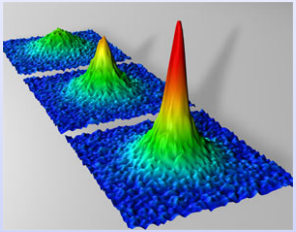
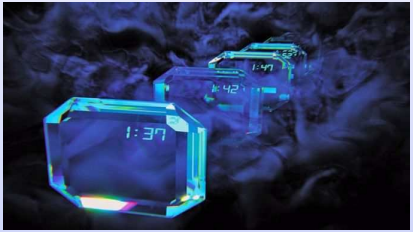
NBIA

Condensed matter physics

Center for Quantum Devices





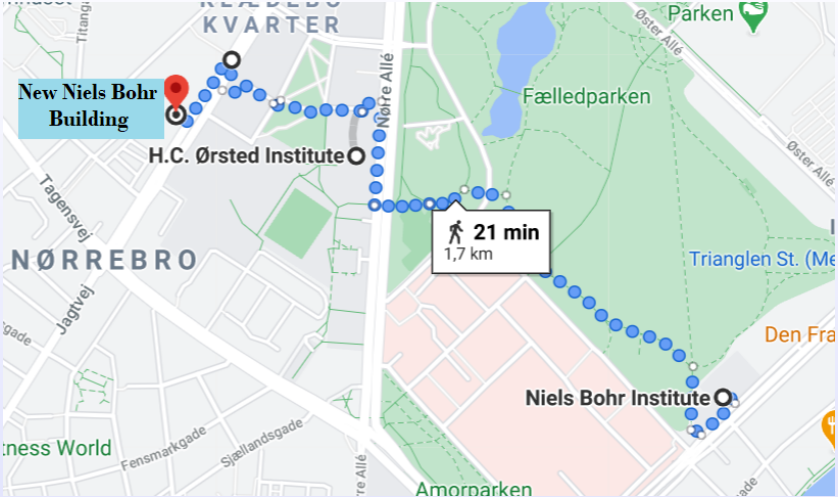
Mark Rudner

Evert van Nieuwenburg

Michele Burrello

Condensed Matter Theory and QDEV

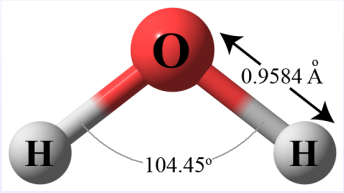
Where are we?



More is different!

P. Anderson

The challenge of many-body physics is to master the complexity of thermodynamic systems and describe their emergent properties.



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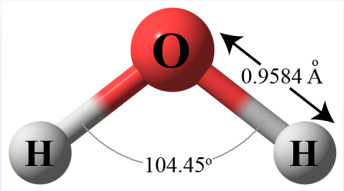

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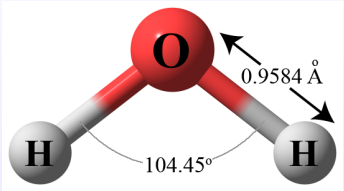

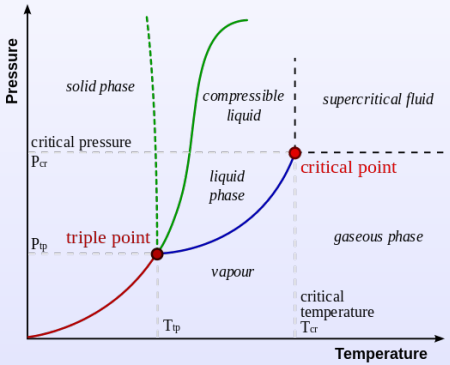

Let’s discuss about energies

From High Energy....

... to Low Temperatures

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- Penalty kick by Cristiano Ronaldo:
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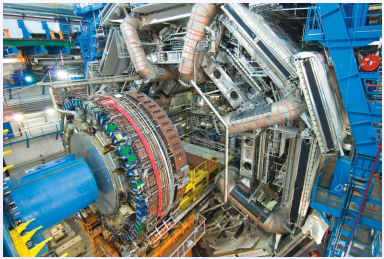

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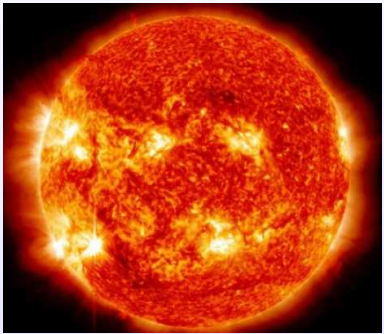

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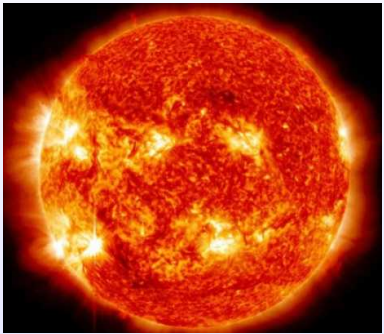

