Partial synchronization patterns in brain networks

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Partial synchronization patterns play an important role in the functioning of neuronal networks, both in pathological and in healthy states. They include chimera states, which consist of spatially coexisting domains of coherent (synchronized) and incoherent (desynchronized) dynamics. We show that partial synchronization scenarios are governed by a delicate interplay of local dynamics and network topology. Our focus is in particular on applications to brain dynamics like unihemispheric sleep [1], epileptic seizure [2], and relay synchronization between distant areas of the brain [3]. Chimera states might be of relevance in inducing and terminating epileptic seizures, which are characterized by excessive synchrony, or in unihemispheric sleep which is found in certain migratory birds and mammals. In the human brain the first-night effect, which describes troubled sleep in a novel environment, has been related to asymmetric dynamics recently, i.e., a manifestation of one hemisphere of the brain being more vigilant than the other. In our simulations we use the FitzHugh-Nagumo system, which is a paradigmatic model of neuronal dynamics, and empirical brain connectivities obtained from diffusion-weighted magnetic resonance imaging of human brains.

References

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