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A fully-programmable universal quantum simulator using Floquet technology

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With the size of quantum information processors increasing, quantum simulation has become one of its promising near-future applications. Now it is known that when the computational problem at hand is difficult, the difficulty often appears in terms of an increased quantum circuit depth in gate based implementations or as many-body interaction terms in Hamiltonian based computation. In particular, many-body interactions are difficult to directly implement. To circumvent such difficulties, we introduce a reverse engineering based Floquet technology to turn one-dimentional non-universal superconducting qubit arrays Into a full-programmable universal quantum simulator. A time dependent Hamitonian can give a unitary map equivalent of the time-evoluation of a non-trivial Hamiltonian different from the original physical Hamiltonian. Using this Floquet nature, we can tune the evolution time of this physical resource to create an arbitrary Hamiltonian. This creates a tradeoff between the time necessary for the simulation and the simplicity of its hardware implementation. We discuss the advantages and disadvantages of the universal quantum simulator as a model to investigate complex quantum dynamics as well as for experimental implementation.

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