

# Summer school on $C^*$ -algebras and their interplay with dynamical systems

Nordfjordeid, Norway, 31 May – 4 June 2010

## Schedule of talks

	Monday	Tuesday	Wednesday	Thursday	Friday
09.00–10.45	Kaliszewski/Quigg	Sims	Kaliszewski/Quigg	Sims	Kaliszewski/Quigg
11.00–11.25	Cameron	Möller	Kasprzak	Capraro	Willis
11.35–12.00	Sato	Palma	Kasprzak	Robertson	Wright
14.00–15.45	Thom	Excursion	Thom	Thom	Sims
16.15–16.40	Patani	Excursion	Silvestrov	Yamashita	

## Detailed Schedule

### Sunday

20.30 Dinner

### Monday

**08.00** Breakfast

**09.00** Lecture: Kaliszewski/Quigg

**09.45** Break

**10.00** Lecture: Kaliszewski/Quigg

**10.45** Break

**11.00** Contributed talk: Jan Cameron, Vassar College

**11.25** Break

**11.35** Contributed talk: Yasuhiko Sato, Ritsumeikan University

**12.00** Break

**12.15** Lunch

**13.15** Coffee break

**14.00** Lecture: Thom

**14.45** Break

**15.00** Lecture: Thom

**15.45** Coffee Break

**16.15** Contributed talk: Nura Patani, Arizona State University

**16.40** Break

**18.00** Dinner

## **Tuesday**

**08.00** Breakfast

**09.00** Lecture: Sims

**09.45** Break

**10.00** Lecture: Sims

**10.45** Break

**11.00** Contributed talk: Sören Möller, University of Southern Denmark

**11.25** Break

**11.35** Contributed talk: Rui Palma, University of Oslo

**12.00** Break

**12.15** Lunch

**13.00** Excursion

**18.30** Dinner

## **Wednesday**

**08.00** Breakfast

**09.00** Lecture: Kaliszewski/Quigg

**09.45** Break

**10.00** Lecture: Kaliszewski/Quigg

**10.45** Break

**11.00** Contributed talk: Pawel Kasprzak, University of Copenhagen

**11.25** Break

**11.35** Contributed talk: Pawel Kasprzak, University of Copenhagen

**12.00** Break

**12.15** Lunch

**13.15** Coffee break

**13.15** Coffee break

**14.00** Lecture: Thom

**14.45** Break

**15.00** Lecture: Thom

**15.45** Coffee Break

**16.15** Contributed talk: Sergei Silvestrov, Lund University

**16.40** Break

**18.00** Dinner

## **Thursday**

**08.00** Breakfast

**09.00** Lecture: Sims

**09.45** Break

**10.00** Lecture: Sims

**10.45** Break

**11.00** Contributed talk: Valerio Capraro, University of Rome "Tor Vergata"

**11.25** Break

**11.35** Contributed talk: David Robertson, University of Southern Denmark

**12.00** Break

**12.15** Lunch

**13.15** Coffee break

**14.00** Lecture: Thom

**14.45** Break

**15.00** Lecture: Thom

**15.45** Coffee Break

**16.15** Contributed talk: Shinji Yamashita, Kyushu University

**16.40** Break

**18.00** Dinner

## **Friday**

**08.00** Breakfast

**09.00** Lecture: Kaliszewski/Quigg

**09.45** Break

**10.00** Lecture: Kaliszewski/Quigg

**10.45** Break

**11.00** Contributed talk: Paulette N. Willis, University of Iowa

**11.25** Break

**11.35** Contributed talk: Sarah Wright, Dartmouth College

**12.00** Break

**12.15** Lunch

**13.15** Coffee break

**14.00** Lecture: Sims

**14.45** Break

**15.00** Lecture: Sims

**15.45** Coffee Break

**18.00** Dinner

**Saturday**

**07.15** Breakfast

## Abstracts of contributed talks

### Jan Cameron, Vassar College

**Time:** Monday, 11.00–11.25.

**Title:** Mixing subalgebras of finite von Neumann algebras.

**Abstract:** It is well-known that generalizations of mixing properties of probability measure-preserving transformations can be defined in dynamical systems arising from the action of a countable, discrete group on a von Neumann algebra. Recently, Jolissaint and Stalder observed that the mixing properties of the action of a discrete abelian group on a von Neumann algebra  $M$  are encoded by certain analytical and algebraic properties of the associated crossed product von Neumann algebra. Using their definitions as a starting point, we introduce and study various mixing properties of inclusions  $N \subset M$  of finite von Neumann algebras. This perspective yields some applications to ergodic theory, for example, a new generalization of a result of Halmos on automorphisms of a compact group. We also present a characterization of mixing von Neumann subalgebras in terms of their normalizers, and a number of new examples of mixing phenomena in the operator algebra setting. This is ongoing joint work with Junsheng Fang (Texas A&M university) and Kunal Mukherjee (Institute of Mathematical Sciences, Chennai).

