【RIMS 合宿型セミナー】

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② 題　目：作用素環と数理物理学

(英文名：Operator Algebras and Mathematical Physics)

③実施期間： 平成 23 年 10 月 25 日～平成 23 年 10 月 28 日(4 日間)

④参加者数: 17名(内、外国人 5名)

⑤講 演 数： 15 コマ (内、英語で行なわれたもの 15 コマ)

⑥合宿型セミナーの概要 (開催目的、成果など)：

作用素環論と数理物理学は von Neumann の時代から多くの交流を持ち続けてきており，現在も場の量子論，統計力学などを通じて密接な関係がある．また，近年急速に発展している量子情報理論も作用素環論の立場から有益な知見が得られると期待される．
そこで今回は，非平衡量子統計力学および量子情報に重点を置き，さらにランダム行列なども交えた最近の進展について，各講演者に 3 回ずつの講演をお願いした．講演者，参加者の間で多くの有益な議論を行うことができた．
講演者は，京大数理研プロジェクト研究で客員准教授として滞在中であった Collins のほか，Bjelaković, Jakšić, Schlein, Seiringer と，世界的に著名なメンバーを集めることができた．

研究成果の公表方法

⑦ 講究録を □ 発行する ☑ 発行しない
※発行する場合: 原稿完成予定時期 平成 年 月 日頃

⑧ 講究録以外の方法で報告集を発行する場合：
タイトル:
出 版 社: 出版予定時期：平成 年 月 日頃

⑨ 専門誌等による場合：
主要な論文リスト (掲載予定、プレプリントを含む。準備中も可)

※２～３ページ目に合宿型セミナー実施プログラム添付 (Ａ４版)

Operator Algebras and Mathematical Physics

October 25 (Tue) - 28 (Fri), 2011

Kyoto, JapanKansai Seminar House

October 25

13:30-14:30 Robert Seiringer Bose Gases, Bose-Einstein Condensation, and the Bogoliubov Approximation

14:50-15:50 Vojkan Jakšić Liouviellans

16:10-17:10 Benjamin Schlein Spectral Properties of Wigner Matrices

October 26

9:30-10:30 Igor Bjelaković

10:50-11:50 Benoît Collins

13:30-14:30 Robert Seiringer Bose Gases, Bose-Einstein Condensation, and the Bogoliubov Approximation

14:50-15:50 Vojkan Jakšić Liouviellans

16:10-17:10 Benjamin Schlein Spectral Properties of Wigner Matrices

October 27

9:30-10:30 Igor Bjelaković

10:50-11:50 Benoît Collins

13:30-14:30 Robert Seiringer Bose Gases, Bose-Einstein Condensation, and the Bogoliubov Approximation

14:50-15:50 Vojkan Jakšić Liouviellans

16:10-17:10 Benjamin Schlein Spectral Properties of Wigner Matrices

October 28

9:30-10:30 Igor Bjelaković

10:50-11:50 Benoît Collins

Robert Seiringer

Title: Bose Gases, Bose-Einstein Condensation, and the Bogoliubov Approximation

Abstract: We present an overview of mathematical results on the low temperature properties of dilute Bose gases, which have been obtained in the past few years. The presentation includes results on the ground state energy in the thermodynamic limit, and on Bose-Einstein condensation and the excitation spectrum in trapped gases. In particular, the validity of the Bogoliubov approximation will be investigated. We shall give a description of the mathematics involved in understanding the various phenomena, starting from the underlying many-body Schroedinger equation.

Vojkan Jakšic

Title: Liouviellans

Abstract: In these lectures I will review the concept of Liouvillean (quantum transfer operator) and discuss its applications to equilibrium and non-equilibrium quantum statistical mechanics.

Benjamin Schlein

Title: Spectral Properties of Wigner Matrices

Abstract: The entries of Wigner random matrices are, up to symmetry constraints, independent and identically distributed random variables. In this mini-course, I am going to discuss recent results concerning the spectrum of N by N Wigner matrices in the limit of large N. In 1955, Wigner showed that, in this limit, the density of states of Wigner matrices converges to the famous semicircle law. In the first lecture, I plan to explain an extension of Wigner's original result to prove the semicircle law also on very small "microscopic" intervals. In the second lecture, I will present some of the consequences of the refined convergence to the semicircle law. In particular, I will show the complete delocalization of the eigenvectors of Wigner matrices (every component of any eigenvector is typically of the same size) and I will show the phenomenon of eigenvalue repulsion. In the last lecture, I will discuss the universality of the local eigenvalue statistics. Universality refers to the fact that, in the limit of large N, the (local) eigenvalue correlation functions depend on the symmetry of the ensemble but are otherwise independent of the choice of the probability law of the matrix entries.

Igor Bjelaković

Title: Quantum Communications under Channel Uncertainty

Abstract: In this series of talks we give an introduction to our recent work on quantum communication over unknown quantum channels. Starting from the quantum state merging (Horodecki, Oppenheim, and Winter 05), which is one among the fundamental protocols of Quantum Information Theory giving an operational explanation of the phenomenon of negative information we will derive optimal entanglement distillation rates and capacity results for quantum channels.

After explaining a universal merging result,not relying on the full knowledge of the quantum state being merged, we shall derive a multi letter formula for the entanglement transmission capacity for communication over partially known quantum channel.
This will lead us to capacity results for arbitrarily varying quantum channels which are obtained via a robustification technique.
This model describes the situation where the sender and the receiver try to generate entanglement via a quantum channel which is selected by an adversary and can vary in an arbitrarily and unknown manner from one channel use to the next.
This is a joint work with R. Ahlswede, H. Boche, G. Janssen, and J. Noetzel
References: arXiv:1106.2850, arXiv:1010.0418, arXiv:0811.4588

Benoît Collins
Title: Applications of Random Matrix Theory to Quantum Information Theory.
Abstract: in this series of lectures, I will explain how techniques in Random Matrix Theory can give a new insight into important problems in Quantum Information Theory. The important problems that we are interested in, are the quantification of entanglement of typical subspaces in a tensor product, and the problem of additivity for the minimum output entropies of quantum channels. The techniques from random matrix theory are Weingarten calculus and recently obtained norm estimates. These techniques fit well in the conceptual framework of free probability theory. I will first spend some time on the techniques, and then on the applications.