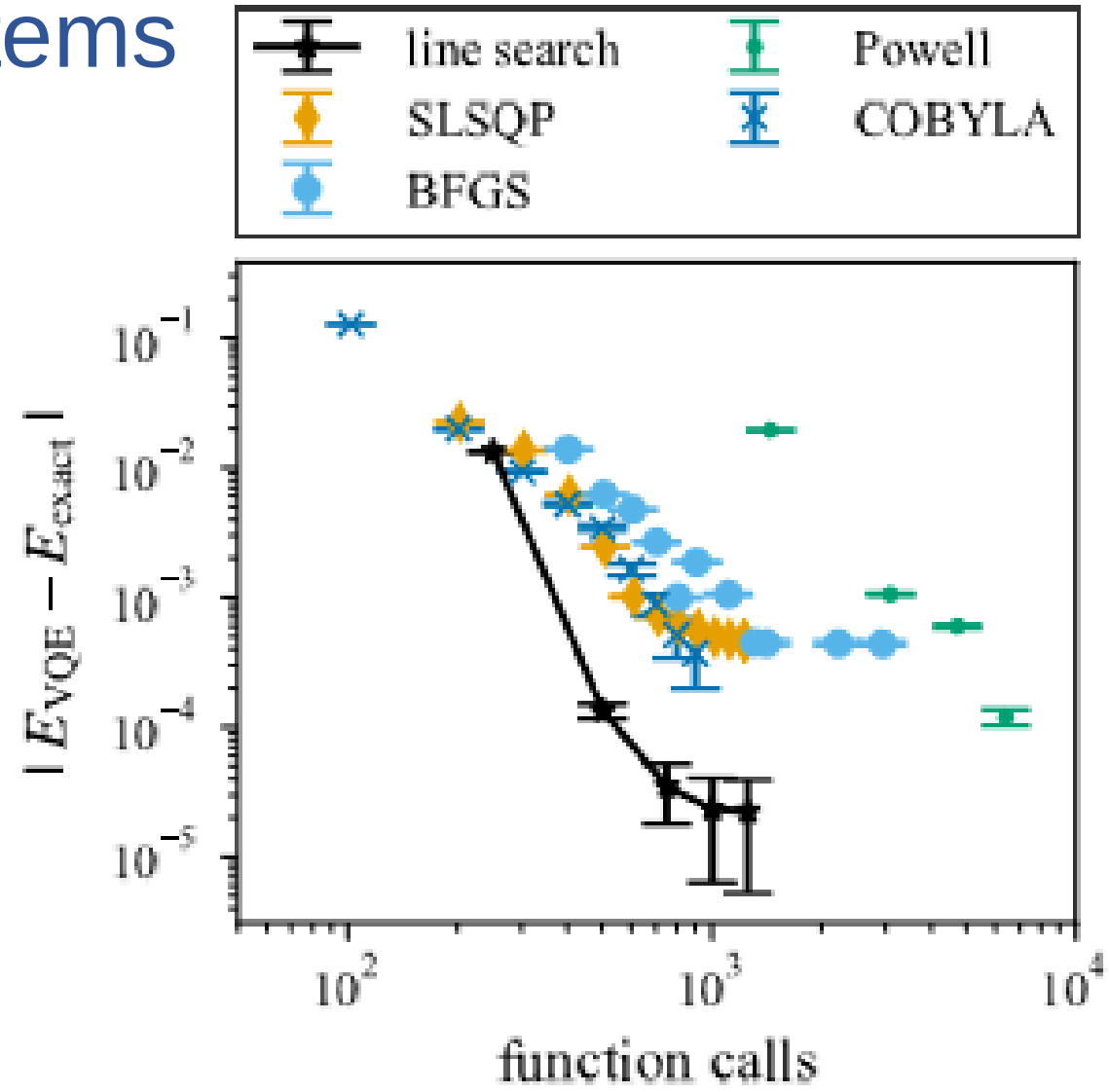
By University of Warwick/Mark Garlick, CC BY 4.0, https://commons.wikimedia.org/w/index.php?curid=63436916