### Yasuhiko Sato, Ritsumeikan University

**Time:** Monday, 11.35–12.00.

**Title:** The shift automorphism of the Jiang-Su algebra.

**Abstract:** I will talk on the crossed product of the infinite tensor product of the Jiang-Su algebras by the two-sided shift automorphism, and show its absorption of the Jiang-Su algebra.

### Nura Patani, Arizona State University

**Time:** Monday, 16.15–16.40.

**Title:** Obstructions to a general characterization of graph correspondences.

**Abstract:** Let  $V$  be a locally compact Hausdorff space. When  $V$  is discrete, we have shown that every nondegenerate separable  $C^*$ -correspondence over  $c_0(V)$  is isomorphic to one coming from a directed graph with vertex set  $V$ . In this talk we demonstrate why the analogous characterizations for topological graphs and higher-rank graphs fail to hold and discuss the obstructions that arise, along with several interesting results.

**Sören Möller, University of Southern Denmark**

**Time:** Tuesday, 11.00–11.25.

**Title:** A law of large numbers for the free multiplicative convolution.

**Abstract:** In classical probability the law of large numbers for multiplicative convolution follows directly from the law for additive convolution. In free probability, this direct relationship is missing, so the multiplicative law requires a proof of its own. We provide such a proof by using the  $S$ -transform of probability measures on  $]0, \infty[$ .

**Rui Palma, University of Oslo**

**Time:** Tuesday, 11.35–12.00.

**Title:** Existence of Enveloping  $C^*$ -algebras of Hecke algebras.

**Abstract:** Just like for group algebras, the representation theory of Hecke algebras is related with the representation theory of groups. But unlike for group algebras,  $*$ -representations do not always correspond to unitary representations. This happens only when certain  $C^*$ -completions of the Hecke algebra coincide and an enveloping  $C^*$ -algebra exists. I will discuss sufficient condition for a  $*$ -algebra to have an enveloping  $C^*$ -algebra and explain how this general approach covers many well-known classes of ecke algebras and more general ones.

**Sergei Silvestrov, Lund University**

**Time:** Tuesday, 16.15–16.40.

**Title:** Freeness of actions, commutants and ideas in crossed products and their generalizations.

**Abstract:** In this talk I will present new developments connecting freeness, minimality and ergodicity properties of dynamical systems with relative commutants, maximal abelian sub-algebras and intersections of ideals in generalizations of crossed product  $C^*$ -algebras and  $W^*$ -algebras to non-invertible dynamics.

The talk will be mainly based on the recent joint works with Toke Meier Carlsen (Trondheim) and also partially on joint works with Johan Öinert (Lund), Christian Svensson (Lund), Marcel de Jeu (Leiden) and Jun Tomiyama (Tokyo).

**Pawel Kasprzak, University of Copenhagen**

**Time:** Wednesday, 11.00–12.00.

**Title:** Quantum Homogeneous Spaces

**Abstract:** The aim of this talk is to present the notion of a quantum homogeneous space. It will be shown to be an appropriate quantum counterpart of the classical notion of homogeneity. It also provides a unified framework for different classes of examples such as the quotient of a locally compact quantum group by its closed quantum subgroup due to S. Vaes, quantum homogeneous spaces of a compact quantum group studied by P. Podleś and the Rieffel deformation of  $G$ -homogeneous spaces. It is also shown that the quantum homogeneous spaces satisfy a minimality condition - a quantum counterpart of the density of all orbits.

**Valerio Capraro, University of Rome "Tor Vergata"**

**Time:** Thursday, 11.00–11.25.

**Title:** Product between ultrafilters and application to hyperlinear groups.

**Abstract:** Hyperlinear groups were introduced by Florin Radulescu in order to attack Connes' embedding conjecture. He proved that a countable i.c.c. group is hyperlinear if and only if its group von Neumann algebra verifies Connes' embedding property. We use the notion of product between ultrafilters (already known in model theory) in order to: simplify and generalize Radulescu's result (we are able to get rid of the hypothesis of countability); answer positively to Radulescu's question whether the free group on a continuous family of generators is hyperlinear; prove that limit (in the space of marked groups) of hyperlinear groups is still hyperlinear.

**David Robertson, University of Southern Denmark**

**Time:** Thursday, 11.35–12.00.

**Title:**  $C^*$ -algebras generated by  $C^*$ -correspondences and applications to non-commutative geometry.

**Abstract:**  $C^*$ -correspondences generalize the theory of Hilbert spaces by replacing the field of scalars with an arbitrary  $C^*$ -algebra. In the talk I will recall the definition of a  $C^*$ -correspondence and show how one can associate a  $C^*$ -algebra to it as a universal object. I will also state a result showing that this process is functorial and respects pull-backs, and briefly explain how the theory can be applied to the study of certain non-commutative spaces. This is joint work with Dr. Wojciech Szymanski.

