



Machine Learning Topics for Master and Bachelor Theses in 2022/23

Department of Condensed Matter Physics
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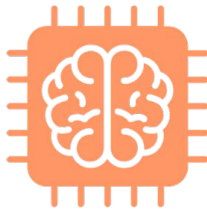
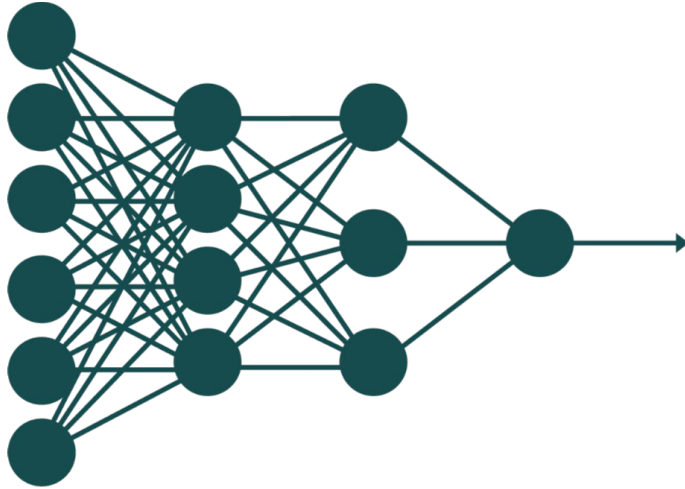
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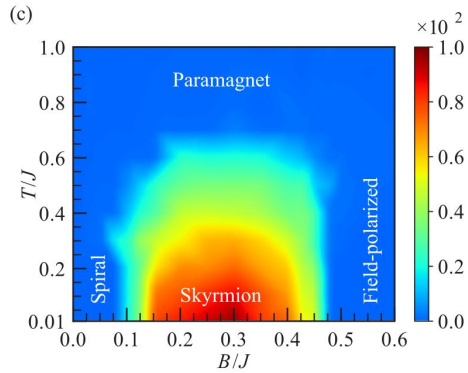
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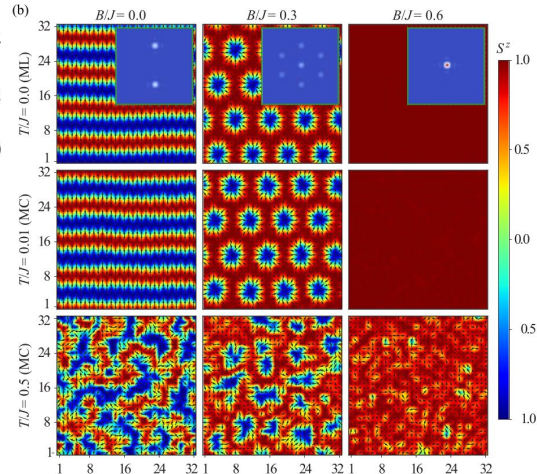
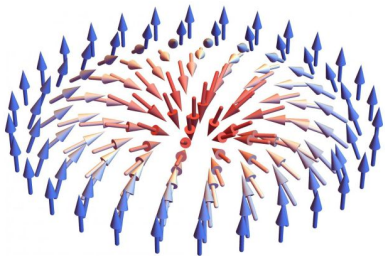
Neural networks



Automatic classification of phases



Skyrmions

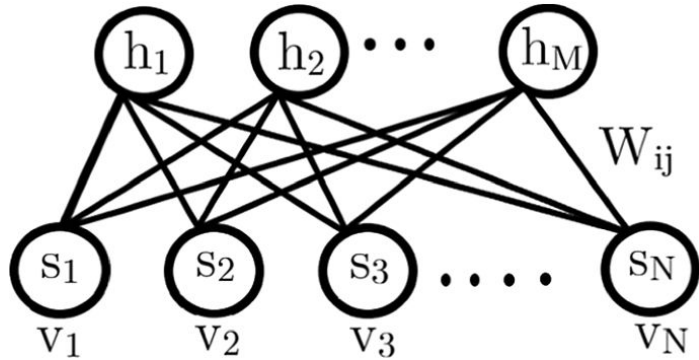


What would you learn and investigate?

- model systems that combine classical spins with electrons
- Quantum-classical equations of motion
- Basic **Machine Learning** techniques for unsupervised phase classification
- Automatic **phase classification** using neural networks

N Swain et al., PRB 104, 23515 (2021)

Neural Network Quantum states

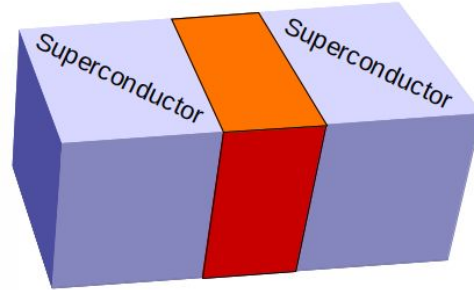


- approximate many-body wave function using a neural network
- training using quantum Monte Carlo

What would you learn and investigate?

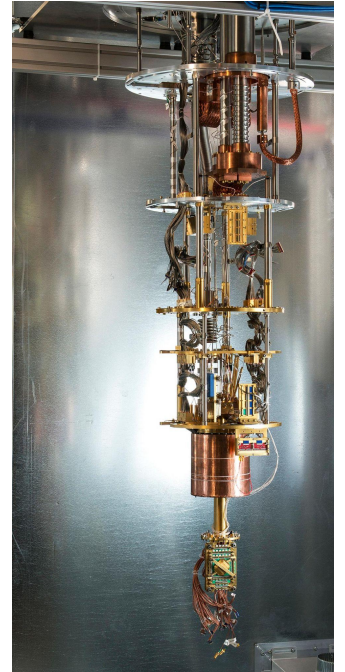
- basic lattice spin models
- [quantum Monte Carlo](#) simulations
- numerical calculations of many-body ground state
- artificial [neural networks](#)
- NetKet Python module
- how various neural networks can be used to find ground states of quantum spin models

Identification of anomalies in stochastic time series

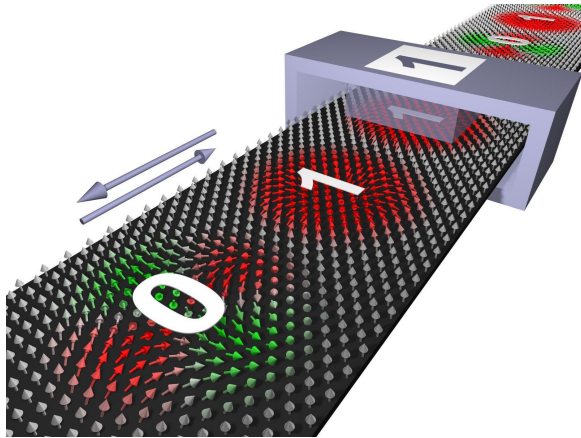


What would you learn and investigate?

- Physics of [Josephson junctions](#)
- Stochastic simulations
- Analysis of noisy time series via [Machine Learning](#)
- Identification of anomalies in data



Neuromorphic computing



- artificial neural networks in real physical systems
- skyrmions: topological quasiparticle

What would you learn and investigate?

- numerical simulations of [magnetization dynamics](#)
- physics of magnetic [skyrmions](#) and other topological defects
- basic concepts in neuromorphic computing
- how to use dynamic properties of magnetic skyrmions in future [neuromorphic computational devices](#)



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