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Mechanical Surface Waves Accompany Action Potential Propagation BENJAMIN MACHTA, Lewis Sigler Institute, Princeton University, AHMED EL HADY, Princeton Neuroscience Institute, Princeton University — The action potential (AP) is the basic mechanism by which information is transmitted along neuronal axons. Although the excitable nature of axons is understood to be primarily electrical, many experimental studies have shown that a mechanical displacement of the axonal membrane co-propagates with the electrical signal. While the experimental evidence for co-propagating mechanical waves is diverse and compelling, there is no consensus for their physical underpinnings. We present a model in which these mechanical displacements arise from the driving of mechanical surface waves, in which potential energy is stored in elastic deformations of the neuronal membrane and cytoskeleton while kinetic energy is stored in the movement of the axoplasmic fluid. In our model these surface waves are driven by the traveling wave of electrical depolarization that characterizes the AP, altering the electrostatic forces across the membrane as it passes. Our model allows us to predict the shape of the displacement that should accompany any traveling wave of voltage, including the well-characterized AP. We expect our model to serve as a framework for understanding the physical origins and possible functional roles of these AWs in neurobiology. See Arxiv/1407.7600

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