

# ITGP Research Networking Programme

ESF

Scientific Meeting – Scientific Report

**Proposal Title: GEOQUANT 2013**

**Application Reference Number: 4549**

## 1. Summary:

The School/International Conference on Geometry and Quantization took place at *The Erwin Schrödinger International Institute for Mathematical Physics (ESI)* in Vienna, Austria, 18.8. – 31.8. 2013.

It was a two weeks activity. The first week was a school intended to enable young scientists to enter the field. The second week was an international scientific conference.

The topics considered were: algebraic-geometric and complex-analytic-geometric aspects of quantization, geometric quantization and moduli space problems, asymptotic geometric analysis, K3 surfaces and conformal field theory, relations with modern theoretical physics.

In total 80 people participated in the event.

## 2. Description of the scientific content and of the discussions at the event

The main scientific direction presented at the School–Conference was **Geometric Quantization** understood in a broad sense. This field is a direction of ongoing intensive mathematical research. Some of the appearing mathematical problems originate from inside the mathematical theory. In addition, particular during the last years, a number of challenging mathematical problems came from theoretical physics. It was the scientific goal of the Geoquant conference to address some of these problems. The following topics were covered in Vienna:

- concepts of differential and complex geometry arising in quantization
- relations between quantization and the geometry of moduli spaces
- algebraic aspects of quantization, in particular, infinite-dimensional Lie algebras and groups and their representations
- asymptotic geometric analysis
- relations with modern theoretical physics

- K3 surfaces, conformal field theory
- non-commutative quantum field theory.

The international dimension of the activity was already documented by the members of the **Scientific Organisation Committee**. Those were Harald Grosse (Vienna, Austria), Ryoichi Kobayashi (Nagoya University, Japan), Martin Schlichenmaier (Luxembourg University, Luxembourg), Armen Sergeev (Steklov Mathematical Institute, Moscow, Russia), Oleg Sheinman (Steklov Mathematical Institute, Moscow, Russia), Weiping Zhang (Chern Institute of Mathematics, Tianjin, P.R.China).

The conference in Vienna was the 5th GEOQUANT conference. The previous conferences were held in: (a) Japan (Tokyo, Nagoya) (2005), (b) Russia (Moscow) (2007), (c) Luxembourg (Luxembourg City) (2009), (d) China, (2011).

During the school seven lecture courses were presented. Six of the courses lasted for 3 times one hour. As it has been proven very effective in former schools organized in the frame of the GEOQUANT activity, regular discussion sessions were foreseen in the late afternoon. They were quite frequented. There the participants asked the lecturers additional questions in a less formal way, demanded for more background information or even presented themselves certain supplementary information,

### Lecturer of the School

The following lecture courses were given

- Yael Fregier (MIT, USA; Lens, France), *Moduli spaces of algebraic structures and Maurer-Cartan equations*
- Harald Grosse (Vienna, Austria), *An introduction to non-commutative quantum field theory*
- Alexander Kuznetsov (Steklov Mathematical Institute, Moscow, Russia), *Derived categories of coherent sheaves and moduli spaces*
- Yoshihiro Ohnita (Osaka City University, Japan), *Hamiltonian stability problem of Lagrangian submanifolds in Kähler manifolds*
- Vincent Rivasseau (Paris, France), *Random Tensors*
- Boris Shoikhet (Antwerp, Belgium), *About deformations*
- Katrin Wendland (University of Freiburg, Germany), *K3 surfaces: Geometry, conformal field theory and number theory*

## List of talks:

The following invited talks were presented in the conference week:

1. Anton Alekseev, Geneva, Switzerland, *Logarithms and deformation quantization*
2. Ugo Bruzzo, Trieste, Italy, *Stacky resolutions of moduli spaces of instantons*
3. Detlev Buchholz, Göttingen, Germany, *The resolvent algebra: a new approach to canonical quantum systems*
4. Miroslav Engliš, Prague, *Spektral triples and Toeplitz operators*
5. Jürgen Fuchs, Karlstad, Sweden, *Three-dimensional topological field theories on manifolds with boundaries and defects*
6. Hajimi Fujita, Tokyo, Japan, *Equivariant local index and transverse index for circle action*
7. Tomohiro Fukaya, Sendai, Japan, *The coarse Baum-Connes conjecture for relatively hyperbolic groups*
8. Alexey Gorodentsev, Moscow, Russia, *Mukai Lattices*
9. Brian Hall, Notre Dame, USA, *The large- $N$  limit of the Segal-Bargmann transform on unitary groups*
10. Alexander Karabegov, Abilene, USA, *On Gammelgaards formula for a star product with separation of variables*
11. Will Kirwin, Cologne, Germany, *Complex-time evolution in geometric quantization*
12. Ryoichi Kobayashi, Nagoya, Japan, *Hamiltonian volume minimizing property of maximal torus orbits in complex projective space*
13. Gandalf Lechner, Leipzig, Germany, *Non-local perturbations of hyperbolic PDEs and QFT models on non-commutative spacetimes*
14. Xiaonan Ma, Paris, France, *Flat vector bundle and Toeplitz operators*
15. George Marinescu, Cologne, *Equidistribution of random zeros on complex manifolds*
16. Shin-Ichi Oguni, Matsuyama, Japan, *On the coarse Baum-Connes conjecture*
17. Alexey Parshin, Moscow, Russia, *Base change and automorphic induction in the Langlands theory*
18. Armen Sergeev, Moscow, Russia, *Quantum Calculus and non-commutative Bloch theory*
19. Andrei Shafarevich, Moscow, Russia, *Quantization conditions on Riemann surfaces and spectral series of non-selfadjoint operators*