Developing algorithms



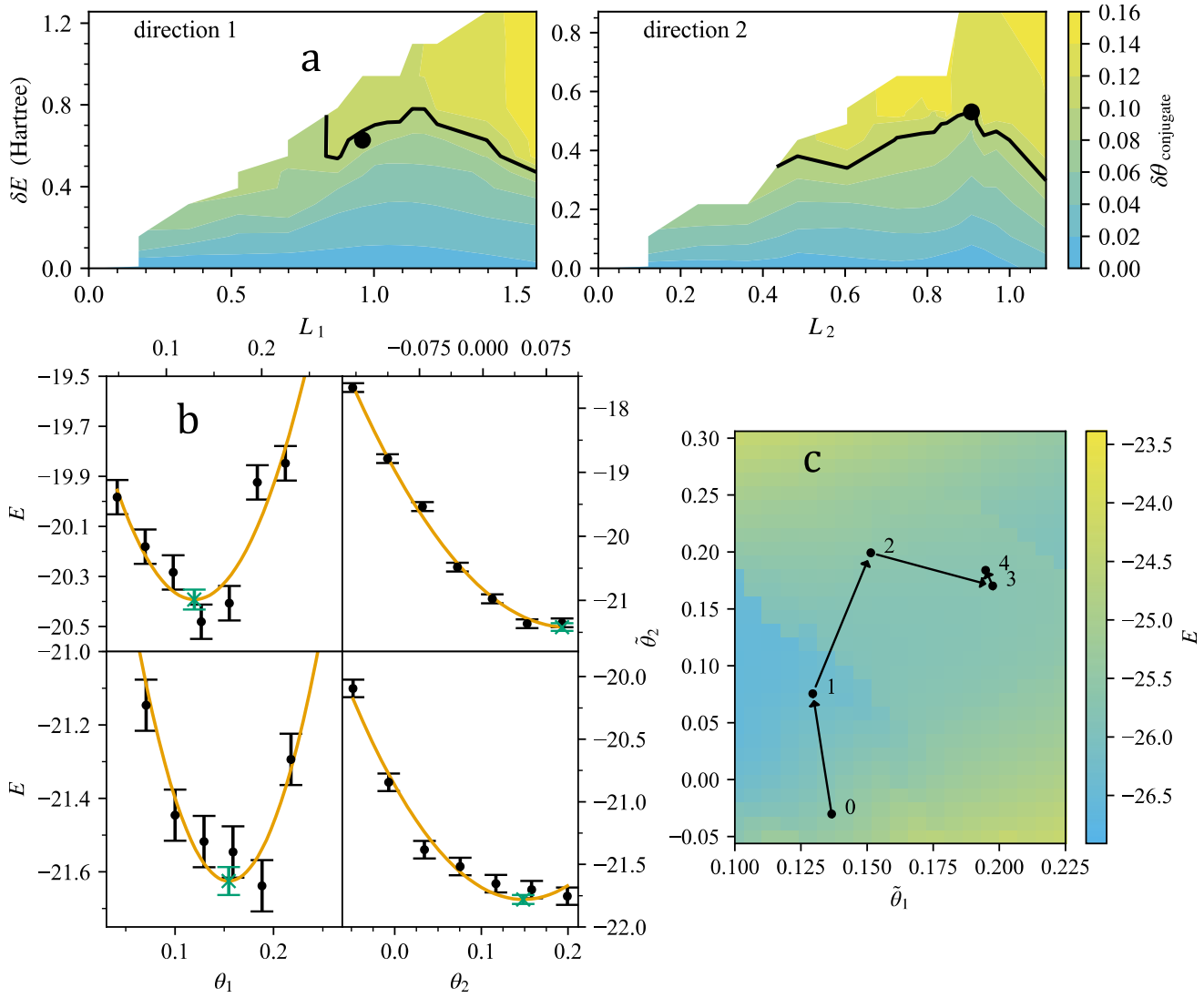
Simulations of material systems

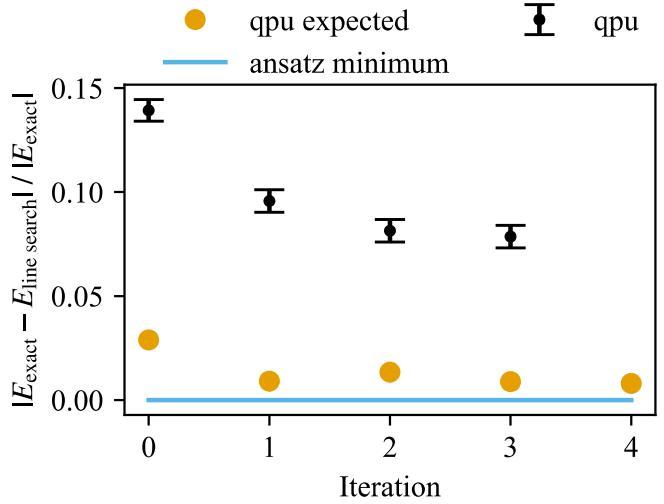


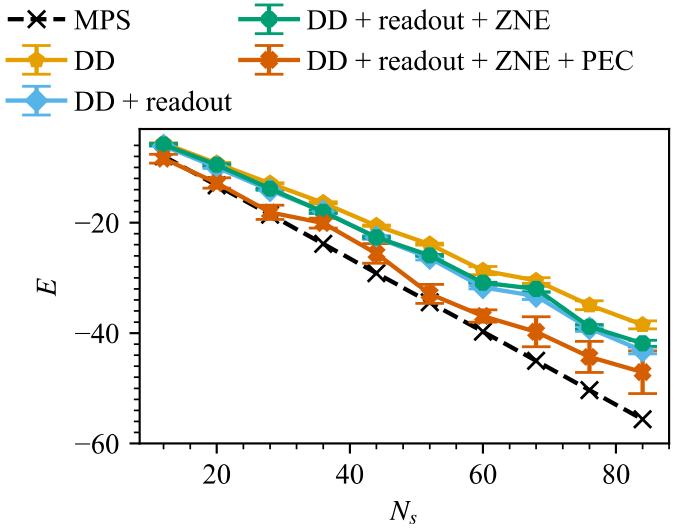


