GENERAL

The Master Classes and Spring Schools occupy an important place in the programme of studies offered by the nation-wide Mathematical Research Institute (MRI) in The Netherlands. These activities are open to anyone in his/her final year of undergraduate studies in mathematics, theoretical physics, or a related field with a comparable mathematical background, as well as to graduate students, and are specifically aimed at an international audience. Offering a unique opportunity for mathematical talent to develop, both Master Classes and Spring Schools have proved to be successful in bringing together Dutch and foreign students. The language of instruction is English.

In general, an MRI Master Class may form a substantial preparation for a PhD programme in The Netherlands or elsewhere, possibly even contributing to one. In such a Master Class some advanced topic in contemporary mathematics is studied intensively and in depth. In 2003/2004, this topic will be **Noncommutative Geometry**. The Master Class on Noncommutative Geometry runs from September through June, and includes two full days of lectures and seminars per week and individual work on a test problem. Students who successfully complete the courses will be awarded a Master Class Certificate.

The MRI Spring Schools, on the other hand, offer participants the opportunity to delve intensively, but for a brief period, into the chosen current topic. In 2004, this will be **Lie Groups and Hamiltonian Systems**. The 2004 Spring School will be held in April or May, preceded by a preparatory period in one's own country. The programme in The Netherlands starts with three weeks of lectures and seminars, concluding with a week-long instructional conference in which international experts participate. Successful participation in the Spring School can be part of one's regular university studies.

Admission and tuition fees for the Master Class are € 2269. The cost of a modest but pleasant stay in The Netherlands, including residence and insurance, is approximately € 650 per month. In addition to the cost of travel to and from The Netherlands, an extra amount of € 700 will be needed to cover travel expenses in The Netherlands to and from the locations of supplemental educational activities.

Admission and tuition fees for the Spring School are € 908. Stay in the Netherlands will cost participants approximately € 1135, including residence and insurance.

MRI offers a limited number of stipends to outstanding applicants. Otherwise, participants who need financial support are requested to approach potential sponsors themselves, for example through their own universities or through international institutions (see www.nuffic.net/). In a few cases, MRI may be able to help with applications for a stipend. It is advisable in any case to apply as early as possible, because early acceptance as a participant enhances the possibilities for obtaining external scholarships.

Details of the application procedure are described at the end of this leaflet.

MASTER CLASS

Noncommutative Geometry is a recent development in pure mathematics, which combines and to some extent unifies such diverse areas of mathematics as algebra, topology, geometry, and functional analysis in a powerful way. Here is the guiding principle. Algebraic topology and differential geometry provide tools such as topological K-theory, de Rham cohomology, differential calculus on manifolds, and index theory, which can be reformulated purely algebraically in terms of the commutative ring of continuous or smooth functions on the underlying space. Motivated mainly by problems in quantum mechanics and in the theory of foliated manifolds, these tools have successfully been extended to certain noncommutative algebras. This development has led to "non-commutative geometry", a subject which has now acquired a life of its own.

In the noncommutative setting, the first three tools listed above are replaced by the K-theory of C*-algebras, cyclic cohomology, and spectral triples, respectively, which in combination lead to deep noncommutative analogues of the Atiyah-Singer index theorems. These techniques are ultimately based on the theory of operator algebras and on homological algebra, whereas many interesting examples in noncommutative geometry come from Lie groupoids and their associated Lie algebroids and convolution algebras. This program has mainly been formulated and developed by Alain Connes, and anyone interested in this course should first have a look at his amazing book *Noncommutative Geometry* from 1994.

The aim of the Master Class is to bring students to a level at which they understand the techniques and ideas in Connes' book as well in more recent research literature.

PROGRAMME

First semester

- *Analysis on manifolds*
  (E. Looijenga, Utrecht)
- *C*-algebras and K-theory I*
  (N.P. Landsman, Amsterdam)
- *Homological algebra*
  (I. Moerdijk, Utrecht)
- *Seminar (various speakers)*

Second semester

- *Cyclic (co)homology*
  (M. Crainic, Utrecht)
- *C*-algebras and K-theory II*
  (N.P. Landsman, Amsterdam)
- *Lie groupoids and foliations*
  (I. Moerdijk, Utrecht and J. Mrcun, Llubljana and Utrecht)
- *Seminar (various speakers)*

In the seminar the students themselves are the main speakers. There is a weekly consultation hour for individual questions. Regular evaluation and testing guarantees the quality of the programme. Further information on the content of the courses may be obtained from:

npl@science.uva.nl
moerdijk@math.uu.nl
http://www-mri.sci.kun.nl/

SPRING SCHOOL

The 2004 Spring School will be concerned with **Lie Groups and Hamiltonian Systems**. Lie groups are groups which at the same time are smooth manifolds. A Lie group is almost completely determined by its Lie algebra, which is the tangent space of the groups at it identity element, provided with the so-called Lie brackets, the commutator in the case of linear transformations in a vector space. Lie groups often arise as groups of transformations, viewed as symmetries of the spaces or systems on which these act. The analysis of the actions often reveals a great deal about the spaces or systems in question.

In the Spring School, after a quick review of the basic general properties of Lie groups and their actions, we will concentrate on applications to classical mechanics, (symplectic) differential geometry and algebraic geometry. Representation theory is the study of the corresponding action by means of linear operators on spaces of functions on the manifold on which the group acts, a situation which is familiar in quantum mechanics.

The lectures are complemented by computer sessions and exercise classes. Background material for the Spring School will be distributed some months before the course starts. In principle, participants can use this to independently prepare for the school. Participants receive help with these preparations at a distance, or in collaboration with the home university.