20. Georgy Sharygin, Moscow, Russia, *Full symmetric Toda system and Bruhat order*
21. Dimitry Talalaev, Moscow, Russia, *On deformation quantization of integrable systems*,
22. Alejandro Uribe, Michigan University, USA, *The exponential map of the complexification of  $\text{Ham}(M, \omega)$  in the real-analytic case*
23. Michele Vergne, Paris, France, *An Euler-MacLaurin formula for the equivariant index of a transversally elliptic operator*
24. Siye Wu, Hong Kong, China, *Hitichin's equation on a non-orientable manifold*
25. Tilmann Wurzbacher, Metz, Bochum, *Integration of vector fields on supermanifolds and applications*
26. Takahiko Yoshida, Tokio, Japan, *Equivariant local index and symplectic cut*
27. Xiangyu Zhou, Beijing, China, *Some results on the  $L^2$ -extension problem*

### Sponsors:

In total the expenses for the activity was **Euro 49 805**. The following organisations contributed to this amount.

Erwin-Schrödinger International Institute for Mathematical Physics (ESI), Vienna, Austria, **Euro 26 000**

ESF Research Networking Programme ITGP (Interaction of Geometry and Low-Dimensional Topology with Mathematical Physics), **Euro 9 000**

Foundation Compositio Mathematica, **Euro 6 000**

University of Luxembourg, Mathematics Research Unit, **Euro 7 920.90**

Belspo IAP Project DYGEST, University of Louvan, Belgium, **Euro 884.10**

**Participants** 80, including 34 speakers

**Webpage:** <http://math.uni.lu/geoquant2013>

### 3. Assessment of the Results and impact of the event on the future directions of the field.

The conference and school attracted mathematicians from Europe, Russia, China, USA and other places. It fostered the international collaboration of mathematicians working in the field, gave cross-fertilizations of different communities in the field and helped to bundle the efforts of researchers.

We got an extremely good feedback from the participants, expressing that it is a conference on timely topics, that they got inspired a lot and that new interactions were created. In particular, the participants urged us to continue with this type of school-conference. We got much more applications for attendance than we could accommodate at the ESI.

In fact, we intend to run further GEOQUANT conferences in different countries. The next one is foreseen for 2015. As every time we plan to move the focus enough to explore different aspects of this fast developing and exciting field.

#### **4b. Full list of speakers and participants:**

##### **Speakers:**

Anton Alekseev, Geneva, Switzerland  
Ugo Bruzzo, Trieste, Italy  
Detlev Buchholz, Gttingen, German  
Miroslav Englis, Prague  
Yael Fregier, Lens, France and MIT, USA  
Jürgen Fuchs Karlstad, Sweden  
Hajimi Fujita, Tokyo, Japan  
Tomohiro Fukaya, Sendai, Japan  
Alexey Gorodentsev, Moscow, Russia  
Harald Grosse, Vienna  
Brain Hall, Notre Dame, USA  
Alexander Karabegov, Abilene, USA  
Will Kirwin, Cologne, Germany  
Ryoichi Kobayashi, Nagoya, Japan  
Alexander Kuznetsov, Moscow, Russia  
Gandalf Lechner, Leipzig, Germany  
Xiaonan Ma, Paris, France  
George Marinescu, Cologne  
Shin-Ichi Oguni, Matsuyama, Japan  
Yoshihiro Ohnita, Osaka, Japan  
Alexey Parshin, Moscow, Russia  
Vincent Rivasseau, Paris, France  
Armen Sergeev, Moscow, Russia  
Andrei Shafarevich, Moscow, Russia  
Georgy Sharygin, Moscow, Russia  
Boris Shoikhet, Antwerp, Belgium  
Dimitry Talalaev, Moscow, Russia  
Alejandro Uribe, Michigan University, USA  
Michele Vergne, Paris, France  
Katrin Wendland, Freiburg, German  
Siye Wu, Hong Kong, China  
Tilman Wurzbacher, Metz, Bochum  
Takahiko Yoshida, Tokio , Japan  
Xiangyu Zhou, Beijing, China

