

# **Fourier analysis of groups in combinatorics**

CIMPA-UNESCO-MESR-MINECO-INDIA

Shillong, India, November 18-30

Shillong, November 18, 2013

Michel WALDSCHMIDT, Université de Paris 6

<http://www.math.jussieu.fr/~miw/>

<http://www.cimpa-icpam.org>

International CIMPA Research School & Conference on  
**FOURIER ANALYSIS OF GROUPS IN COMBINATORICS**



Department of Mathematics  
North Eastern Hill University  
Shillong

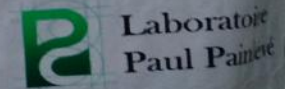


18<sup>th</sup> – 30<sup>th</sup> November, 2013

*Sponsors:*



Government of India  
National Board for Higher Mathematics  
Department of Atomic Energy



NEHU

CIMPA



The Abdus Salam  
International Centre  
for Theoretical Physics



**CEMPI**  
CENTRE DE RECHERCHES  
MATHÉMATIQUES  
POUR LES MATHÉMATIQUES  
LEURS INTERACTIONS

# **1. Introduction of CIMPA**

## **2. Indo-French cooperation**

**CNRS in India**

**Campus-France**

**Service pour la Science et la Technologie**

**India fund at IHÉS**

**CEFIPRA**

## **3. European Mathematical Society**

**Committee for Developing Countries**



# CIMPA

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# ICPAM

## CENTRE INTERNATIONAL DE MATHÉMATIQUES PURES ET APPLIQUÉES

## INTERNATIONAL CENTER FOR PURE AND APPLIED MATHEMATICS

Shillong, November 18, 2013

Michel WALDSCHMIDT, Université Paris 6  
<http://www.math.jussieu.fr/~miw/>

<http://www.cimpa-icpam.org>



# CIMPA's mission

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To promote international cooperation for developing research in mathematics and its applications in higher education

- to this end CIMPA organizes research schools and supports schools or networks in connection with continental mathematical societies
- its actions are concentrated in locations where there is the will to further develop mathematics and where a research project is sustainable
- a main endeavour is to maintain three equilibria: gender, geography and subject

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INTERNATIONAL CENTRE FOR PURE AND APPLIED MATHEMATICS



# CIMPA's history

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CIMPA is:

- a non-profit organization created in 1978 by mathematicians, with offices in Nice, France
- mainly funded by France. More recently it is also funded by Spain, Norway and Switzerland.
- a category 2 centre of UNESCO since the 90's

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# CIMPA Research Schools

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Open call every year

- proposals for two-week schools come from everywhere
- some are encouraged by CIMPA members
- the Scientific Council analyzes, evaluates and makes recommendations
- the Steering Council selects about 15 to 20 research school projects

Schools are organized locally with scientific and administrative help from CIMPA, in a so-called North-South-South format

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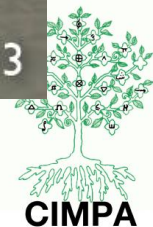


# CIMPA Research Schools



Barranquilla (Colombia) CIMPA Research School 2013

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# CIMPA Research Schools

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- Young participants from neighboring countries apply
- Among the young participants accepted both by the organizers and CIMPA, several receive full CIMPA financial support (at least 2/3 of CIMPA total support)
- Lecturers and speakers are not paid. In most cases they use their own funding for travel
- CIMPA helps through letters, discussions with organizers, explanation to authorities, fund raising etc.



# CIMPA Research Schools

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- 40 K€ = average budget for a RS  
12 K€ = average CIMPA participation  
8 K€ - at least - for young people from neighboring developing countries  
4 K€ - at most - for lecturers, speakers or local expenses
- A four-page Road map helps from the very beginning to have a successful RS
- Each RS has two final complete reports. One from the local organizers, the other from CIMPA representative.