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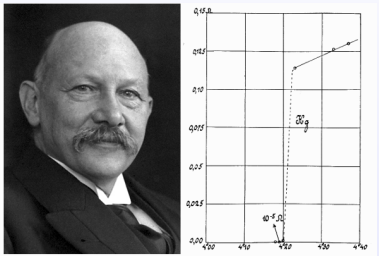

Kamerlingh Onnes 1911

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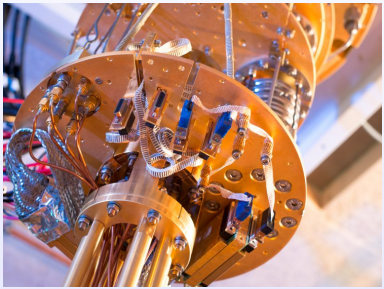

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- Ultracold atoms: 10^{-8}K

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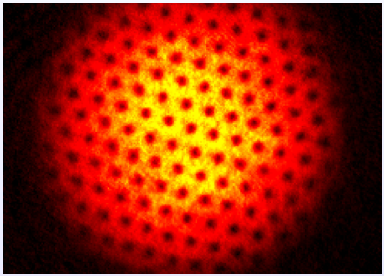
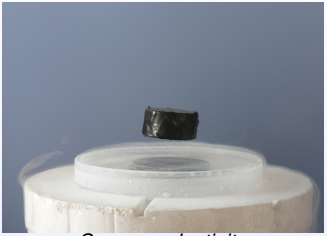
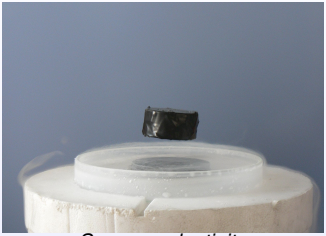


Quantum world at low temperature



Superconductivity

Quantum world at low temperature



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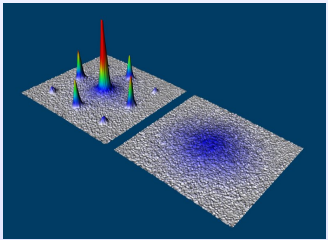
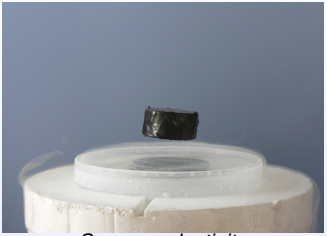


Superfluid-Mott phase transition in cold atoms

Quantum world at low temperature



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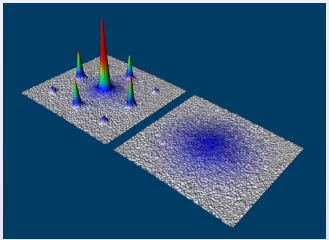

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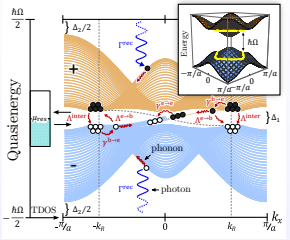
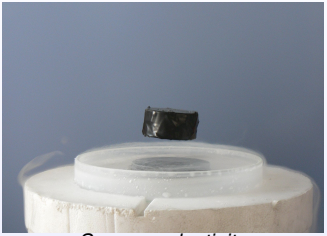


Controlled dynamical phases of matter

Quantum world at low temperature



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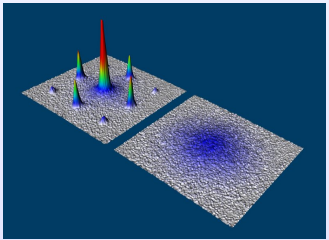

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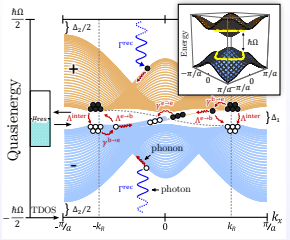

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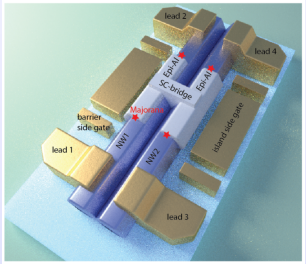
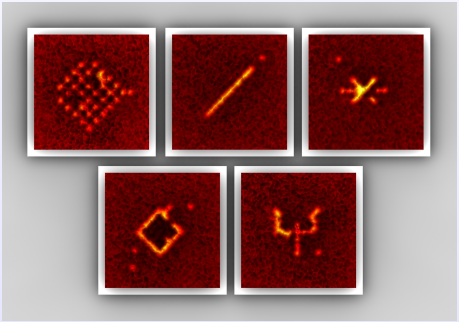


