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Slow and fast rhythms in the cerebral cortex

Basal network excitability and recurrent connectivity in the cerebral cortex network allows neuronal firing that reverberates in the circuit, resulting in an emergent network activity. During slow-wave sleep and anesthesia, cortical spontaneous activity is organized into a slow (<1Hz) rhythmic pattern consisting of interspersed Up (or active) and Down (or silent) states. A very similar activity emerges from cortical slices, as far as some level of excitability allows spontaneous firing (Sanchez-Vives and McCormick, Nat Neurosci 3:1027, 2000). Further, local activity is spontaneously synchronized in fast, beta and gamma rhythms during Up states both in vivo (Steriade et al., J Neurosci 16: 392, 1996; Hasenstaub et al., Neuron 47:423) and in cortical slices (Compte et al., J Neurosci 28: 13828, 2008).
In this talk I will first discuss some of the cellular and network mechanisms that determine the generation and propagation of cortical rhythmic activity. Next, how rhythmicity and synchronicity are transformed when there is a transition to a different brain state or alteration of physiological variables such as temperature. An emphasis will be made on the cortical excitatory / inhibitory balance and how a progressive alteration of this balance induces parametric alterations of rhythmicity. Progressive reduction of inhibition in the in vitro cortical network induces linear changes in different parameters of Up and Down states, linearity that is lost when the activity becomes epileptiform.