Qubit Lattice Algorithms for 2D Scattering of Electromagnetic Waves from Scalar Dielectric Objects

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Qubit lattice algorithms (QLA) are developed as initial value solvers for both the full Maxwell equations in a scalar dielectric and the curl-curl subset commonly used in the modeling of wave propagation in a plasma The QLA consists of an interleaved sequence of unitary collision-streaming operators in which the collision operators entangle the local on-site qubits, while this entanglement is spread throughout the lattice by the streaming operators. For scalar dielectric media, the Riemann-Silberstein-Weber representation of the electromagnetic fields permits Maxwell equations to be expressed in a form similar to the Dirac equation. For a minimal set of qubits, the QLA involve potential operators that are not unitary, although embedding in higher qubit dimensions could resolve this. For an electromagnetic wave propagation in 1D, incident normally on a dielectric interface, the QLA initial value results are in full agreement with the standard boundary value Fresnel results, except that the ratio of the amplitude of the transmitted to the incident electric fields is augmented by the square root of the ratio of the two refractive indices. In 2D scattering from scalar dielectric objects we observe internal sloshing of the electromagnetic fields inside the dielectric. This leads to re-emission of waves into the background medium resulting in intricate field structures. The QLA representation of the two curl-curl Maxwell equations requires fewer qubits/lattice site than that for the full Maxwell system. (For x-y dependence one requires 6 vs. 8 qubits/lattice site). From our current QLA runs, the curl-curl subset seems to be a good representation of the full Maxwell system, although there are non-trivial differences.

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