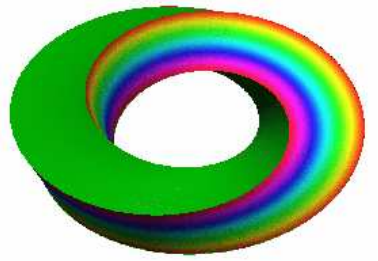
Universität Bielefeld

Fakultät für Mathematik



Special Afternoon on Mathematics in the Sciences

27 November 2009, 14:00 – 17:00 h

Room V3–201

Program

14:15 – 15:15 h
Sara A. Solla
(Department of Physiology & Department of Physics and Astronomy, Northwestern University)
Decoding neural signals for the control of movement

15:30 – 16:30 h
Predrag Cvitanović
(School of Physics, Georgia Institute of Technology;
Humboldt Awardee, currently MPI for Dynamics and Self-Organization, Göttingen)
Geometry of turbulence: a stroll through 61 506 dimensions

Everyone is welcome!

For further information, please contact Barbara Gentz (`gentz@math.uni-bielefeld.de`).

Special Afternoon on Mathematics in the Sciences

Abstracts

14:15 – 15:15 h
Sara A. Solla (Northwestern University)
Decoding neural signals for the control of movement

The activity of neurons in an area of the brain referred to as primary motor cortex provides the signals that control the ability to execute movements. One of the crucial questions, still unresolved, is that of identifying the code used by this neural ensemble. We address this question through the analysis of data obtained for an awake behaving monkey. An implanted multielectrode array records the activity of about one hundred neurons in primary motor cortex during the execution of a sequence of straight reaches to nearby targets. A natural representation for the ensemble activity is provided by a high-dimensional space in which each axis represents the activity of a single neuron as an independent degree of freedom. However, the observed correlations among neurons whose activity is detectably modulated by the task suggest that the population defines a low-dimensional space within the high-dimensional space of independent firing activities. We have used linear and nonlinear methods for dimensionality reduction to find the low-dimensional structure that captures the underlying relationship between population neural activity and behavioral task. The use of multidimensional scaling in conjunction with an empirical measure of geodesic distances yields a low-dimensional manifold whose intrinsic coordinates capture the geometry of the task in the external physical space. Although the dimensionality of this manifold follows from a linear model that considers neurons as independently modulated by reach direction, its curvature is a consequence of neural interactions.

15:30 – 16:30 h
Predrag Cvitanović (Georgia Institute of Technology, currently MPI Göttingen)
Geometry of turbulence: a stroll through 61 506 dimensions

In the world of moderate Reynolds number, everyday turbulence of fluids flowing across planes and down pipes a velvet revolution is taking place. Experiments are almost as detailed as the numerical simulations, DNS is yielding exact numerical solutions that one dared not dream about a decade ago, and dynamical systems visualization of turbulent fluid's state space geometry is unexpectedly elegant.

We shall take you on a guided tour (`ChaosBook.org/tutorials`) of this newly breached, hitherto inaccessible territory. Mastery of fluid mechanics is no prerequisite, and perhaps a hindrance: the talk is aimed at anyone who had ever wondered why – if no cloud is ever seen twice – we know a cloud when we see one? And how do we turn that into mathematics?