**Other Participants:**

Francesca Arici (Trieste)  
Masaki Asono (Japan)  
Tatyana Barron (Canada)  
Julia Belopshapka (Moscow)  
Adam Biggs (Manchester)  
Xiongwei Cai (Luxembourg)  
Simone Camosso (Milano)  
Hector Castejon (Luxembourg)  
Oscar Chavez Moline (Mexico)  
Anton Fonarev (Moscow)  
Akito Futaki (Tokyo)  
Dimitry Gurevich (France)  
Pedram Hekmati  
Huebschmann, Johannes (Lille, France)  
Oleksandr Iena (Luxembourg)  
Noriaki Ikeda (Japan)  
Hiroshi Iriyeh (Tokio)  
Igor Kanatchikov  
Hovannes Khudaverdian (Manchester)  
Gianni Landi (Trieste, Italy)  
Silvain Lavau (Lyon)  
Hui Li (China)  
Jucko Mickelsson (Helsinki)  
Stepan Moskaliuk (Ukraine)  
Elena Netay (Moscow)  
Igor Netay (Moscow)  
Takahiro Noda (Nagoya)  
Albert Georg Passeger  
Nina Prudova (Moscow)  
Jian Qiu (Luxembourg)  
Martin Schlichenmaier (Luxembourg) (organiser),  
Oleg Sheinman (Moscow, Russia) (organiser),  
Harold Steinacker (Vienna, Austria)  
Michael Stiller (Hamburg)  
Thomas Strobl (Lyon, France)  
Ryosuke Takahasi (Japan)

Matteo Tommasini (Luxembourg)

Yuri Ustinovsky (Moscow)

Huiping Zhang (China)

#### **4a. Programme**

**GEOQUANT 2013**  
**August 19 - 30****Organized by:****Pierre Bieliavsky, Harald Grosse, Ryoichi Kobayashi,  
Martin Schlichenmaier, Armen Sergeev, Oleg Sheinman, Weiping Zhang****Summer School Schedule: August 19 - 23, 2013****• Monday, August 19, 2013:****09:30 Registration and Opening**

[Prof. Schlichenmaier on behalf of the Organizers and Prof. Schwermer, ESI]

**09:45 – 10:45 Katrin Wendland***K3 surfaces: Geometry, conformal field theory and number theory I*

10:45 – 11:15 Coffee break

**11:15 – 12:15 Yael Fregier***Moduli spaces of algebraic structures and Maurer-Cartan equations I*

12:15 – 14:00 Lunch break

**14:00 – 15:00 Yoshihiro Ohnita***Hamiltonian stability problem of Lagrangian submanifolds in Kähler manifolds I***15:10 – 16:10 Alexander Kuznetsov***Derived categories of coherent sheaves and moduli spaces I***• Tuesday, August 20, 2013****09:30 – 10:30 Katrin Wendland***K3 surfaces: Geometry, conformal field theory and number theory II*

10:30 – 11:00 Coffee break

**11:00 – 12:00 Harald Grosse***Noncommutative Quantum Field Theory I*

12:00 – 14:00 Lunch break

**14:00 – 15:00 Yael Fregier***Moduli spaces of algebraic structures and Maurer-Cartan equations II***15:10 – 16:10 Yael Fregier***Moduli spaces of algebraic structures and Maurer-Cartan equations III*

16:30 – 17:30

*Discussion and problem session*



- **Wednesday, August 21, 2013**

09:30 – 10:30 **Vincent Rivasseau**

*Random Tensors I*

10:30 – 10:50 Coffee break

10:50 – 11:50 **Katrin Wendland**

*K3 surfaces: Geometry, conformal field theory and number theory III*

12:00 – 13:00 **Boris Shoikhet**

*About deformations*

- **Thursday, August 22, 2013**

09:30 – 10:30 **Vincent Rivasseau**

*Random Tensors II*

10:30 – 11:00 Coffee break

11:00 – 12:00 **Harald Grosse**

*Noncommutative Quantum Field Theory II*

12:00 – 14:00 Lunch break

14:00 – 15:00 **Yoshihiro Ohnita**

*Hamiltonian stability problem of Lagrangian submanifolds in Kähler manifolds II*

