Implications of Causality for Quantum Biology

D.F. Scofield, T.C. Collins, Dept. of Physics, Oklahoma State University, Stillwater, OK

This talk summarizes the logical chain leading from the causality hypothesis to new methods of causal quantum biology, an improved approach to the ab initio description of biomolecular processes. The new approach provides a causal description of such processes consistent with the first and second laws of thermodynamics. The motivation for examining the implications of causality stems from the fact causality is of fundamental importance as it governs the sequence of events in all biophysical processes. Causality begins with the propagation of signals limited a finite maximum speed of light. Other processes, naturally, have lower maximum speeds because of interaction of the signal with the quantum environment. Physically, these speed limits are generally enforced by processes analogous to Cherenkov radiation which occurs when an a particle field propagates into a medium of higher index of refraction; it looses energy by radiating photons. These processes occur at different rates, often propagating over long distances. At whatever level of accuracy is practically attainable, the theoretical and numerical methods must preserve/conserve certain invariants. These include causality, conservation of stress-energy, angular momentum, current, and other topological quantities, yet be consistent with thermodynamics. The talk discusses the formulation of the quantum mass-spacetime mechanics so it reflects these speed limits assuring causality and the other topological quantities following from causality. The numerical methods are shown to preserve the topology implied by causality with the numerical accuracy improving with smaller mesh size.

[1] D. F. Scofield, Quantum dynamical manifolds – 5, IJQC, 80, 369-393 (2000).

[2] T. C. Collins and D. F. Scofield, Quantum dynamical manifolds – 4, High temperature superconductors, IJQC 80, 341-368 (2000).

[3] D. F. Scofield and T. C. Collins, Quantum dynamical manifolds; Applications to excitonic coupled high temperature superconductivity, IJQC, 90, 719-750 (2002).

[4] D. F. Scofield, Quantum mass-spacetimes, Adv. Appl. Clifford, Alg., 25, 673-706 (2015).

[5] D.F. Scofield and P. Huq, Fluid dynamical Lorentz force law and Poynting theorem - Derivation and implications, Fluid. Dyn. Res., 40, 055514 (2014).

.