



The Abdus Salam  
**International Centre  
for Theoretical Physics**



# ICTP COLLOQUIUM

**14:00, Tuesday, 19 November 2013**  
**Main Lecture Hall, Leonardo Building, ICTP**

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## **Life at the edge: critical dynamics in the brain**

**Abstract:**

A number of biological systems organize themselves so as to be perpetually at the fulcrum between large, opposing forces. Simultaneously rapid synthesis and degradation of mRNA or proteins, ion channels open while ion pumps go at full blast, muscle tone of both muscles and countermuscles pulling our limbs in opposite directions, and large amounts of simultaneous excitatory and inhibitory activity in cortex: all these are well-established examples of this strategy. Like running the air conditioning and the heating at full blast at the same time, this strategy appears wasteful, since it continuously consumes energy, but what does it in fact achieve?

The precarious balance at the center of such tug-of-wars is called a critical point. We shall review a number of studies in the cochlea and in neural activity in cortex. In the cochlea self-tuned criticality has been shown to underlie the high frequency selectivity and sensitivity of our hearing organ. In models of cortical dynamics various critical poising scenarios balancing excitation and inhibition allow for the creation of flexible, rapidly changing states, and for adaptive strategies that can vary temporal or spatial scales of sensory integration depending on the signal-to-noise level of the input. We shall finally review analysis of ecocorticography recordings in humans and primates, showing that critical dynamics features present during awake behaviour disappear during induction of sleep and anesthesia.