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A Process Algebra Model of QED

Background: The process algebra approach to quantum mechanics posits a finite and discrete ontology of primitive events which are generated by processes (in the sense of Whitehead [1]). In this ontology, primitive events serve both as elements of an emergent space-time as well as of fundamental particles and fields, which are viewed as discrete waves formed from coherently generated sub-collections of primitive events.
These events are generated using only local information propagated at no more than luminal speed. Each process generates a set of primitive elements, forming a causal space [2] termed a “causal tapestry”. Each causal tapestry can be thought of as a discrete and finite space-like sub-hyper-surface of an emergent causal manifold (space-time) M. Interactions between processes are described by a process algebra which possesses 8 commutative operations (sums and products) together with a non-commutative concatenation operator. The process algebra possesses a representation via nondeterministic combinatorial games through which causal tapestries are constructed. The process covering map associates each causal tapestry with a Hilbert space over M, providing the connection to non relativistic quantum mechanics. The probability structure of non-relativistic quantum mechanics emerges from interactions between processes. The process algebra model has been shown to reproduce many features of the theory of non-relativistic scalar particles to a high degree of accuracy [2-6]. The process ontology appears to avoid the paradoxes and divergences that plague standard quantum mechanics.

Summary: This paper reports on an extension of the process algebra model to vector particles, in particular photons. Light is represented as a discrete wave whose local amplitude is described by a 4-vector corresponding to the values of the scalar and vector potential. The information entering into the construction of primitive elements (photons) is propagated locally at luminal and sub-luminal speeds via a discrete version of the usual propagator. As in the scalar case this yields a high degree of accuracy compared to the usual quantum mechanical model. Both classical and quantum mechanical versions of light are discussed. Explicit extensions of the model to incorporate relativistic constraints are introduced, paving the way for an extension of the process model to quantum field theory.
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