PROGRAMME

The programme consists of 3 weeks of courses on:

- Structure theory of Lie groups and Lie algebras (J. Kolk, Utrecht)
- Group actions
  (J. Kolk and H. Duistermaat, Utrecht)
- Symplectic geometry
  (H. Duistermaat, Utrecht)
- Symmetry in mechanics
  (R. Cushman, Utrecht)
- Representation theory and applications in classical quantum mechanics
  (E. van den Ban, Utrecht)
- Analysis on principal fiber bundles and gauge theory (H. Duistermaat, Utrecht)
- The momentum map from an algebraic and differential geometric point of view
  (G. Heckman, Nijmegen)

This will be followed by a short conference, for which we will invite specialists in the field, who will present lectures on a for the participants comprehensible level. Further information on the content of the courses may be obtained from:

ban@math.uu.nl
heckman@sci.kun.nl
http://www-mri.sci.kun.nl/

STUDYING IN THE NETHERLANDS

The kingdom by the North Sea with its mild climate has been an international meeting point for scientists and artists for centuries. The well-known wooden shoes and windmills are charming stereotypes, but knowledge and science represent a larger part of The Netherlands' international trade than Dutch cheese and tulips. There is a long tradition of university research and education in The Netherlands. The oldest Dutch universities have their roots in medieval times. Through the centuries, the universities have developed from monks' schools into modern research and educational institutions.

Higher education is a fundamental component of Dutch culture, and studying in The Netherlands has become more than simply following courses: it has become a way of life. The scientific climate in The Netherlands is open and communicative. The relationship between students and lecturers, and among students themselves, is less formal than in many other countries. Student life offers opportunities for culture, sport and recreation. Foreign students will find that a well-organized and lively student life and a tolerant national culture make for a pleasant period of study in The Netherlands. Language need not be a problem, as many Dutch people speak English.

STUDYING AT MRI

The Master Class in Noncommutative Geometry is a joint initiative of the Universities of Utrecht and Amsterdam. Most activities will take place at the University of Utrecht, where the students will preferably live. Some courses might take place at the University of Amsterdam, which can be reached from Utrecht by a train journey of less than 30 min.

The Spring School on Lie Groups and Hamiltonian Systems is jointly organized by the Universities of Utrecht and Nijmegen. Its location and precise timing will be announced on the MRI website

In both cases, MRI helps students find housing. Furthermore, participants in the Master Class and Spring School have full use of the university facilities, such as excellent libraries and computers with internet connection and e-mail.

"When I started my Ph.D. in Tilburg, my supervisor immediately recommended that I participate in the MRI Master Class of 2001/2002 in Mathematical Finance. As a Ph.D. student you want to see things in depth, and that's exactly what I saw in the Master Class. The lecturers were enthusiastic and focused in on every detail of their topics, which helped me to understand the essence of the problems they presented. I also got a broader view of the world of mathematical finance through the seminar series, which included presentations from academics as well as people working in the field. I think the real power of MRI is in the resources it can call on; being a cooperative effort between four universities means that it has access to world class researchers in many field. In fact I liked it so much I participated in the Master Class again the following year."

(Steffan Berridge from New Zealand, participated in the Master Class 2001-2002 and 2002-2003).

The participants in the Master Class are very different, both in their level and their cultural background. But that is no problem, on the contrary. The students spend time together and help each other; a bond develops rather quickly. The scientific climate in The Netherlands is open and hospitable, and that seems to be infectious. I remember one group of five students that rented a house together and spent weekends working on problems. As a lecturer, I find test problems a fantastic way to gain insight into the extent of students' knowledge. You can tell whether someone is motivated, curious, or creative, important characteristics for a researcher. Every student approaches a problem differently, depending on his or her background, knowledge and personality. We try to attune our work to each student's talents and capacities, to help them develop further.

(Prof. dr. Frans Oort, lecturer in the Master Class)

HOW TO APPLY

To apply for the Master Class, please send the following documents to the address at the back:

- curriculum vitae (including the following details: first name, surname, date of birth, nationality, address, postal code, city, country, phone number, fax, email address)
- academic record: list of subjects/classes taken at university, subjects for degree examination, photocopy of diploma (if available)
- recommendations from members of the academic staff of the home university (at least one)
- a summary of financial circumstances (if financial support is necessary).

The **application deadline for the 2003/2004 Master Class is APRIL 1, 2003 for non-EU residents and JULY 1, 2003 for EU-residents**, by which date applications and the necessary documents must have been received by the MRI.

The **application deadline for the Spring School 2004 is OCTOBER 15, 2003**. Applications and the necessary documents must have been received by the MRI secretariat by that date.

In both cases, candidates will be selected on the basis of previous academic achievement and references from the home university.

ABOUT MRI

In 1994, four of the leading mathematics departments of universities in the Netherlands joined forces to form an inspiring platform for interaction by founding the **Mathematical Research Institute (MRI)**. In doing so, the universities of Groningen, Nijmegen, Twente and Utrecht have further reinforced the position of Dutch mathematical research, the quality and productivity of which is ranked in the European top. MRI covers a broad range of specialisations, with emphasis on five central areas in mathematics: algebra and geometry, analysis, stochastics and operations research.

MRI's research is characterized by its attention to the dynamic relationship between fundamental and applied aspects of mathematics. In order to stimulate the quality and the development of its research, MRI pays a great deal of attention to education and training of researchers.

The general philosophy behind MRI is that there is something paradoxical about mathematical research. Unraveling a mathematical problem is a highly individual activity, but it is precisely in discussion with colleagues that questions and problems emerge. Interaction is crucial!

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