Scrambling Quantum Information in Cold Atoms with Light

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When a qubit falls into a black hole, the information is rapidly “scrambled,” i.e., entangled with the black hole’s many internal degrees of freedom. Scrambling is a manifestation of many-body quantum chaos, suggesting that strongly interacting quantum systems realizable in the laboratory might offer a route to table-top simulations of quantum gravity. Conducive to fast scrambling are non-local interactions. I will describe prospects for implementing chaotic non-local spin models with cold atoms strongly coupled to photons in an optical resonator. Numerical simulations indicate fertile ground for explorations ranging from collective spin dynamics compatible with semi-classical intuitions to inherently many-body chaos.