

## RELATÓRIO DE ATIVIDADES

### WORKSHOP ON CONTEMPORARY MATHEMATICS IMPA, April 25 - 26th, 2005

Aproveitando a reunião do Comitê Executivo do International Mathematical Union, foi realizada a reunião científica “Workshop on Contemporary Mathematics”, no período de 25 a 26 de abril de 2005 de no Instituto de Matemática Pura e Aplicada (IMPA), congregando matemáticos de renome e prestígio internacional.

Para a sua realização a Conferência Internacional contou com o apoio financeiro Instituto do Milênio – IM-AGIMB, *do Instituto de Matemática Pura e Aplicada (IMPA)*, do International Mathematical Union (IMU) bem como de várias universidades brasileiras e agências de amparo à pesquisa estaduais que financiaram a passagem de seus pesquisadores.

Participaram desta Conferência cerca de 100 pesquisadores, incluindo ouvintes dentre professores e alunos de doutorado. A lista de palestras, e uma lista parcial dos participantes encontra-se a seguir.

#### Lista de Palestras:

**John Ball, (Oxford University)**, Some open problems in the calculus of variations and elasticity

**Jean Michel Bismut** (Université Paris-Sud), The hypoelliptic Laplacian

**Martin Groetschel** (TU and ZIB Berlin), TSP: State and art

**Masaki Kashiwara**, (Kyoto University), Quantization of contact manifolds

**Zhi-Ming Ma** (Ac. of Math and Syst. Sciences Inst. of Applied Math. - CAS), Quasi-regular dirichet forms and stochastic analysis on configuration spaces

**Ragni Piene** (Univ. of Oslo), The curve counting problem

**Victor A. Vassiliev**, (Steklov Institute of Mathematics), Invariants of self-intersecting curves in  $R^3$

**Marcelo Viana** (IMPA), Dynamics in the moduli space of Abelian differentials

## **ABSTRACTS DAS PALESTRAS:**

### **Some open problems in the calculus of variations and elasticity**

**John Ball**

The talk will discuss various open problems in the multi-dimensional calculus of variations motivated by elasticity, in particular related to quasiconvexity, the regularity of minimizers, and criteria for local minimizers.

### **The hypoelliptic Laplacian**

**Jean-Michel Bismut**

We construct a deformation of Hodge theory, whose corresponding Laplacian is a hypoelliptic operator on the cotangent bundle. This Laplacian interpolates between classical Hodge theory and the geodesic flow, and more generally any Hamiltonian dynamical system. This Laplacian should be thought of as a semiclassical limit of the Witten deformation of the Laplacian on the loop space, associated to the energy functional on the loop space. Applications to the Ray-Singer analytic torsion will be presented.

### **TSP: state and art**

**Martin Groetschel**

The travelling salesman problem (TSP) is probably the best known example of a combinatorial optimization problem. Moreover, the TSP has, since the birth of combinatorial optimization in the fifties, served as a "role model" for the development of the theory and algorithmic techniques in combinatorial optimization. I will outline the progress that has been made in this area during the last 50 years along the milestones of the "TSP history" finishing with the state of the art. What does the TSP have to do with art? An answer will be presented at the end of the lecture.

**Quantization of contact manifolds**  
**Masaki Kashiwara**

There exists a canonical stack on the contact manifold which corresponds to the modules over micro-differential operators.

I want to speak on an attempt to its topological counterparts.

Quasi-regular Dirichlet Forms and Stochastic Analysis on Configuration Spaces

**Academy of Math and Systems Science, CAS**

**Zhi-Ming MA**

The framework of quasi-regular Dirichlet forms provides a one to one correspondence between a class of Markov processes and the associated Dirichlet forms, and has been used in different areas of stochastic analysis. In this talk I shall briefly introduce the notion of quasi-regular Dirichlet forms and review its applications to the stochastic analysis on configuration spaces. In particular I shall explore Dirichlet form approach in the study of infinite particle systems. At the end of the talk I shall mention its recent connection to the space of geometric graphs and to totally disconnected spaces.

