Vacuum Fluctuations as a Substratum for Computation and Cognition

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Organisms manifest vast capabilities for acquiring and processing information from the environment and using the processed information to act in an adaptive manner. Brain mediated perception, conceptualization, decision-making, and effector control are for humans the most dramatic examples. Are capabilities of this type achievable in a universe whose dynamics are at base linear and reversible, and is our internal sense of them (given in experience) possible in such a universe? Or are they expressions of the fact that the true dynamics of the universe is itself irreversible, measurement-embedding, and adaptive? The purpose of this talk is to show that it is possible to construct expanded nonlinear models of the latter type that possess features both of physical and biological interest. The basic idea is that their forces between manifest particles are mediated by propagating transient excitations of unmanifest vacuum particles (called fluctuons). The motions of the manifest particles alter the structure of the unmanifest particles, and hence alter the forces among the manifest particles. Wave function collapse and irreversibility are endogenously generated by this cyclic interaction between the manifest macrostructure of the universe and the unmanifest microstructure of the vacuum. However, the endogenous irreversibility is pronounced only when the manifest and unmanifest structures are inconsistent. This would have been the case in the early universe. But as the universe evolved to a self-consistent form, the underlying irreversibility was masked, except on the very large scale or near very large masses, where it is not easily detectible. Our hypothesis is that it is also unmasked by the sensitive transduction-amplification schemes present in biological cells, and that this is the basis both for the objectively observable capabilities of biological organisms and for the subjectivity and privacy of our own experience.