OBERWOLFACH-SEMINARS 2001

These seminars are a continuation of the DMV-Seminars initiated by **Deutsche Mathematiker Vereinigung.** They address postdocs and Ph.D. students from all over Europe. The aim is to introduce the participants to a particular hot development. The seminars take place at Mathematisches Forschungsinstitut Oberwolfach. The number of participants is restricted to 25. Applications including a short summary of previous work and interest should be sent to

Prof. Dr. Matthias Kreck
Universität Heidelberg, Mathematisches Institut
Im Neuenheimer Feld 288, 69120 Heidelberg, Germany

Borcherds' Products and Geometric Applications

Richard Borcherds (Berekeley), Eberhard Freitag (Heidelberg), Rainer Weissauer (Mannheim)

June 3 - 9, 2001, Deadline for Application: May 1, 2001

Subjects: Borcherd's products are modular forms in several variables (related to the group O(2,n)), which arise as infinite products.

They are constructed as liftings of elliptic modular forms, which are holomorphic on the upper half plane but may have poles at the cusps. The zeroes and poles of the infinite products are located at Heegner divisors which correspond to embeddings O(2,n-1) to O(2,n). Several applications and relations to other subjects will be discussed: Computation of Chern classes of Heegner divsiors; Generalized Kac-Moody algebras; Lorentzian lattices; Complex reflection groups; Cubic surfaces.

Prerequisites: Some basic knowledge in algebra, geometry and number theory, modular forms, elementary representation theory

Random Matrix Theory and Combinatorics

Persi Diaconis (Stanford), Kurt Johansson (Stockholm)

June 3 - 9, 2001, Deadline for Application: May 1, 2001

Subjects: Random matrix theory (RMT) has a surprisingly rich mathematical structure in its own right, important applications in physics as well as interesting and deep connections to other areas of mathematics. For example, during the last years new and interesting connections between RMT and certain problems in combinatorial probability, related to random growth models in statistical physics, have been discovered. Topics to be considered include: Basic distributions in RMT. What is Haar measure? Data fitting RMT from particle scattering to telephone encryption. Random permutations, longest increasing subsequences, the Robinson-Schensted-Knuth correspondence and relations to random growth models. Symmetric function theory and its applications to RMT. Szegð's theorem for Toeplitz determinants and linear statistics in RMT. Random tilings, non intersecting paths and their connection with RMT. RMT and the Riemann zeta function.

Prerequisites: Basic knowledge in probability and analysis.

Noncommutative Geometry

Alain Connes (Paris)

October 14 - 20, 2001, Deadline for Application: September 1, 2001

Subjects: We describe basic concepts of noncommutative geometry and a general construction which extends the familiar duality between ordinary spaces and commutative algebras to a duality between Quotient spaces and Noncommutative algebras. The basic tools of the theory, K-theory, Cyclic cohomology, Morita equivalence, Operator theoretic index theorems, Hopf algebra symmetry are reviewed. We discuss the foundational problem of "what is a manifold in NCG" and explain the fundamental role of Poincare duality in K-homology which is the basic reason for the spectral point of view. This leads us, when specializing to 4-geometries to a universal algebra called the "Instanton algebra" (joint work with G. Landi). We describe•examples of noncommutative manifolds and develop the basic notions of curvature and spectral action. We show that any compact Riemannian spin manifold whose isometry group has rank r >1 admits isospectral deformations to noncommutative geometries. We give a survey of other recent developments, in particular from joint work with H. Moscovici and D. Kreimer.

Numerical Methods for Free Boundary Problems

Gerhard Dziuk (Freiburg), Ricardo Nochetto (Maryland)

October 14 - 20, 2001, Deadline for Application: September 1, 2001

Subjects: Free boundary problems arise in a variety of applications from phase transitions (crystal growth or continuous casting) to geometry (curvature driven motion of surfaces or curves). This course will provide an introduction to mathematical models for free boundary problems and the design and numerical analysis of algorithms. Topics will include numerical methods for isotropic and anisotropic mean curvature flow (parametric model and level set model) as well as for variational inequalities and degenerate parabolic equations (with emphasis on error control and adaptivity).

Prerequisites: Basic knowledge of theory and numerics for partial differential equations.

Mathematical Challenges of Molecular Biology

Andreas Dress (Bielefeld), Peter Schuster (Wien) (verhindert), Günter Wagner (Yale) (verhindert), zusätzlich: Arndt von Haeseler (Leipzig)

November 11 - 17, 2001, Deadline for Application: October 1, 2001

Subjects: Molecular biology is currently undergoing a technological revolution. As more and more genomic and structural data become available, fundamental questions about evolution, sequence-structure relations and functional genomics can be studied for the first time in a quantitative way allowing for computer simulation and mathematical analysis. The new developments involve many mathematical fields including dynamical systems, combinatorics, random graph theory and evolution in random media, topology and Fourier analysis. Specific topics will include: Old and new models of phylogenetic evolution and their underlying mathematical structure; sequence-structure relations of biopolymers based on the concepts of combinatory maps and landscapes; analysis of the genotype-phenotype map and modeling of gene interaction (space configuration topology and their Fourier decomposition; continuum effect models).

Prerequisites: This seminar is open to all mathematicians interested in questons arising from molecular biology. Working knowledge of combinatorics and some basic ideas about combinatorial algorithms and dynamical systems. References: A. Dress, W. Terhalle, ICM 98, pp. 565-574 http://www.mathematik.uni-bielefeld.de/documenta/xvol-icm/16/16.html P. Schuster, Math Unlimited, Springer, 2001, pp. 1019-1038 and additional literature available from http://www.tbi.univie.ac.at/papers/

Front Propagation, Homogenization for First- and Second-Order PDE's, and Applications

Guy Barles (Tour), Panagiotis Souganidis (Austin)

November 11 - 17, 2001, Deadline for Application: October 1, 2001

Subjects: Models in phase transitions and combustion give rise to interfaces moving with prescribed normal velocities. The theory of viscosity solutions provides a very good framework for the rigorous analysis of such models. Asymptotic problems in periodic and random environments are also related to homogenization questions for first- and second order pde as well as to stochastic nonlinear pde. Topics to be covered in the course are: (i) A theory for generalized front propagation and its applications to asymptotic problems, reaction diffusion equations and particle systems, turbulent combustion (ii) Homogenization theory for Hamilton-Jacobi equations and fully nonlinear second-order pde and its connections to phase transitions and Hamiltonian dynamics (iii) Fully nonlinear stochastic pde.

Prerequisites: A good background in pde; some probability knowledge will also be useful, but is not required.