Gustafson Tiihonen, Tubman et al. arXiv:2404.02951

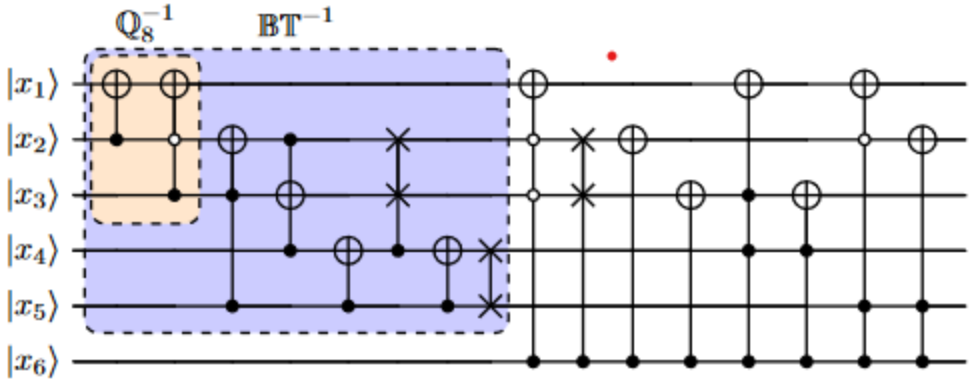
Ground state Optimization of transverse Ising model on QPU

