

# INVESTIGATING COMPUTATIONAL PHASES OF MATTER ON NISQ DEVICES

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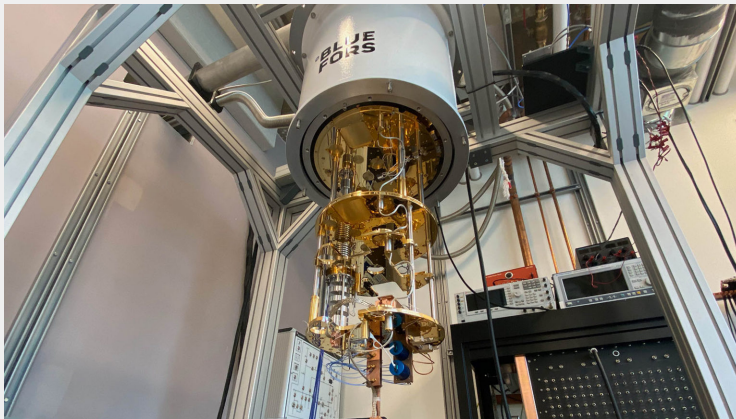


# MOTIVATION (EXPERIMENT) - NISQ AND GRAND CHALLENGES



Image Credit: Stewart Blusson Quantum Matter Institute

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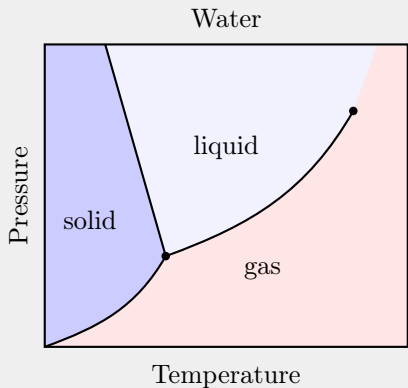


- NISQ era - Applications like Shor, large-scale quantum simulation inaccessible.
- What are interesting things we can do with such devices?

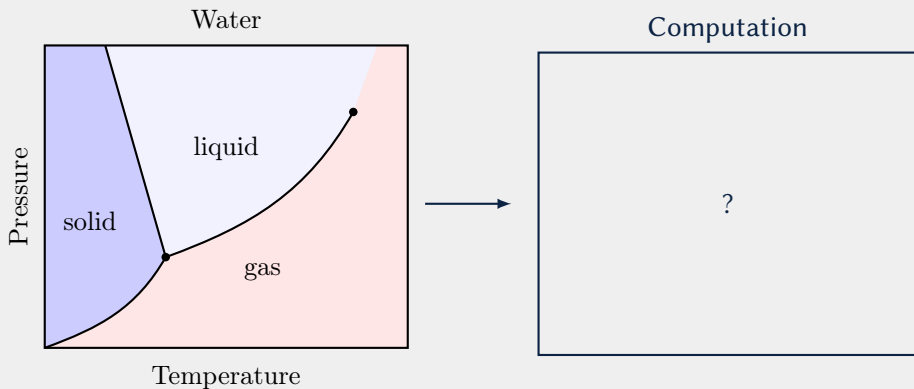
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Image Credit: Stewart Blusson Quantum Matter Institute

# MOTIVATION (THEORY) - COMPUTATIONAL PHASES OF MATTER



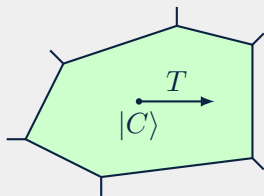
# MOTIVATION (THEORY) - COMPUTATIONAL PHASES OF MATTER



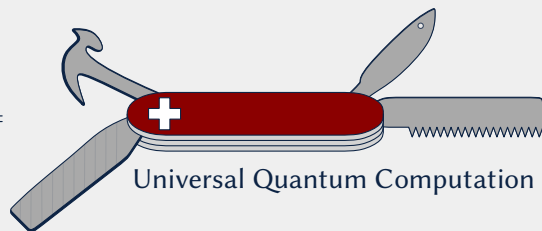
- Can we classify states capable of quantum computation via local measurements?

# CHARACTERIZING COMPUTATIONAL POWER - SPTO AND ORDER PARAMETERS

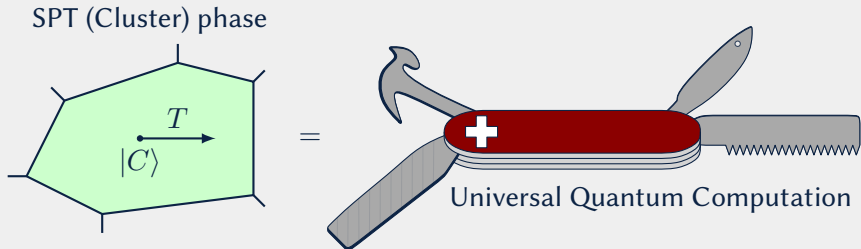
SPT (Cluster) phase



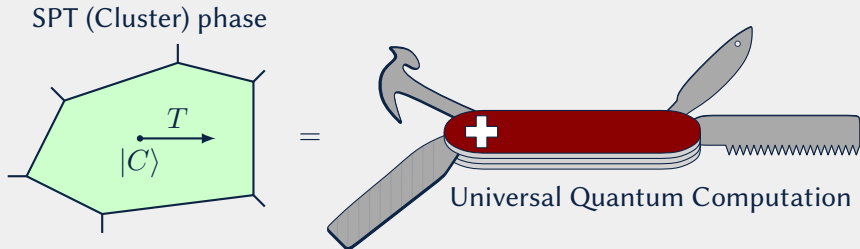
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Universal Quantum Computation



