

# THE QUANTUM STACK

Frontiers in QIST Research  
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“How do you view the current status of your field, and where would you like to see it (and your work in it) progress in ten years?”

*An identity crisis!*

# The quantum stack

*Quantum algorithm*



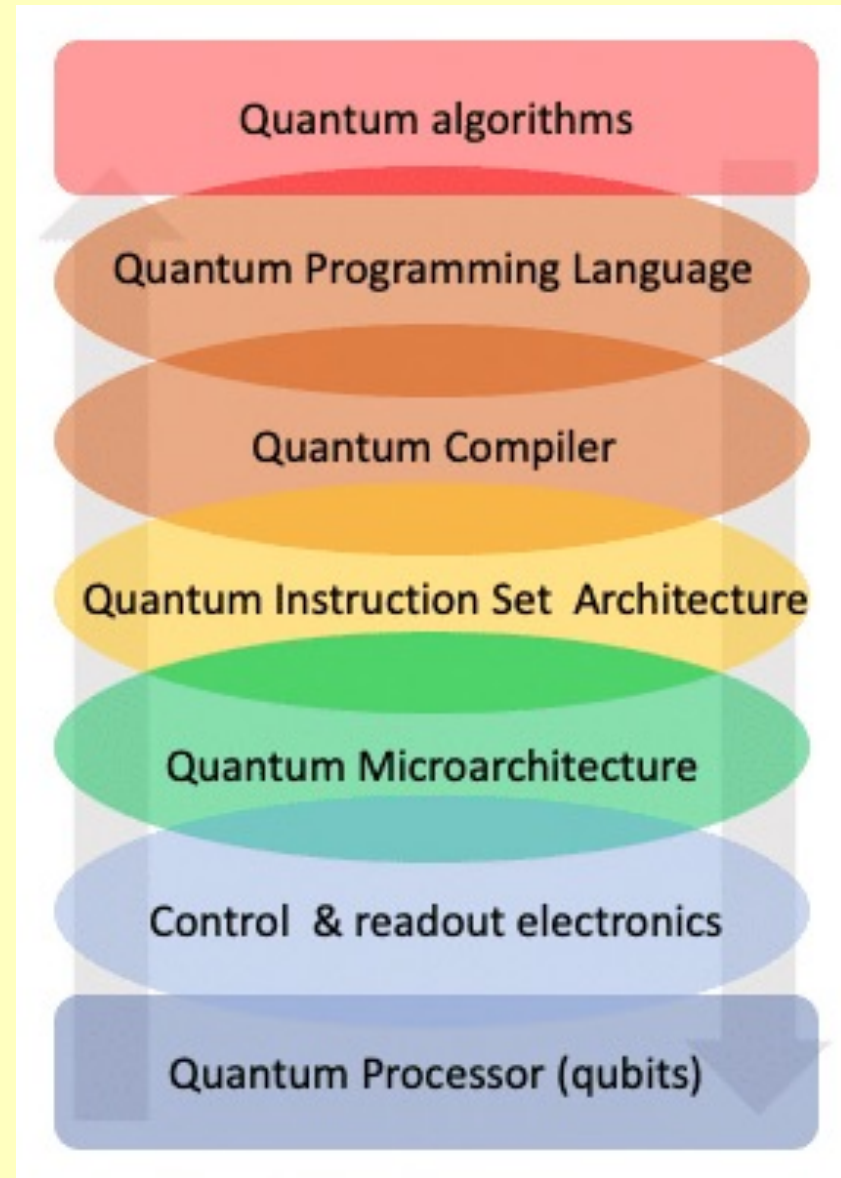
*Quantum hardware*

## The quantum stack

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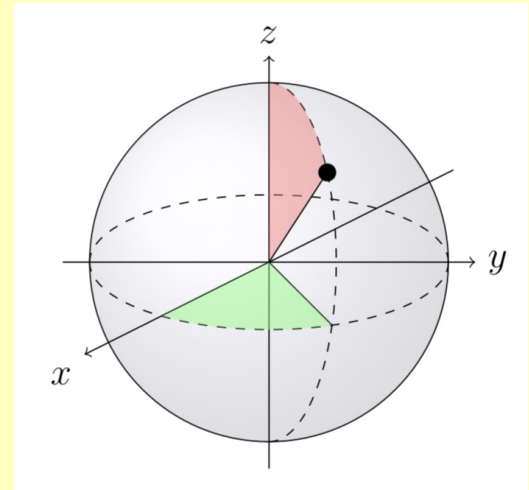


```
qft_adder :: [Qubit] -> [Qubit] -> Circ ()
qft_adder _ [] = return ()
qft_adder as (b:bs) = do
  qft_adder' as b 1
  qft_adder (tail as) bs
```

