Atelier
« Dynamiques invariantes d'échelle et réseaux en neurosciences »
21-24 octobre 2013

Workshop on
Scale-Free Dynamics and Networks in Neurosciences
October 21–24, 2013

A multiscale assessment of scale-free dynamics and networks: From frequency scaling to avalanche dynamics

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Computation in brain happens at many different scales. At the large-scale, we present a comparative power spectral analysis of non-invasive modalities. We show that theoretically, with the assumption of resistivity of the medium, magnetoencphalography and electroencephalography should scale similarly. Our experimental evidence show that, EEG scales in general between $1/f$ and $1/f(2)$ with spatial inhomogeneity. However, MEG, when it is noise-corrected behaves differently. The scaling differences hint at the existence of a non-resistive medium. At the micro-circuitry level, we assess the avalanche dynamics of spiking and LFP in multielectrode recordings of multiple species (cat, monkey and human). Spiking avalanche, in awake, slow-wave sleep and REM, show no signs of power-law across all its decades. Rather it shows exponential or intermediate scaling. LFP avalanches from both negative and positive peaks show power-law scaling. The differential relation of these peaks with spiking, provides a clue against self-organized criticality of network spiking in microcircuitry of the brain. We show that multiple exponential fitting yields optimal fits of the avalanche dynamics with bi-exponential distributions. Together, these evidence show that the brain is more complex than to simply fit the picture of an SOC system.

References

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