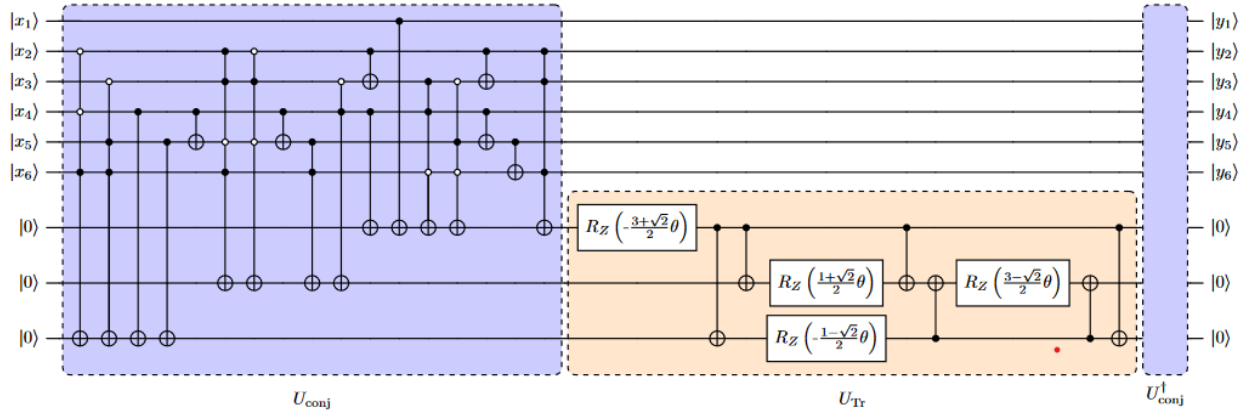




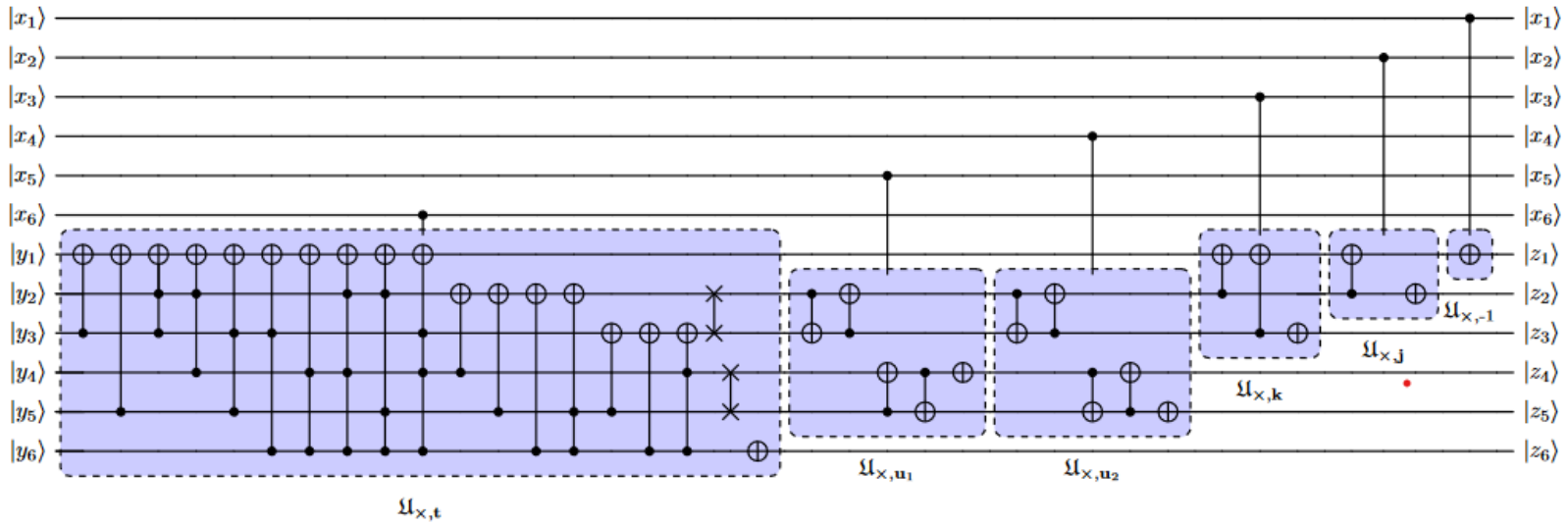


Devising primitive circuits:

