



The Institute of Advanced Studies presents a free public lecture

# How to Think about the Structure and Dynamics of the Brain using Mathematics

by Professor Jack Cowan, Mathematics Department, University of Chicago

## About this Lecture

This talk will be a brief introduction to two topics on which it has proved possible to learn about how the brain may work using methods of mathematical physics. It has some relevance to the way in which theorists approach the problems of the shape, structure, and distribution of galaxies, and of stellar and galactic dynamics. The first topic will be how cooperative activity in millions of interacting nerve cells in the brain leads to the formation of stable patterns of activity. The mechanism underlying such pattern formation will be used to explain the seeing of hallucinations, near-death experiences and migraines, and the generation of epileptic seizures. The second topic will be the effects of fluctuations and correlations of brain activity, on the large-scale dynamics. It will be shown how non-equilibrium phase transitions occur in brain dynamics, and how this gives rise to scaling laws that allow the interpretation of various experimental measures of large-scale brain activity such as local field potentials, EEG and fMRI signals, and the spiking activity of single nerve cells. This leads to a comprehensive overview of how brain states are generated, and a theory for the origins of both random and rhythmic brain activity.

## About Jack Cowan

Jack Cowan is a Professor in the Mathematics Department of the University of Chicago. He also has joint appointments in the Department of Neurology and in the Committee on Computational Neuroscience. He was born in the UK and educated both in the UK and at MIT. In 1967 he and his family moved from London to Chicago where he became Professor and Chairman of the Committee on Mathematical Biology. Since 1981 he has been a Professor in the Mathematics Department. Over the past forty-five years Jack Cowan has worked on a variety of mathematical topics including how to build reliable computers with unreliable elements, the population dynamics of large-scale neural networks, and (for the past thirty years) the statistical mechanics of networks of neuron-like elements. His main contributions have been the formulation (with Hugh Wilson) of what are now known as the Wilson-Cowan equations, which capture the attractor dynamics of such networks, his work with Bard Ermentrout on their mathematical analysis, his work with Paul Bressloff, Martin Golubitsky, and others on modeling the structure and dynamics of the primate visual cortex, and (more recently) his work with Michael Buice on the statistical mechanics of neural networks. He is perhaps best known for his work on Geometric Visual Hallucinations, and what they tell us about the human brain.



## Lecture Details

**Date:** Tuesday, 21 July 2009

**Time:** 6pm

**Venue:** Webb Lecture Theatre, Room G21,  
Ground Floor Geography Building, UWA

The nearest parking is P20 off Fairway Entrance 1

**This lecture is free and open to the public, no RSVP required**

### Institute of Advanced Studies

The University of Western Australia  
M021, 35 Stirling Highway, Crawley WA 6009

Tel +61 8 6488 1340

Fax +61 8 6488 1711

Email [iasuwa@admin.uwa.edu.au](mailto:iasuwa@admin.uwa.edu.au)

Web [www.ias.uwa.edu.au](http://www.ias.uwa.edu.au)

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