Title: “Distinct non-equilibrium brain dynamics revealed by violations of the fluctuation-dissipation theorem following an external perturbation”

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Abstract:

The mechanisms that support life require living organisms to operate out of thermodynamic equilibrium. The brain, a complex system composed of neural elements interacting at different levels of organization, exhibits multiple non-equilibrium processes across scales. At the macroscopic level, these non-equilibrium dynamics change in different brain states such as wakefulness and deep sleep. Thus, recent works leveraged various tools from thermodynamics to characterize the hierarchical dynamics of brain states over time. Among these tools are the fluctuation-dissipation relations (FDRs), which connect the internal spontaneous fluctuations of a system with its response to an external perturbation [1,2,3]. In this work, we adapted a recent formalism, a nonlinear generalized FDR as a test for Markovianity, and tested it in models of nonlinear oscillators corresponding to a supercritical Hopf bifurcation that have been used to model whole-brain dynamics in different states [4]. This provides a novel approach to quantifying the response of the brain to targeted perturbations, as well as a theoretical framework that is essential for neuroscience experiments that use direct perturbations of the brain to discriminate consciousness states.

References:

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