15:10 – 16:10 **Alexander Kuznetsov**

*Derived categories of coherent sheaves and moduli spaces II*

16:30 – 17:30

*Discussion and problem session*

- **Friday, August 23, 2013**

09:30 – 10:30 **Vincent Rivasseau**

*Random Tensors III*

10:30 – 11:00 Coffee break

11:00 – 12:00 **Harald Grosse**

*Noncommutative Quantum Field Theory III*

12:00 – 14:00 Lunch break

14:00 – 15:00 **Yoshihiro Ohnita**

*Hamiltonian stability problem of Lagrangian submanifolds in Kähler manifolds III*

15:10 – 16:10 **Alexander Kuznetsov**

*Derived categories of coherent sheaves and moduli spaces III*

16:30 – 17:30

*Discussion and problem session*

**All lectures take place at the ESI Boltzmann Lecture Hall**

**GEOQUANT 2013****August 19 - 30****Organized by:****Pierre Bieliavsky, Harald Grosse, Ryoichi Kobayashi,  
Martin Schlichenmaier, Armen Sergeev, Oleg Sheinman, Weiping Zhang****Conference Schedule: August 26 - 30, 2013****• Monday, August 26, 2013:**09:30 **Registration and Opening**09:45 – 10:35 **Anton Alekseev***Logarithms and deformation quantization*

10:35 – 11:05 Coffee break

11:05 – 11:55: **Ryoichi Kobayashi***Hamiltonian volume minimizing property of maximal torus orbits in complex projective spaces*11:55 – 12:45 **Michele Vergne***An Euler-MacLaurin formula for the equivariant index of a transversally elliptic operator*

12:45 – 14:30 Lunch break

14:30 – 15:20 **Dimitry Talalaev***On deformation quantization of integrable systems*15:20 – 16:10 **Georgy Sharygin***Full symmetric Toda system and Bruhat order*16:40 – 17:30 **Xiangyu Zhou***Some results on the  $L^2$  extension problem***• Tuesday, August 27, 2013**09:30 – 10:20: **Shin-Ichi Oguni***On the coarse Baum-Connes conjecture*

10:20 – 10:50 Coffee break

10:50 – 11:40 **Tomohiro Fukaya***The coarse Baum-Connes conjecture for relatively hyperbolic group*11:40 – 12:30 **Ugo Bruzzo***Stacky resolutions of moduli spaces of instantons*

12:30 – 14:30 Lunch break

14:30 – 15:20 **Alexey Gorodentsev***Mukai Lattice*

15:20 – 16:10 **Detlev Buchholz**

*The resolvent algebra: a new approach to canonical quantum systems.*

16:40 – 17:30 **Alexey Parshin**

*Base change and automorphic induction in the Langlands theory*

• **Wednesday, August 28, 2013**

09:30 – 10:20: **Armen Sergeev**

*Quantum Calculus and non-commutative Bloch theory*

10:20 – 10:50 Coffee break

10:50 – 11:40 **Gandalf Lechner**

*Non-local perturbations of hyperbolic PDEs and QFT models on non-commutative spacetimes*

11:40 – 12:30

**Miroslav Engliš**

*Spectral triples and generalized Toeplitz operators*

• **Thursday, August 29, 2013**

09:30 – 10:20 **Alexander Karabegov**

*On Gammelgaard's formula for a star product with separation of variables*

10:20 – 10:50 Coffee break

10:50 – 11:40 **George Marinescu**

*Equidistribution of random zeros on complex manifolds*

11:40 – 12:30 **Xiaonan Ma**

*Flat vector bundle and Toeplitz operators*

12:30 – 14:30 Lunch break

14:30 – 15:20 **Alejandro Uribe**

*The exponential map of the complexification of  $\text{Ham}(M, \omega)$  in the real-analytic case.*

15:20 – 16:10 **Will Kirwin**

*Complex-time evolution in geometric quantization*

16:40 – 17:30 **Siye Wu**

*Hitchin's equations on a non-orientable manifold*

• **Friday, August 30, 2013**

09:30 – 10:20 **Brian Hall**

*The large- $N$  limit of the Segal-Bargmann transform on unitary groups*

10:20 – 10:50 Coffee break

10:50 – 11:40 **Andrei Shafarevich**

*Quantization conditions on Riemann surfaces and spectral series of non-selfadjoint operators*

11:40 – 12:30 **Hajimi Fujita**

*Equivariant local index and transverse index for circle action*

12:30 – 14:30 Lunch break

14:30 – 15:20 **Takahiko Yoshida**

*On the local index*

15:20 – 16:10 **Tilman Wurzbacher**

*Integration of vector fields on supermanifolds and applications*

16:40 – 17:30 **Jürgen Fuchs**

*Three-dimensional topological field theories on manifolds with boundaries and defects*

**All lectures take place at the ESI Boltzmann Lecture Hall**