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Electrodynamic Signaling by the Dendritic Cytoskeleton: Toward an Intracellular Information Processing Model

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Abstract:

A novel model for information processing in dendrites is proposed based on electrodynamic signaling mediated by the cytoskeleton. Our working hypothesis is that the dendritic cytoskeleton, including both microtubules (MTs) and actin filaments plays an active role in computations affecting neuronal function. These cytoskeletal elements are affected by, and in turn regulate, a key element of neuronal information processing, namely, dendritic ion channel activity. We present a molecular dynamics description of the C-termini protruding from the surface of an MT that reveals the existence of several conformational states, which lead to collective dynamical properties of the neuronal cytoskeleton. Furthermore, these collective states of the C-termini on MTs have a significant effect on ionic condensation and ion cloud propagation with physical similarities to those recently found in actin filaments. Our objective is to provide an integrated view of these phenomena in a bottom-up scheme, demonstrating that ionic wave interactions and propagation along cytoskeletal structures impacts channel functions and, thus, neuronal computational capabilities.

Keywords:

Actin filaments, Denrites, Information processing, Ion channels, Ionic waves propagation, Microtubules

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