

Theory Colloquium

Torsten Zache, Institute for Theoretical Physics, University of Innsbruck
“Quantum Simulation of Gauge Theories”

Abstract

Gauge theories are ubiquitous in fundamental physics with applications ranging from high-energy particle physics over emergent phenomena in condensed matter to quantum information science and technology. Since several regimes of interest have remained inaccessible to classical simulations, they constitute an ideal target for quantum simulations.

In this talk, I will present recent progress towards the quantum simulation of lattice gauge theories (LGTs). After highlighting key challenges that are unique to LGTs, I will review the current state-of-the-art, and then discuss outstanding open problems. Our proposed solutions involve digital quantum algorithms [1] and specialised quantum hardware [2] that are tailored to the requirements of LGTs. At the same time, existing hardware already allows us to study phenomenological aspects of LGTs, such as the dynamics of string-breaking, as demonstrated by our recent results using an analog Rydberg quantum simulator [3].

[1] Phys. Rev. Lett. 131, 171902

[2] Quantum 7, 1140

[3] arXiv:2410.16558

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