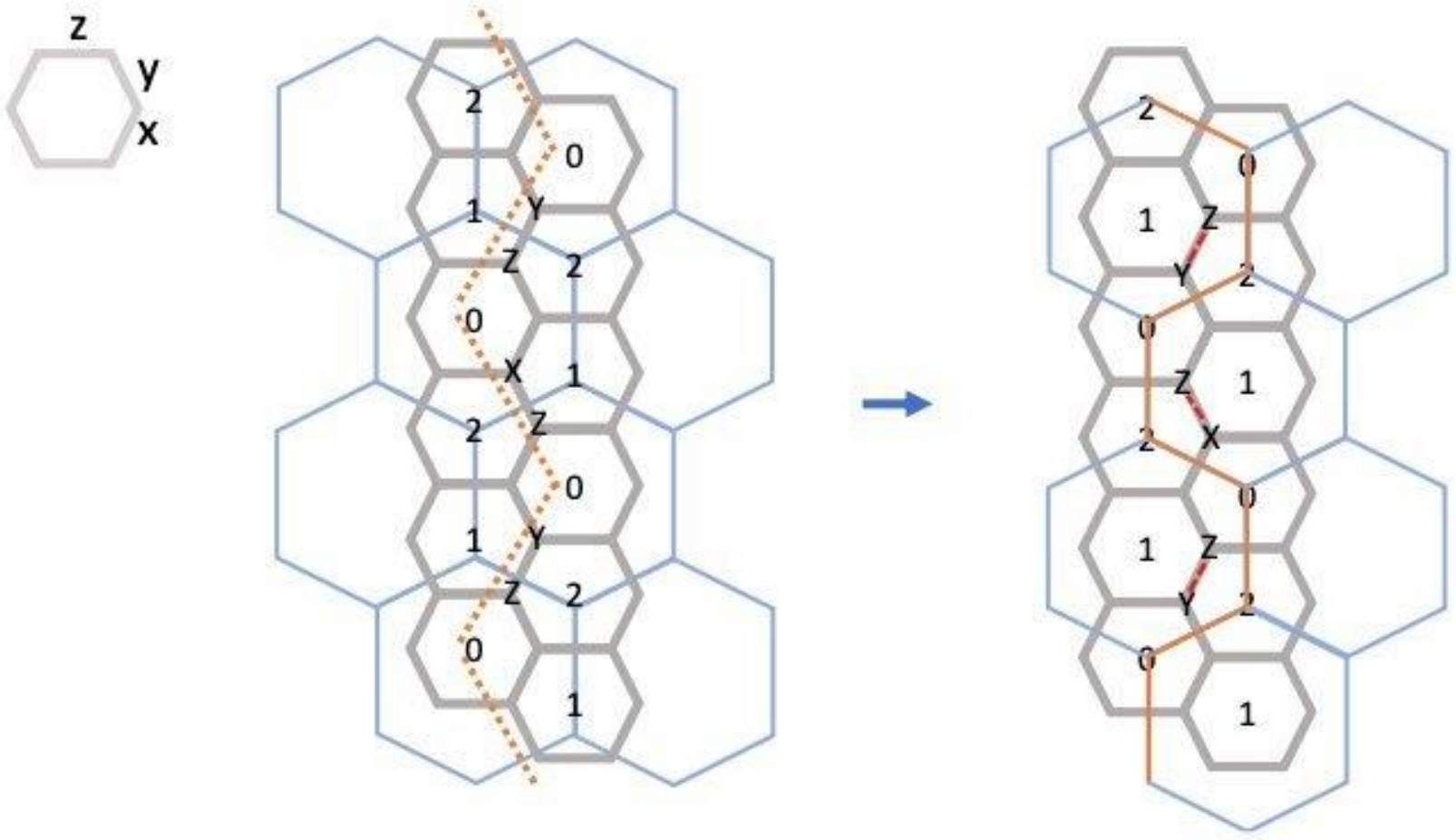




Gustafson, Lamm,
and Lovelace: [PhysRevD.109.054503]



Error Correcting Codes



Acknowledgements

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