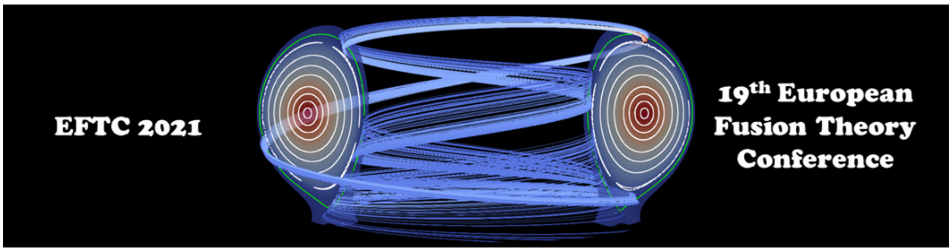

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Simulating Electromagnetic Pulse Propagation in 2D Dielectric Media using Qubit Lattice Algorithms (QLA)

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There is considerable interest in studying plasma physics problems that will be solvable to error-correcting quantum computers. An interesting class of such problems is the propagation of electromagnetic waves based on Maxwell equations, with the plasma physics determining the dielectric properties of the medium. In order to develop the fundamental concepts for casting a classical wave propagation equation into a form suitable for quantum computers, we consider a medium that can be described by a scalar dielectric. We formulate an interleaved sequence of collide-stream operators acting on a lattice of qubits, in which the collision operators entangle the local on-site qubits, while the streaming operators spread this entanglement throughout the lattice. We study the interaction of a plane electromagnetic pulse (propagating in the x-direction) with a 2D cylindrical dielectric in the x-z plane. Initially, Ey and Bz are functions only of x, t. Following the interaction with the dielectric, the fields become 2D with a Bx(x,z,t) generated to preserve div B = 0. Multiple internal reflections create a series of circular wavefronts that emanate from the dielectric cylinder. Our mesoscopic QLA codes are ideally parallelized on classical supercomputers and can be readily encoded onto a quantum computer. For inhomogeneous media one finds both Hermitian and anti-Hermitian evolution operators: the anti-Hermitian operators require a doubling of the number of qubits/lattice site in order to yield a unitary representation. The QLA is easily extended to 3D by taking tensor products of the individual 1D QLAs.

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