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Quantum simulation of arbitrary Hamiltonians with superconducting circuits C. BENJAMIN, E.J. PRITCHETT, M.R. GELLER, A. GALIAUTDINOV, A.T. SORNBORGER, P.C. STANCIL, Dept. of Physics & Astronomy, University of Georgia, Athens, GA 30602, USA, J. MARTINIS, Physics Department, UC Santa Barbara, CA 93106 USA — While advances are continually being made in the computational treatment of atomic and molecular scattering on classical computers, the computational costs grow exponentially with system size. As a consequence, collision complexes involving 5 particles are at the fore-front of modern research with exact treatment of larger systems currently intractable. It has been proposed that quantum computers using quantum logic gates could treat such problems as the computation expense would scale polynomially. However, such digital quantum simulation would require hundreds of qubits and gate operations to treat the simplest 3-atom reactive scattering problem. In contrast, we have developed an analog quantum simulation(AQS) approach in which the scattering (or any arbitrary) Hamiltonian is directly mapped to the Hamiltonian of the quantum simulation device. Physically interesting collision problems could be mapped to just 2 or 3 coupled qubits. We illustrate such mappings and discuss how such an approach can be realized on a system of coupled Josephson junctions(JJs). Previous experiments with quantum circuits consisting of pairs of JJs have demonstrated highly accurate control and readout making them especially well suited for AQS.

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