Quantum field thermal machines

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Quantum systems undergoing out-of-equilibrium dynamics provide insights into how features of quantum statistical mechanics emerge, but they still pose a number of puzzles concerning the details of that connection. In this talk, we will on the one hand revisit some of the foundations of the field: We report on progress on the question of how many-body systems actually equilibrate to apparently stationary states, for systems the ground states of which are random matrix product states [1] and ones featuring volume laws of energy eigenstates [2]. Procrastinating for a minute on the complexity growth in time for random systems [3], we turn - on the other hand - to discussing new experiments with cold atoms on atom chips that offer the capability to probe questions of non-equilibrium physics. We see that notions of Gaussification arise in an unexpected flavour for quantum fields [4,5]. We address the question of read-out of such quantum simulators [6] and see how such tools can be exploited to probe correlation propagation in quantum-simulated curved spacetime [7] and entanglement. We end the talk by taking a technological perspective, asking how non-equilibrium dynamics can actually be machine learned, for precise calibration [8,9].

[1] PRX Quantum 2, 040308 (2021).

[2] Physical Review Letters 123, 200604 (2019).

[3] Nature Physics 18, 528 (2022).

[4] Nature Physics 17, 559 (2021).

[5] SciPost Physics 12, 113 (2022).

[6] Communications Physics 3, 12 (2020).

[7] In preparation (2022).

[8] In preparation (2022).

[9] 2108.08319 (2021).