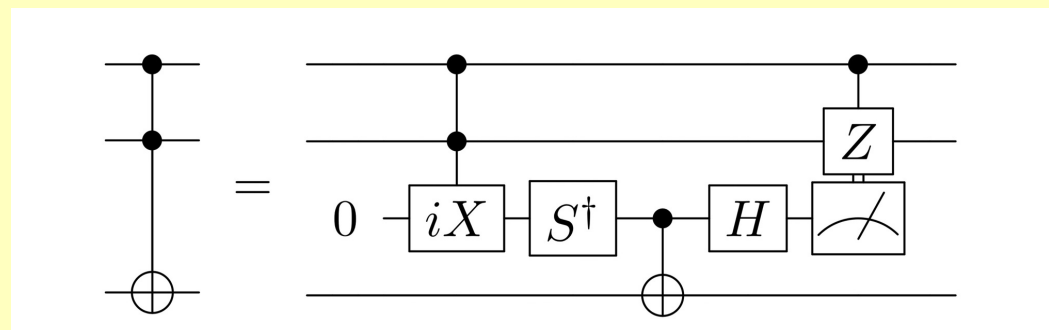
## Quantum programming

- How do you *program* a quantum computer?
  - ▶ A plethora of QPLs: Circ, Q#, Qiskit, Quipper, ...
- How do you *debug* a quantum program? How do you show that a quantum program is *correct*?
  - ▶ Logical foundations of QPLs, formal methods.

## Quantum compiling



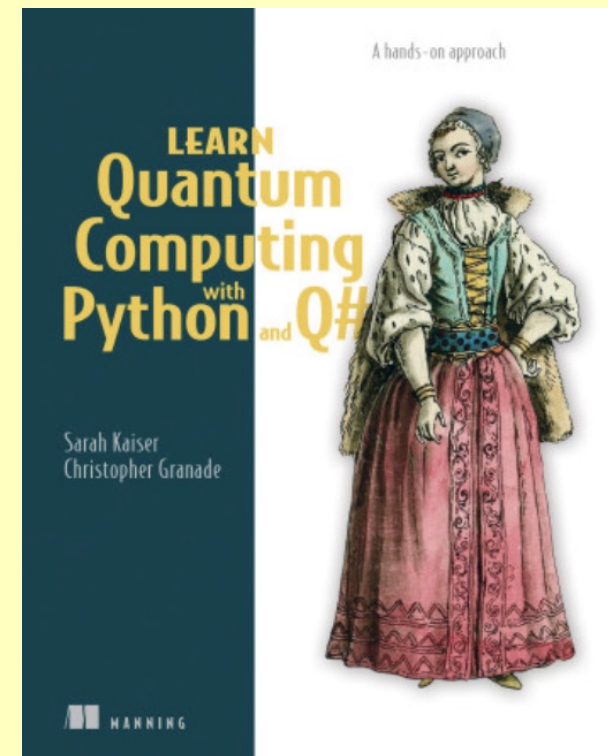
- How do you *decompose* quantum operations?
- How do you *optimize* quantum circuits?
- How do you map a quantum circuit onto *constrained* hardware?



## Applications

- Executing quantum programs.
- Estimating the cost of running quantum programs.
- Education: “shut up and program!”

sired<sup>sup</sup> by taking  $n$  sufficiently large. As a result, for any  $\epsilon > 0$ ,  $n$  can always be picked sufficiently large to ensure that the simulator always tracks the correct time evolution



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- The mathematical foundations of quantum circuit theory.
- Standardization and interoperability.
- Practical quantum advantage? A sober perspective on the cost of quantum algorithms?
- The democratization of quantum computing?

Thank you!

## References

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- Lloyd, *Universal quantum simulators*, 1996. (Slide 6)