# 2013

**Barranquilla**  
Colombia january 13-26  
Differential Calculus theory and multi-sumability

**Banarjato**  
Mexico jan 21 - feb 4  
Moduli spaces and mathematical physics

**Banarjato**  
Mexico feb 17 - march 2  
Associative and nonassociative algebras: theory and algorithms

**Curitiba**  
Brazil feb 25 - march 9  
Algebraic and geometric aspects of representation theory

**La Habana**  
Cuba June 24 - July 5  
PDE methods in biology and medicine

**San Luis**  
Argentina July 22 - August 2  
Modern methods in combinatorics

**Mar del Plata**  
Argentina August 5-16  
New trends in applied harmonic analysis: sparse representations, compressed sensing and multifractal analysis

**Bangalore**  
India July 8-19  
Current trends in computational methods for PDEs

**Shillong**  
India November 18-30  
Fourier analysis of groups in combinatorics

**New Delhi**  
India Nov 25 - Dec 6  
Generalized Nash equilibrium problems, bilevel programming and MPEC

**Bangkok**  
Thailand May 20-31  
Graphs, Codes and Designs (GCD)

**Ulaanbaatar**  
Mongolia July 15-26  
Partial differential equations in mechanics

**Manila**  
Philippines July 22 - August 2  
Algebraic curves over finite fields and applications

**Ulaanbaatar**  
Mongolia August 5-16  
Hypergeometric functions and representation theory

**Hanoi**  
Vietnam December 2-14  
Geometry and topology of singular varieties: theory and applications

**Marrakech & Kalaat M'Gouna**  
Morocco April 8-20  
Statistical methods and applications in insurance and finance

**Tunis**  
Tunisia Oct 28 - Nov 8  
Lax processes and automata

**Sokoto**  
Nigeria June 10-22  
Computer algebra and its applications

**Mulzenberg**  
South Africa July 22 - August 2  
Evolutionary equations with applications in natural sciences

**Saint-Louis**  
Senegal September 2-13  
Numerical methods in fluid mechanics, mathematical epidemiology and reaction-diffusion systems

**CIMPA 2013**  
Écoles de recherche  
Research Schools

INTERNATIONAL CENTER FOR PURE AND APPLIED MATHEMATICS (CIMPA) is an international organization that promotes research and higher education in Mathematics in developing countries. CIMPA is supported by UNESCO and member states: Argentina, Brazil, Canada, France, Germany, Italy, Japan, Korea, Mexico, Spain, Switzerland, Taiwan, Thailand, United Kingdom, United States of America, and the Centre National de la Recherche Scientifique (CNRS).

<http://www.cimpa-icpam.org/>

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# CIMPA Research Schools in India (1996–2002)

January 1996 : Pondicherry University

## **Nonlinear Systems**

*Y. Kosmann-Schwarzbach, B. Grammaticos, K. M. Tamizhmani.*

September 2002, TIFR Mumbai (Bombay)

## **Probability measures on groups : Recent**

**Direction and trends**, *Tata Institute of Fundamental Research, Mumbai (Bombay), S. Dani, P. Graczyk, Y. Guivarc'h.*

December 2002 : ISI Kolkata (Calcutta)

## **Soft Computing approach to pattern recognition and image processing.**

*Ashish Ghosh, Sankar K. Pal.*

# CIMPA Research Schools in India (2003–2008)

February 2003 : Pondicherry

**Discrete Integrable Systems, Pondicherry,**  
*Basil Grammaticos, Yvette Kosmann-Schwarzbach,*  
*Thamizharasi Tamizhmani.*

January 25 - February 5, 2005 : IISc Bangalore

**Security for Computer Systems and Networks.**  
*K. Gopinath, Jean-Jacques Lévy.*

January 2-12, 2008 : IIT Bombay (Mumbai)

**Commutative algebra**  
*L. L. Avramov, M. Chardin, M. E. Ross, J. K.*  
*Verma, T. J. Puthenpurakal.*

# CIMPA Research Schools in India (2013)

November 25-December 6, 2013 : University of Delhi

## **Generalized Nash Equilibrium Problems, Bilevel programming and MPEC**

*Didier Aussel, C. S. Lalitha.*

November 18-30, 2013 : Shillong.

## **Fourier analysis of groups in combinatorics.**

*Gautami Bhowmik, Himadri Mukherjee.*

July 8-19, 2013 : Indian Institute of Science Bangalore.