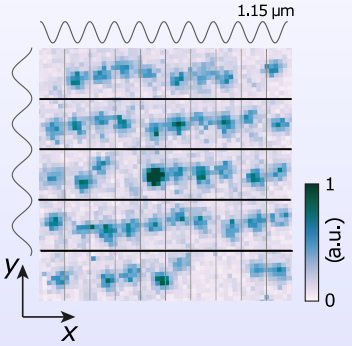
Topological Phases of Matter

Ultracold atoms in optical lattices

- Lasers define time-dependent optical potentials
- Quantum engineering of effective Hamiltonians
- Unprecedented possibility of studying quantum dynamics



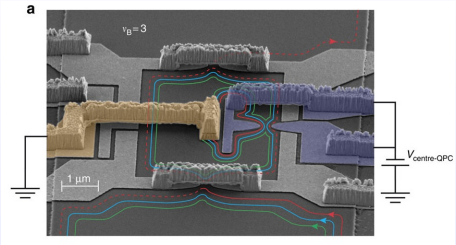
Potential design



Atomic microscope

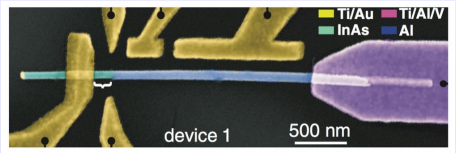
Topological phases of matter

Fractional quantum Hall:



Robustness against local perturbations

Majorana nanowires (@ QDEV):



Topologically protected quasiparticles

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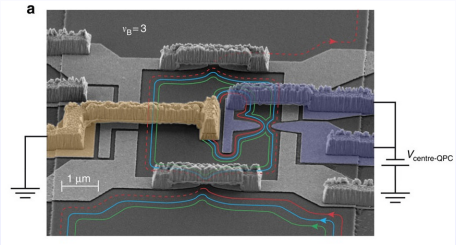

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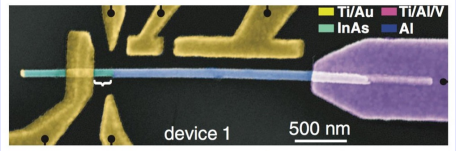

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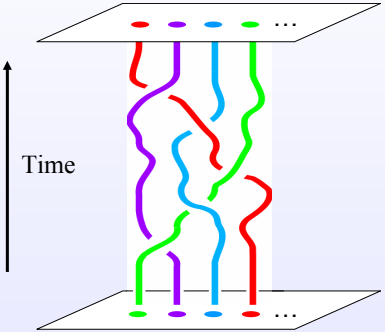
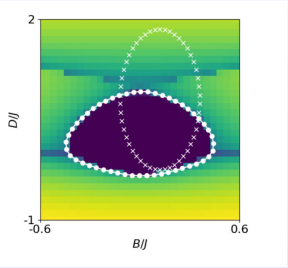
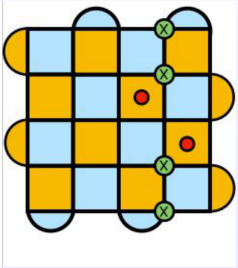


Quasiparticles with fractional charges and anyonic statistics

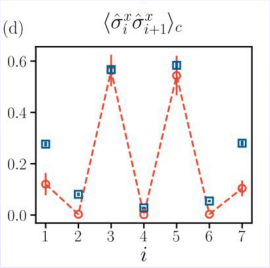
Condensed Matter and Artificial Intelligence



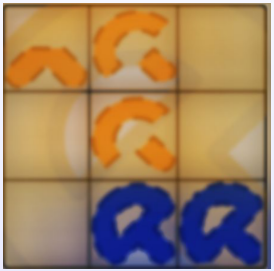
Machine learning phases of matter



AI for quantum control: Error correction



AI for quantum control: Experiments



Quantum games

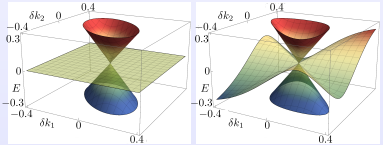
Methods and techniques

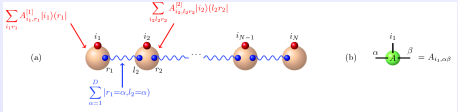
Analytical methods:

- Advanced quantum mechanics
- Floquet analysis
- Quantum field theories
- ...

Numerical methods:

- Exact diagonalization
- DMRG and tensor networks
- Machine learning
- ...





Condensed matter courses

IV year

- **Block 2:**
  - Condensed matter physics 2
    Brian Andersen
  - Condensed matter theory 1
    Mark Rudner
- **Block 3:**
  Condensed matter theory 2
  Jens Paaske
- **Block 4:**
  Advanced topics in condensed matter theory
  Michele Burrello

The group - see also `cmt.nbi.ku.dk`

Contact: michele.burrello@nbi.ku.dk

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Mark Rudner

Assistant professors:

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Other CMT professors:
Jens Paaske
Karsten Flensberg
Brian Andresen
Per Hedegård