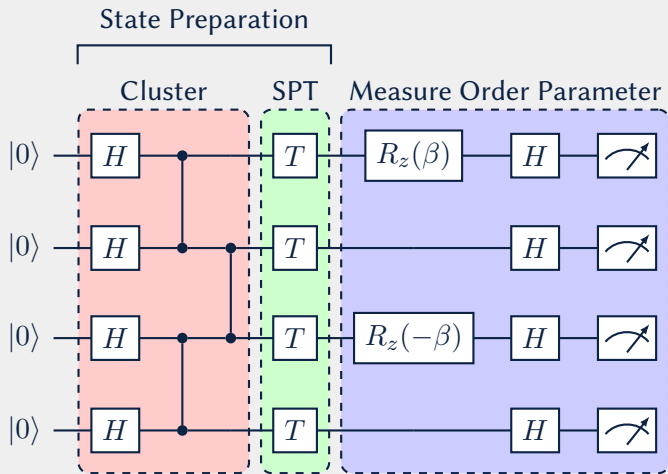
- Finite systems - Measure a (computational) order parameter.



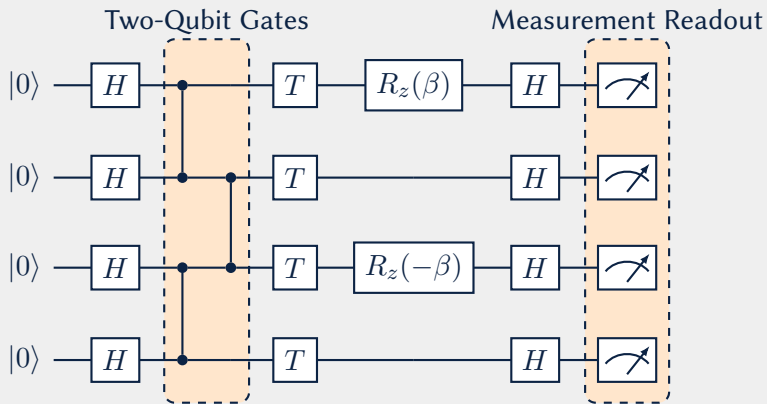
- Finite systems - Measure a (computational) order parameter.
- Project goal:
  1. Prepare states in SPT phase on NISQ devices.
  2. Measure their computational order parameter.

