

# Quantum Simulators in Other Frames of Reference

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The idea of quantum simulators was introduced by Richard Feynman in 1982 [1]. Generally speaking, quantum simulators are highly-controllable systems that can be tuned or programmed to mimic physics of other often theoretically or experimentally intractable physical systems. In the case when a system is tuned to realize some other Hamiltonian the quantum simulator is called an analogue simulator; and when it is programmed according to the Trotter decomposition, it is called a digital quantum simulator [2]. Thanks to the recent technological advances in controlling and tuning Hamiltonian parameters with high fidelity, quantum simulators were realized on a number of experimental platforms including ultra-cold quantum gases [3, 4], trapped ions [5], photonic systems [6], and superconducting circuits [7]. However, the ultimate goal of realizing a universal quantum simulator is still elusive.

In our work [8], we present an alternative approach to quantum simulators which might relax restrictions imposed on the universal quantum simulator. Our model is based on the observation that there always exists a finite set of states that will yield the same quantum trajectories under the action of two arbitrary Hamiltonians. According to this we show how to simulate the most interesting physics of the one-axis twisting Hamiltonian, that leads to generation of many-body entangled states, with the Heisenberg XXX chain with staggered field. Next, we show how the same idea can be used in digital quantum simulators. In comparison to the standard approach to digital quantum simulations, quantum simulators in other frames of reference require less steps and thus should be more precise. These results can be tested in most of the current quantum simulator experimental setups.

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