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Modeling of the brain's dark energy and its potential clinical applications

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Recent studies suggested the brain is not primarily reflexive, and intrinsic activities in the brain are vital to the brain cognitive functions. The evidence is that much of the energy consumed by the brain – termed as the brain's dark energy – is for functions unaccounted for, and the brain's dark energy appears to be relevant to disease. However, it is largely unknown how to model and subsequently to analyze this energy. We show the following. With the Wilson model for dynamic characteristics of neocortical neurons, dynamics of the brain can be modeled by stochastic differential equation (SDE). In the SDE model, the brain dark energy can be modeled, using two well observed biophysical properties of neurons: In every microsecond, any increment (decreasing or increasing) in membrane potential of a neuron is uniformly bounded; and within every microsecond, a neuron's resistance to the internal noise is by its membrane to tolerate effect of the internal noise to a certain degree. Then we can use the above model of the brain's dark energy to analyze the spectrum of the energy. Our previous work indicates the spectrum is directly related to the brain functional connectivity. Here, as in cognitive sciences, the brain functional connectivity refers to a time-dependent statistical dependency between the activities of different regions in the cortex. We discuss how analysis of the spectrum of the brain's dark energy may provide a means to detect whether the brain functional connectivity is at a normal level and hence to diagnose disease in clinic.

Biography

Dawei Hong completed his PhD in computer science (1996) and MS in mathematics (1982). In 1996 he became a faculty member of Minnesota State University, and was tenured in 1999. In 2001 he joined Rutgers University. Hong is a founding member of Center of Computational and Integrative Biology at Rutgers University. He currently is the chair of Department of Computer Science at Rutgers-Camden. His major research interest is modeling and computer simulation of biological systems with stochastic differential equations and their numerical solutions.

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