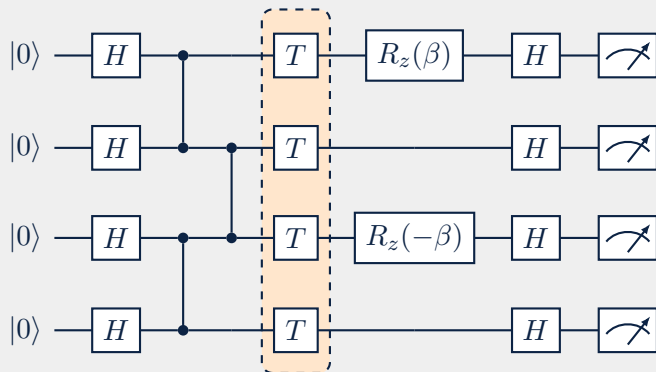


# THE THREE-STEP CIRCUIT



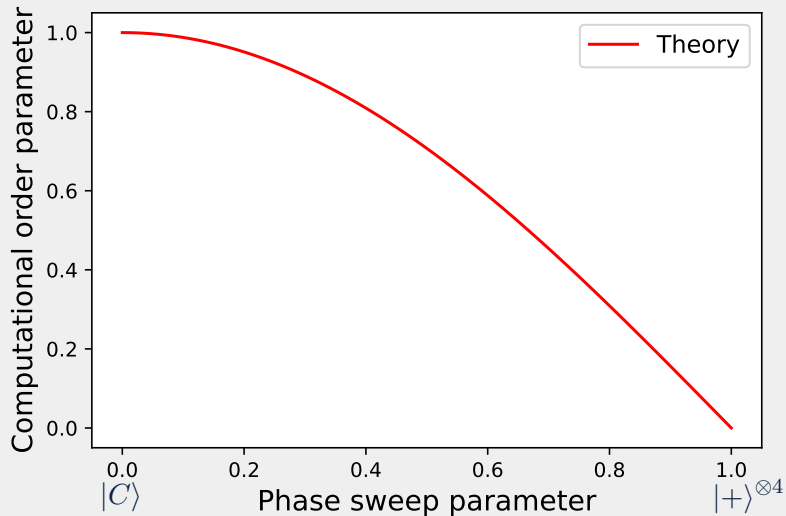
# TECHNIQUES - ERROR MITIGATION

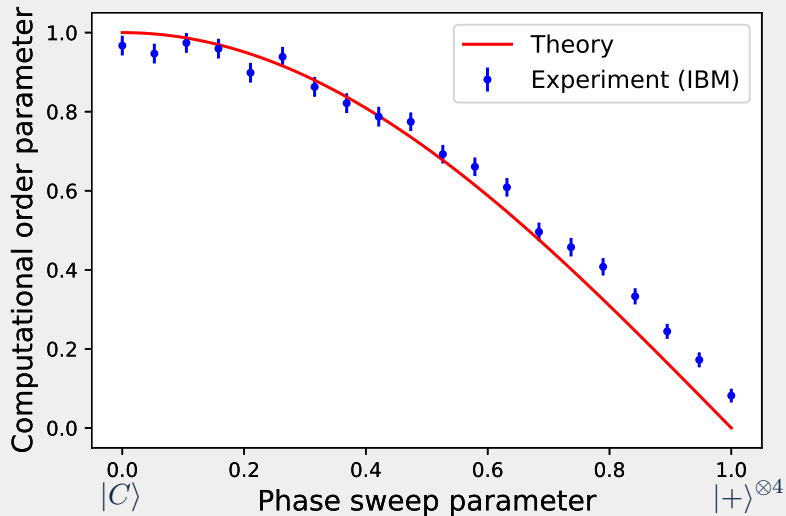


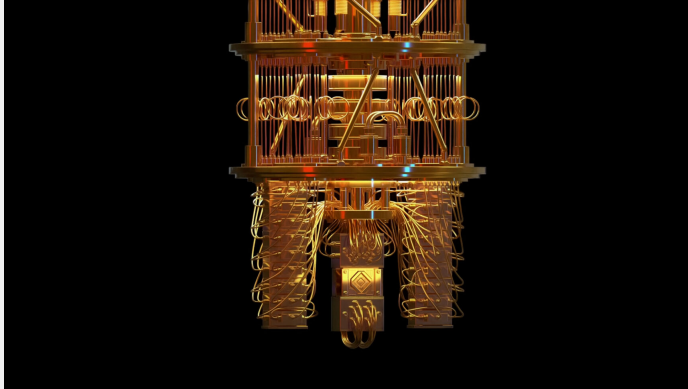


- Determine  $T$  via variational energy minimization to get desired ground state of  $H_0$ :

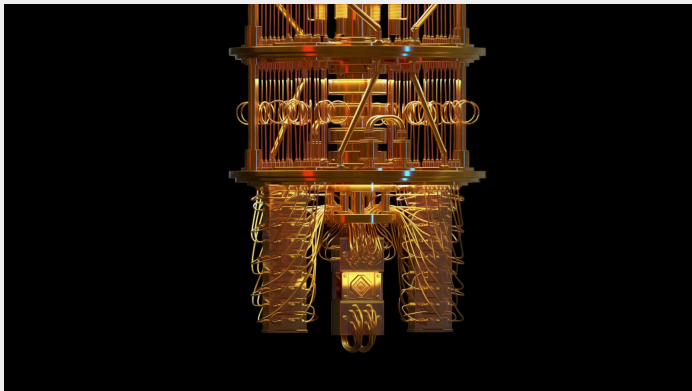
1. Prepare states  $|T(\theta)\rangle$
2. Find  $\theta$  which minimizes  $E(\theta) = \langle T(\theta) | H_0 | T(\theta) \rangle$ .



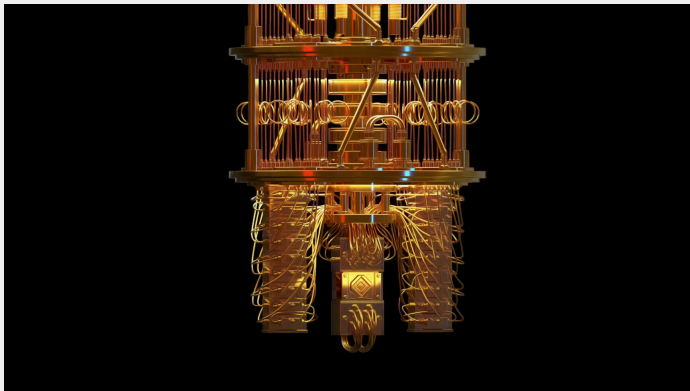




- Demonstration of techniques for decoherence management.



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- Requires larger systems, better (nonlocal) approximation for  $T$ .



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- Investigating other computational phases of matter on NISQ devices.

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Image Credit: Quanta Magazine