## **Current Trends in Computational Methods for PDEs**

*Blanca Ayuso de Dios, Thirupathi Gudi.*

# CIMPA Research Schools in India (2014)

August 11-22, 2014 : Kerala School of Mathematics,  
Kozhikode

## **Mock Modular Forms**

*Lothar Goettsche, Manickam Murugesan, Kathrin  
Bringmann, Lothar Goettsche, Ken Ono.*



# India and West Asia 2013

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## Current Trends in Computational Methods for PDEs

CIMPA-UNESCO-MESR-MINECO-INDIA  
Bangalore, India, July 8-19

## Fourier analysis of groups in combinatorics

CIMPA-UNESCO-MESR-MINECO-INDIA  
Shillong, India, November 18-30

## Generalized Nash Equilibrium Problems, Bilevel programming and MPEC

CIMPA-UNESCO-MESR-MINECO-INDIA  
New Delhi, India, November 25-December 6

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# India and West Asia 2014

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## Inverse problems : Theory and applications

CIMPA-KURDISTAN-IRAQ

Erbil, Kurdistan-Iraq, May 5-14

## Mock Modular Forms

CIMPA-ICTP-INDIA

Research School co-sponsored with ICTP

Kozhikode, India, July 28 - August 8

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# India and West Asia 2014 (continued)

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## Aspects of Dynamical Systems

CIMPA-NEPAL

Kathmandu, Nepal, November 3-16

## Dynamical Systems and Applications : Geometrical, Topological, and Numerical Aspects

CIMPA-PAKISTAN

Lahore, Pakistan, November 10-21

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# CIMPA's organization

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- Our General Assembly elects 7 individual members to the Governing Board
- Permanent institutional members in the GB are UNESCO, France, Norway and Spanish Ministries, University of Nice
- The GB elects its 4 member Executive committee (Bureau in French)
- CIMPA also has a Scientific Council and a Steering Council
- The Director is appointed by the GB and selects a Management team: Regional scientific officers and Project managers.



# Bureau (Executive committee)

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*President:* TSOU Sheung Tsun

University of Oxford (Mathematical physics)

*Vice -President:* Alain DAMLAMIAN

Université Paris 12 (Nonlinear analysis, nonlinear partial diff. equations)

*Secretary:* Jean-Marc BARDET

Université Paris 1 (Probability and statistics)

*Treasurer:* Marc AUBRY

Université Nice Sophia-Antipolis (Algebra, Topology and Geometry)

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# Scientific Council

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Chairman: Enrique ZUAZUA (Spain) (Applied Maths)

- Jean-Marc AZAÏS (France) (Probability, statistics)
- Viviane BALADI (France) (Dynamical systems)
- Edy Tri BASKORO (Indonesia) (Graph theory)
- Suzanne BRENNER (USA) (Numerical analysis)
- Maria Luiza FERNANDEZ (Spain) (Differential geometry)
- Helena NUSSENZVZIG LOPES (Brazil) (PDE, Fluid dynamics)
- Youssef OUKNINE (Marocco) (Probability, stochastic equations)
- Carlos DI PRISCO (Venezuela) (Logic)
- Ragni PIENE (Norway) (Algebraic geometry)
- Ramdorai SUJATHA (India) (Number theory, K-Theory)
- Cédric VILLANI (France) (Fields Medal)



# Management team

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**Director :** Claude CIBILS (U. Montpellier 2, on leave at U. Nice Sophia-Antipolis)

## Scientific Officers:

- *Sub-Saharan Africa:* Sylvain DUQUESNE (U. Rennes 1), Marie-Françoise ROY (U. Rennes 1) and Giulia DI NUNNO (U. of Oslo)
- *Mediterranean:* Ahmad EL SOUFI (U. Tours)
- *Latin America and Caribbean:* Claude CIBILS
- *South-east Asia:* Brigitte LUCQUIN (U. P. et M. Curie) and Christian MAUDUIT (U. Aix Marseille II)
- *India and West Asia:* Jorge JIMENEZ URROZ (U. Politècnica de Catalunya)
- *Transverse :* Mercedes SILES MOLINA (U. Malaga)

Project manager for the Master in Cambodia: Brigitte LUCQUIN

Project manager for communication : Rosane USHIROBIRA (U. Bourgogne, on secondment at Inria Lille)

