Quantum Computing Approach to Electromagnetic Wave Propagation in Plasma

Efstratios Koukoutsis[1], Kyriakos Hizanidis[1], Abhay K. Ram[2]

[1] *School of Electrical and Computer Engineering, National Technical University of Athens, Zographou 15780, Greece*

[2] *Plasma Science and Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA*

Quantum computing (QC) has shown enormous promise for solving classes of problems for which a quantum algorithm can obtain a speedup (advantage) over the classical counterpart [1]. As a result, many contemporary studies exploit the QC techniques in order to apply them to plasma physics [2, 3, 4]. Our studies are on an appropriate formulation of Maxwell equations in a plasma, suitable for implementing on quantum computers. It was recognized early by Oppenheimer [5] that Maxwell equations in vacuum can be cast in a form similar to the Dirac equation. This approach was extended to Maxwell equations for a space-time varying scalar dielectric [6] using the Reimann-Silberstein-Weber (RSW) vectors [7]. Based on this procedure, a quantum lattice algorithm has been developed for wave propagation in scalar dielectrics [3, 8]. For wave propagation in dispersive, magnetized plasmas, we are developing a formalism based on the Schrödinger representation, ensuring unitary time evolution which is crucial for quantum algorithm implementation. We show that the RSW representation of the electromagnetic fields is not ideally suited for time varying media. Therefore, an alternate approach, pertaining to pseudo-Hermitian and non-Hermitian quantum dynamics [9], is adopted which allows us to construct an electromagnetic Schrödinger equation for studying wave propagation in an anisotropic plasma medium under the scope of QC.

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