Physical Principles in Dynamical Information Processing

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Fluctuations are relevant to neural systems processing continuous information such as orientation, head direction, and spatial location. It is commonly believed that these systems represent external information by localized activity profiles in neural substrates. Location fluctuations of these states represent distortions of the information they represent, and at the same time indicate their mobility under external influence. When the motion of these states represents moving stimuli, their mobility will determine their responses, such as the amount of time delay when they track moving stimuli. How are these factors related to each other? We will explain the underlying principles that are similar to physical systems, such as those found by Einstein for Brownian particles. A unified picture emerges, in which neural fields can make use of slow, localized, inhibitory feedback mechanisms such as short-term synaptic depression, spike-frequency adaptation, or inhibitory feedback from other layers to achieve delay compensation during the processing of dynamical information.