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# Scientific partners

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Université Nice Sophia-Antipolis (**UNS**), Institut National de Recherche en Informatique et en Automatique (**Inria**), Centre National de la recherche Scientifique (**CNRS**), Société Mathématique de France (**SMF**), Société de Mathématiques Appliquées et Industrielles (**SMAI**), International Mathematical Union (**IMU**), International Council for Industrial and Applied Mathematics (**ICIAM**), European Mathematical Society (**EMS**), International Centre for Theoretical Physics (**ICTP**), Union Mathématique Africaine (**UMA**), South East Asian Mathematical Society (**SEAMS**), Union Mathématique d'Amérique Latine et Caraïbes (**UMALCA**), Comité National Français des Mathématiciens (**CNFM**), Centro de Modelamiento Matemático (**CMM**), Bordeauxthèque, Institut de Recherche pour le Développement (**IRD**), Comité Español de Matemáticas (**CEMAT**), Real Sociedad Matemática Española (**RSME**), Societat Catalana de Matemàtiques (**SCM**), Sociedad Española de Matemática Aplicada (**SEMA**), Sociedad Española de Estadística e Investigación operativa (**SEIO**)

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# Numbers

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**260** Research Schools since 1979, see the complete list:

<http://www.cimpa-icpam.org/spip.php?rubrique70>

Represented countries by continent:

- Africa : 18
- Asia : 12
- South America and Caribbean : 13
- Middle East : 8

13000 young mathematicians with 2500 speakers, 1100 from so-called Southern countries.

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# Budget 2012

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## 512 K€

- 68% France
- 12% Switzerland
- 6% Norway
- 4% Spain
- 5% ICTP and others
- 5% Membership dues

### **Half of the budget for Africa (Sub-Saharan and Mediterranean)**

- paid from budget : one and a half full time secretaries in Nice
- scientific officers, members of councils and lecturers are volunteers
- Not in the budget: salary of the Director, paid by Université Montpellier 2 and support by Université Nice Sophie-Antipolis and CNRS.



# CARMIN

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CARMIN is an “Excellence Laboratory” in France conducted by Cédric Villani, composed of four centres:

- IHP - Institut Henri Poincaré
- IHÉS - Institut des Hautes Études Scientifiques
- CIRM – Centre International des Rencontres Mathématiques
- CIMPA

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# EMALCAs, EMAs and SEAMS schools

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CIMPA is a partner and encourages schools of Master level.

UMALCA (Union de Matematicos de América Latina y el Caribe) has initiated EMALCAs more than 15 years ago.

2013 EMALCAs : Salta, Tegucigalpa, Lambayeque, Morelia, Barranquilla, Mérida, Cochabamba, Coclé, Quito.

With UMA (Union des Mathématiciens d'Afrique) and SEAMS (South-East Asia Mathematical society) we have initiated recently a partnership in the same direction.

2013 EMAs : Mombasa, Brazzaville

2013 SEAMS schools : Manila, Hanoi

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# International support for CIMPA-ICPAM

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Convention MICINN (Ministerio de Ciencia e Innovación, Spain) – CIMPA, thanks to the former President of CIMPA, Mario Wschebor

- It allows CIMPA-ICPAM to respond to more requests of help from developing countries, much more than we can support at the moment
- It was a first step towards the internationalization of CIMPA-ICPAM

Supports from the governments of Norway and Switzerland

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# Indo-French cooperation in mathematics

**Centre National de la Recherche Scientifique  
CNRS in India**

One Mixed Unit (UMI):  
Indo-French Centre for Applied Mathematics,  
Bangalore

CNRS/DST Department of Science and Technology  
*Partial differential equations, control theory, computing  
sciences, statistical physics, dynamic systems, mathematical  
biology, modeling large networks.*

École Polytechnique, École Normale Supérieure, INRIA,  
Nice Sophia Antipolis, Paul Sabatier  
Indian Institute of Science, Tata Institute of Fundamental  
Research, Indian Institutes of Technology

**Campus-France**      <http://www.inde.campusfrance.org>  
Scholarships  
Studies in France

**Service pour la Science et la Technologie,  
French Embassy in India**      <http://www.ambafrance-in.org/>

### **Global Technology Summit 2013**

State visit to India of François Hollande, President of the  
French Republic in February 2013

October 23rd and 24th, New Delhi: meeting and new  
partnerships between researchers, businesses and clusters  
from both countries. High level delegations, research  
organizations, companies, SMEs...



