

RESEARCH SEMINAR

Bistable Neural Oscillators: A Tale of Two States

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Neurons with intrinsic oscillations in electrical activity are increasingly recognized within circuits involved in motor control, sensory processing, autonomic function, behavioral state, and memory formation. The ability for synaptic inputs to initiate or abolish rhythmic spike activity is important for shaping and modifying normal neural patterns in these circuits. Abnormal neuronal oscillations are implicated in certain disease states, for example repetitive firing of injured axons evoking painful paresthesia, and rhythmic discharges of cortical neurons in patients with epilepsy. For such pathological oscillators, there is a need to control symptoms by therapeutic stimuli that switch off the undesirable spike activity. In this seminar I will discuss specific examples of normal and abnormal neural rhythmicity, with an emphasis on an interesting class of neuronal oscillators in which two stable states co-exist for the same set of biophysical parameters. For such bistable cellular pacemakers, a rapid and persistent change in post-synaptic activity - switching the pacemaker on or off - is induced by a brief synaptic input. In this way, a stable switch in neuronal activity can occur without the need for a persistent change in the concentration of extracellular ions or neuromodulators, or in signal transduction elements associated with adaptive plasticity. I will show how polysynaptic inputs are encoded by a bistable neuronal oscillator to produce changes in spike timing and bursting behavior over long time scales.