

VI School on Geometry and Physics

26 June – 30 June 2017

1. **Marián FECKO** – *Comenius University, Slovakia*

Integral invariants (Poincaré-Cartan) and hydrodynamics

First, we provide a pedagogical account, in modern language, of general theory of integral invariants (due to Poincaré and Cartan). Then we show how the theory might be useful for treating some issues in hydrodynamics of ideal fluid.

2. **Bartosz KWAŚNIEWSKI** – *Uniwersytet w Białymstoku, Poland*

Invitation to Hilbert C^* -modules and Morita-Rieffel equivalence

The lectures are planned to be an introduction to the theory of Hilbert C^* -modules and C^* -correspondences. Viewing C^* -correspondences as dynamic objects leads to a natural unification of number of structures, including product systems, Fell bundles and groupoids. It also provides a natural point of view on Morita equivalence in operator algebra setting developed by Rieffel.

Hilbert C^* -modules play an important role in modern theory of operator algebras and noncommutative analysis. A C^* -correspondence from a C^* -algebra A to a C^* -algebra B is a right Hilbert A -module equipped with a left action of B by adjointable operators. In the context of W^* -algebras the term correspondence was introduced by A. Connes in 1960's. It can be interpreted as a "morphism" – a noncommutative directed graph between two operator algebras. After the seminal paper by M. Pimsner in 1997, "A class of C^* -algebras generalizing both Cuntz-Krieger algebras and crossed products by \mathbb{Z} ", C^* -correspondences became a fundamental tool in the theory of C^* -algebras defined in terms of relations of dynamic or combinatorial nature. Morita-Rieffel equivalence bimodules are invertible "morphisms" in the "category" of C^* -algebras and C^* -correspondences.

3. **Yurii NERETIN** – *Institute for Theoretical and Experimental Physics, Russia*

Noncommutative harmonic analysis: unsolved but solvable problems

During 1950–2005 there were obtained many explicit spectral decompositions ("Plancherel formulas") in various problems of non-commutative harmonic analysis (as decompositions of regular and quasi-regular representations, restriction problems, tensor products, etc.). Usually, such decompositions are regarded as a final purpose of this subject. We discuss applications of 'Plancherel formulas' and 'operational calculus'.

4. **Andrei SHAFAREVICH** – *Moscow State University, Russia*

Extensions of symmetric operators and evolution equations on singular spaces

The lectures will be devoted to certain properties of differential operators and evolution equations on singular spaces. We describe the corresponding operators via extension theory and study geometrical and analytic properties of operators themselves as well as of the corresponding evolution equations.

5. **Andrzej SITARZ** – *Jagiellonian University, Poland*

An introduction to noncommutative geometry

The lectures will present a brief overview of tools and methods of noncommutative differential geometry and its applications to theoretical physics. Starting with basic mathematical foundations of NCG (algebras, K-theory, K-homology and cyclic (co)homology), I will describe the extension of the notion of geometry and demonstrate that changing the paradigm allows to extend the tools of theoretical physics to construct models of quantum spacetime. The overview shall be illustrated by easy do-it-yourself toy models, which help to understand the principles and results.

6. **Alice Barbara TUMPACH** – *Laboratoire Painlevé, France*

Lecture on Hilbert, Banach and Frechet manifolds

This lecture is an introduction to differential geometry with highlights on the infinite-dimensional case. It will be divided into 3 sections :

- (a) Basic notions of manifolds with model spaces Hilbert, Banach or Fréchet spaces. What should be the tangent vector bundle and the co-tangent vector bundle? Does there exist partitions of unity?
- (b) Inverse Function Theorems : the Banach version and the Nash-Moser version. Some applications to submanifolds.
- (c) Kähler manifolds : some pathologies concerning Riemannian, complex and symplectic structures.

During the lecture the notions introduced will be illustrated with examples related to projective spaces, grassmannians, diffeomorphisms groups, spaces of sections, spaces of curves. . .

References:

- [1] R.S. Hamilton, *The inverse function Theorem of Nash and Moser*, Bulletin (New Series) of the American Mathematical Society, Volume 7, Number1, 1982.
- [2] W. Klingenberg, *Riemannian Geometry*, Walter de Gruyter, New York, 1982.
- [3] A. Kriegl and P. W. Michor, *The convenient setting of Global Analysis*, Mathematical Surveys and Monographs, Volume 53.
- [4] S. Lang, *Fundamentals of Differential Geometry*, Graduate Texts in Mathematics, Springer-Verlag, 1999.
- [5] S. Lang, *Differential and Riemannian Manifolds*, Graduate Texts in Mathematics, Springer-Verlag, 1995.

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Monday, June 26

LECTURES 09:30–12:40

- 09:30–10:20** *Extensions of symmetric operators and evolution equations on singular spaces*
Andrei SHAFAREVICH, Moscow State University, Russia
- 10:20–10:50** Coffee break
- 10:50–11:40** *Noncommutative harmonic analysis: unsolved but solvable problems*
Yurii NERETIN, Institute for Theoretical and Experimental Physics, Russia
- 11:50–12:40** *Lecture on Hilbert, Banach and Frechet manifolds*
Alice Barbara TUMPACH, Laboratoire Painlevé, France

Tuesday, June 27

LECTURES 09:30–13:40

- 09:30–10:20** *Noncommutative harmonic analysis: unsolved but solvable problems*
Yurii NERETIN, Institute for Theoretical and Experimental Physics, Russia
- 10:30–11:20** *Lecture on Hilbert, Banach and Frechet manifolds*
Alice Barbara TUMPACH, Laboratoire Painlevé, France
- 11:20–11:50** Coffee break
- 11:50–12:40** *Extensions of symmetric operators and evolution equations on singular spaces*
Andrei SHAFAREVICH, Moscow State University, Russia
- 12:50–13:40** *Invitation to Hilbert C^* -modules and Morita–Rieffel equivalence*
Bartosz KWAŚNIEWSKI, Uniwersytet w Białymstoku, Poland

Wednesday, June 28

LECTURES 09:30–13:40

- 09:30–10:20** *Integral invariants (Poincaré–Cartan) and hydrodynamics*
Marián FECKO, Comenius University, Slovakia
- 10:30–11:20** *Extensions of symmetric operators and evolution equations on singular spaces*
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- 11:50–12:40** *Noncommutative harmonic analysis: unsolved but solvable problems*
Yurii NERETIN, Institute for Theoretical and Experimental Physics, Russia
- 12:50–13:40** *Lecture on Hilbert, Banach and Frechet manifolds*
Alice Barbara TUMPACH, Laboratoire Painlevé, France

Thursday, June 29

LECTURES 09:30–12:40

- 09:30–10:20** *Invitation to Hilbert C^* -modules and Morita–Rieffel equivalence*
Bartosz KWAŚNIEWSKI, Uniwersytet w Białymstoku, Poland
- 10:20–10:50** Coffee break
- 10:50–11:40** *Integral invariants (Poincaré–Cartan) and hydrodynamics*
Marián FECKO, Comenius University, Slovakia
- 11:50–12:40** *An introduction to noncommutative geometry*
Andrzej SITARZ, Jagiellonian University, Poland

Friday, June 30

LECTURES 09:30–13:40

- 09:30–10:20** *Integral invariants (Poincaré–Cartan) and hydrodynamics*
Marián FECKO, Comenius University, Slovakia
- 10:30–11:20** *An introduction to noncommutative geometry*
Andrzej SITARZ, Jagiellonian University, Poland
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