**The curve counting problem**

**Ragni Piene**

Classical enumerative geometry has dealt with problems like counting the number of plane curves of given degree that satisfy certain given conditions - starting with Apollonius' eight circles tangent to three given circles and on to an assortment of problems in projective geometry

over the real or complex numbers, or over fields of positive characteristics. Significant progress was made with the development of modern intersection theory. But the most surprising event was the input from physics, when string theorists predicted solutions to curve counting problems based on the determination of corresponding generating functions via the principle of mirror symmetry. The main focus of the talk will be the problem of counting curves with given singularities and lying on a smooth surface; this will be a report on joint work with Steven Kleiman.

## **Invariants of self-intersecting curves in $\mathbf{R}^3$**

**Victor A. Vassiliev**

We study the invariants of generic smooth maps  $\mathbf{R}^1 \rightarrow \mathbf{R}^3$  with an arbitrary fixed topological type of self-intersections, and, more generally, homology groups of spaces of such maps  $\mathbf{R}^1 \rightarrow \mathbf{R}^3$  for any  $n \geq 3$ . We describe the groups of invariants and homology classes of *degree 1* of these spaces in the sense analogous to the notion of the degree of knot invariants. These calculations provide an easy algorithm of recognizing the planarity of a selfintersecting curve. Also we study possible combinatorial representations of such invariants, and use them to obtain lower estimates of denominators in combinatorial formulas of knot invariants.

## **Dynamics in the moduli space of Abelian differentials**

**Marcelo Viana**

An Abelian differential is a holomorphic 1-form on a Riemann surface. Alternatively, it may be seen as a translation structure on the surface: a flat metric plus a global parallel vector field (the "South" direction).

The Teichmuller flow acts naturally on the space of Abelian differentials, and its behavior often translates to properties of typical (full Lebesgue measure) translation surfaces.

For instance, Masur and Veech proved that the Teichmuller flow is ergodic on each stratum of the space of Abelian differentials. As a consequence, the geodesic flow on almost every translation surface is uniquely ergodic. In the early nineties, Zorich and Kontsevich discovered, through numeric experiments, that the statistical behavior of these geodesic flows is governed by a complete asymptotic flag, to a remarkable level of detail. Moreover, they provided an explanation for this phenomenon in terms of a conjecture on the Lyapunov spectrum of the Teichmuller flow on each stratum. This conjecture was recently established by A. Avila and myself.

## Lista de Participantes

Abramo Hefez	UFF
Adolfo guillot	IMPA
Alcides Lins Neto	IMPA
Alexandre Baraviera	UFRGS
Andre Nachbin	IMPA
Arnaldo Garcia	IMPA
Aryana Jacy da Silva	IMPA
Barbara Nelli	Univ. del Aquilla
Luis Bladismir	IMPA
Carlos Gustavo Moreira	IMPA
Carlos Matheus Silva	IMPA
Celina Figueiredo	UFRJ
Clovis Gonzaga	UFSC
Cristian Ortiz	IMPA
Detang Zhou	UFF
Eduardo Esteves	IMPA
Eugene Gutkin	IMPA
Fernando Codá	IMPA
Flavio abdenur	IMPA
Gabriel Calsamiglia	IMPA
Hyman Bass	Univ. of Michigan
Israel Vainsencher	UFMG
Jimmy Santamaria	IMPA

Jorge Zubelli	IMPA
Karl otto	IMPA
Luiz Henrique Figueiredo	IMPA
Luiz Velho	IMPA
Marcelo Viana	IMPA
Marcelo Bernardes	IMPA
Marco Brunella	Univ. Bourgogne
Marcos Jardim	UFRGS
Maria João da Costa	Univ. Porto
Maria João Resende	IMPA
Maria José Pacifico	UFRJ
Nilvaldo Muniz	IMPA
Pablo Castaneda	IMPA
Paulo Ruffino	UNICAMP
Paulo Sad	IMPA
Roger Metzger	IMCA
Samuel Senti	IMPA
Wellington de Melo	IMPA
Yang Ziagang	IMPA