GOETHE UNIVERSITÄT FRANKFURT AM MAIN
Fachbereich Physik
Institut für Theoretische Physik

CONDENSED MATTER THEORY SEMINAR

Subject: **Neural network-based reinforcement learning for quantum error correction**

Speaker: **Prof. Florian Marquardt, MPL, Erlangen**

Date & time: **Friday, May 17th, 2019 at 3:15 p.m.**

Venue: **Seminar room 1.114**

Machine learning with artificial neural networks is revolutionizing science. The most advanced challenges require discovering answers autonomously. In the domain of reinforcement learning, control strategies are improved according to a reward function. The power of neural-network-based reinforcement learning has been highlighted by spectacular recent successes such as playing Go, but its benefits for physics are yet to be demonstrated. Here, we show how a network-based "agent" can discover complete quantum-error-correction strategies, protecting a collection of qubits against noise. These strategies require feedback adapted to measurement outcomes. Finding them from scratch without human guidance and tailored to different hardware resources is a formidable challenge due to the combinatorially large search space. To solve this challenge, we develop two ideas: two-stage learning with teacher and student networks and a reward quantifying the capability to recover the quantum information stored in a multiqubit system. Beyond its immediate impact on quantum computation, our work more generally demonstrates the promise of neural-network-based reinforcement learning in physics.

Reinforcement Learning with Neural Networks for Quantum Feedback
Thomas Fösel, Petru Tighineanu, Talitha Weiss, Florian Marquardt
Physical Review X 8(3) (2018)