# India fund at IHÉS



## Institution Details



**Name:** Institut des hautes études scientifiques

**Category:** Institutionnal

**Web Link:** [www.ihes.fr/jsp/site/Portal.jsp](http://www.ihes.fr/jsp/site/Portal.jsp)

**Description:**

An institution devoted to fundamental research and created in 1958, IHÉS is a reference point in the international scientific community. The Institute has achieved unquestionable success in mathematics and theoretical physics: of the ten permanent mathematicians recruited by IHÉS since its beginning, seven have been awarded the Fields Medal

IHÉS has been supported by French and international public institutions from its early years and developed an international network of industry partners from the very beginning. Creating an India Fund at IHÉS is an initiative based on the long tradition of exchanges with scientists from India and will increase the number of indian visitors hosted each year.

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Michel WALDSCHMIDT, Université Paris 6 <http://www.math.jussieu.fr/~miw/>

## India fund at IHÉS



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**CEFIPRA - IFCPAR**  
**Indo-French Centre for the**  
**Promotion of Advanced Research**

**<http://www.cefipra.org/>**



# Pure and Applied Mathematics

## List of projects (1989–1994)

- NUMERICAL MODELLING OF THE OCEAN–ATMOSPHERE SYSTEM WITH SPECIAL REFERENCE TO MONSOONS  
One year (April, 1989 to March, 1990)
- A STUDY OF SOME FACTORISATION AND COMPOSITION PROBLEMS IN GRAPHS  
Three years and six months (September, 1992 to February, 1996)
- NONLINEAR HYPERBOLIC EQUATIONS AND APPLICATIONS  
Three years (March, 1992 to February, 1995)
- GEOMETRY AND NUMBER THEORY  
Three years (February, 1992 to January, 1995)

# List of projects (1995–1996)

- ASYMPTOTIC ANALYSIS IN PARTIAL DIFFERENTIAL EQUATIONS  
Three years (February, 1995 to February, 1998)
- INTEGRABILITY ASPECTS OF DISCRETE AND CONTINUOUS EQUATIONS  
Three years (August, 1995 to July, 1998)
- CHAOS, TURBULENCE AND COLLECTIVE RELAXATION IN NON-EQUILIBRIUM PLASMAS  
Four years (December, 1995 to November, 1999)
- ARITHMETIC AND AUTOMORPHIC FORMS  
Three years (November, 1996 to October, 1999)

# List of projects (1997–1999)

- NONLINEAR HYPERBOLIC AND ELLIPTICAL EQUATIONS AND APPLICATIONS

Three years (May, 1997 to April, 2000)

- GEOMETRY

Three years (May, 1997 to April, 2000)

- RIGOROUS RESULTS ON SCHRODINGER EQUATIONS AND FOUNDATIONS OF QUANTUM THEORY AND APPLICATIONS TO PARTICLE PHYSICS AND ASTROPHYSICS

Three years and six months (March, 1999 to August, 2002)

- THEORETICAL STUDY OF ELECTRONIC AND MOLECULAR DYNAMIC

Three years and six months (March, 1999 to August, 2002)

# List of projects (1999–2002)

- NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS AND CONTROL  
Three years and six months (July, 1999 to December, 2002)
- NON-CUMULATIVE MARKOV PROCESSES AND OPERATOR SPACES  
Three years (May, 2001 to April, 2004)
- ALGEBRAIC GROUPS IN ARITHMETIC & GEOMETRY  
Three years (September 2001 to August, 2004)
- STUDIES IN GEOMETRY OF BANACH SPACES  
Three years (November 2001 to October, 2004)
- MATHEMATICAL TOPICS IN HYPERBOLIC SYSTEMS OF CONSERVATION LAWS  
Four years (July 2002 to June, 2006)