**Shinji Yamashita, Kyushu University**

**Time:** Thursday, 16.15–16.40.

**Title:** Cuntz-Krieger Uniqueness Theorem on Topological Higher-rank Graph  $C^*$ -algebras.

**Abstract:** Cuntz-Krieger Uniqueness on topological (1-)graph is solved by Katsura, however higher-rank version is needed different techniques from the picture of product system  $C^*$ -algebras. I would like to explain on this point.

**Paulette N. Willis, University of Iowa**

**Time:** Friday, 11.00–11.25.

**Title:** Labeled Graph  $C^*$ -algebras with Group Actions.

**Abstract:** In this presentation, I will discuss joint work with Teresa Bates and David Pask concerning (discrete) group actions on labeled graphs and the resulting crossed product  $C^*$ -algebras. In particular, I will discuss a version of the Gross-Tucker Theorem for labeled graphs. A labeled graph  $(E, \mathcal{L})$  over an alphabet  $\mathcal{A}$  consists of a directed graph  $E$  together with a labeling map  $\mathcal{L} : E \rightarrow \mathcal{A}$ . One can associate a  $C^*$ -algebra to a labeled graph  $(E, \mathcal{L})$  in such a way that if the labeling  $\mathcal{L}$  is trivial then the resulting  $C^*$ -algebra is the  $C^*$ -algebra of the graph  $E$ . Further, just as there is a canonical correspondence between graph  $C^*$ -algebras and shifts of finite type, there is a similar correspondence between the  $C^*$ -algebras of labeled and sofic shifts.

**Sarah Wright, Dartmouth College**

**Time:** Friday, 11.35–12.00.

**Title:** Aperiodicity in Topological  $k$ -Graphs.

**Abstract:** The condition "every cycle has an entry" first appeared in the literature in Kumjian, Pask, and Raeburn's paper on Cuntz-Krieger algebras of directed graphs, where it was called Condition (L). It provides a necessary condition for simplicity of the associated graph algebra. This condition has been generalized to aperiodicity conditions in the theory of topological graphs (Katsura),  $k$ -graphs (Kumjian, Pask), and the unifying theory of topological  $k$ -graphs (Yeend). We'll discuss the details of these generalizations as well as the theorems associated with them. We'll then introduce a Condition (F) on the finite paths of a topological  $k$ -graph that is equivalent to the corresponding aperiodicity condition. Hence we obtain a condition which is much easier to check than the aperiodicity of infinite paths.

## List of participants

- Rui Palma (University of Oslo, Norway)
- Pawel Kasprzak (University of Copenhagen)
- Shinji Yamashita (Kyushu University, Japan)
- Tron Omland (NTNU, Norway)
- Martin Wanvik (NTNU, Norway)
- Siri-Malén Høyne (NTNU, Norway)
- Magnus Norling (NTNU, Norway)
- Sören Möller (University of Southern Denmark)
- David Robertson (University of Southern Denmark)
- Nura Patani (Arizona State University, USA)
- Andrew Hawkins (University of Nottingham, England)
- Valerio Capraro (University of Rome "Tor Vergata", Italy)
- Hannes Thiel (University of Copenhagen, Denmark)
- Marc Palm (Georg-August-Universität Göttingen, Germany)
- Yasuhiko Sato (Ritsumeikan University, Kyoto, Japan)
- Craig Kleski (University of Virginia, USA)
- Johan Richter (Lund University, Sweden)
- Sergei Silvestrov (Lund University, Sweden)
- Konrad Zimmermann (University of Leipzig, Germany)
- Adam Peder Wie Sørensen (University of Copenhagen, Denmark)
- Gunnar Restorff (University of Faroe Islands)
- Paulette N. Willis (University of Iowa, USA)
- Jan Cameron (Vassar College, USA)
- Toke Carlsen (NTNU, Norway)
- Magnus Landstad (NTNU, Norway)
- Nadia Larsen (University of Oslo, Norway)
- Simen Rustad (University of Oslo, Norway)
- Erik Bedos (University of Oslo, Norway)

- Sarah E. Wright (Dartmouth College, USA)
- Kostiantyn Iusenko (Chalmers Tekniska Högskola, Sweden)
- Aidan Sims (University of Wollongong, Australia)
- John Quigg (Arizona State University, USA)
- Steve Kaliszewski (Arizona State University, USA)
- Andreas Thom (Universität Leipzig, Germany)