# List of projects (2003–2008)

- ANALYTIC AND COMBINATORIAL NUMBER THEORY  
Three years (October 2003 to September 2006)
- ADVANCED NUMERICAL METHODS IN NONLINEAR FLUID MECHANICS AND ACOUSTICS : NONLINEAR ANALYSIS AND OPTIMISATION  
Three years (March, 2006 to February, 2009)
- CONSERVATION LAWS AND HAMILTON JACOBI EQUATIONS  
Three years (September, 2006 to August, 2009)
- ARITHMETIC OF AUTOMORPHIC FORMS  
Three years (September, 2007 to August, 2010)
- CONTROL OF SYSTEMS OF PARTIAL DIFFERENTIAL EQUATIONS  
Three years (February, 2008 to January, 2011)



# List of projects (2009–2010)

- NUMERICAL TREATMENT OF INTEGRAL OPERATORS WITH NON-SMOOTH KERNELS  
Three years (September 2009 to August 2012)
- KLEINIAN GROUPS : GEOMETRICAL AND ANALYTICAL ASPECTS  
Three years (September, 2010 to August, 2013)
- DISCONTINUOUS GALERKIN METHOD FOR NONLINEAR ACOUSTICS  
Three years (September, 2010 to August, 2013)

Seminar on Successful Indo–French  
S&T Cooperation

**Indo–French cooperation  
in mathematics**

*Michel Waldschmidt*

Université Pierre et Marie Curie (Paris 6)  
Institut de Mathématiques de Jussieu

<http://www.math.jussieu.fr/~miw/>

# Indo–French relations in mathematics

The relations between mathematicians from France and from India are old. The first links were established by A. Weil in 1930, and shortly after that, Father Racine played a major role in the development of mathematical research in India.

# Father Racine

Father Racine (1897–1976) reached India in 1937 as a Jesuit missionary after having taken his Doctorate in Mathematics in 1934 under Élie Cartan. He taught mathematics first at St Joseph's College in Tiruchirappally (Trichy, Tamil Nadu) and from 1939 onwards at Loyola College (Madras). He had connections with many important French mathematicians of that time like J. Hadamard, J. Leray, A. Weil, H. Cartan. His erudition was clear from his lectures, his courses were research oriented in contrast with the traditional way of teaching which aimed only at leading the largest number of students to success in their exams.

# Two Indo–French achievements

The most important part of cooperation between France and India in mathematics is constituted by the new results proved by the joint works of mathematicians from both countries. We give two such outstanding results.

# Waring's Problem

The final step to the determination of Waring's constant  $g(4) = 19$  in 1986 by R. Balasubramanian, J-M. Deshouillers and F. Dress :

*Any positive integer is the sum of at most 19 biquadrates.*

*Problème de Waring pour les bicarrés. I : schéma de la solution, II : résultats auxiliaires pour le théorème asymptotique, C. R. Acad. Sci. Paris, **303**, (1986), 4, 85–88 & 5, 161–163*

# Serre's Modularity Conjecture

*Serre's Modularity Conjecture* was proved in 2006 in a joint work by Chandrashekhara Khare and Jean-Pierre Wintenberger :

Let

$$\rho : G_{\mathbb{Q}} \rightarrow GL_2(F).$$

be an absolutely irreducible, continuous, and odd two-dimensional representation of  $G_{\mathbb{Q}}$  over a finite field  $F = \mathbb{F}_{\ell^r}$  of characteristic  $\ell$ , There exists a normalized modular eigenform

$$f = q + a_2q^2 + a_3q^3 + \dots$$

of level  $N = N(\rho)$ , weight  $k = k(\rho)$ , and some Nebentype character  $\chi : \mathbb{Z}/N\mathbb{Z} \rightarrow F^*$  such that for all prime numbers  $p$ , coprime to  $N\ell$ , we have

$$\text{Trace}(\rho(\text{Frob}_p)) = a_p \quad \text{and} \quad \det(\rho(\text{Frob}_p)) = p^{k-1}\chi(p).$$

**European Mathematical Society  
Committee for Developing Countries**  
<http://euro-math-soc.eu/EMS-CDC/>



The European Mathematical Society  
Committee for Developing Countries

Workshops on electronic access  
<http://workshop.ems-cdc.org/doku.php>

**F**inding **O**nline **I**nformation in  
**M**athematics