

ISSN 1881-6193

**RIMS Kôkyûroku Bessatsu B96**

# Recent developments in mathematics of integrable systems

edited by Hiroshi Miki

July, 2024

Research Institute for Mathematical Sciences  
Kyoto University

*RIMS Kôkyûroku Bessatsu B96*

*Recent developments in  
mathematics of integrable systems*

*September 4 ~6, 2023*

*edited by Hiroshi Miki*

*July, 2024*

*Research Institute for Mathematical Sciences*

*Kyoto University, Kyoto, Japan*

The papers presented in this volume of RIMS Kôkyûroku Bessatsu are in final form and refereed.  
©2024 by the Research Institute for Mathematical Sciences, an International Joint Usage/Research  
Center located in Kyoto University. All rights reserved. Printed in Japan.

## Preface

This volume is the proceedings of the workshop “Recent developments in mathematics of integrable systems” held from September 4 to September 6, 2023. This workshop was supported by the joint research program of the Research Institute for Mathematical Sciences (RIMS), an International Joint Usage/Research Center located in Kyoto University. The workshop was held in-person and online (Zoom) at Maskawa Hall.

The aim of the workshop was to connect researchers working on classical or quantum integrable systems with professions working on various mathematical objects such as applied mathematics, random matrices, quantum walks, etc. There were 13 lectures and 83 participants during the workshop. This volume collects 11 contributions from the speakers. All the papers have been refereed and are in their final forms.

The organizer would like to express his sincere gratitude to all participants, invited speakers, and RIMS staff for their kind cooperation and support. He also appreciates the helps of anonymous referees.

July, 2024  
Hiroshi Miki



## Program

### RIMS Workshop 2023

#### Recent developments in mathematics of integrable systems

2023 年度 RIMS 共同研究（公開型）

「可積分系数理における最近の展開」

#### September 4 (Mon)

13:40–14:30 井上 玲

クラスター変異と三次元可積分系

14:40–15:30 野邊 厚

Integrable discretization of the SIR model with vaccination

15:50–16:40 廣瀬 三平

振動積分の満たす微分方程式の WKB 解について

#### September 5 (Tue)

9:30–10:20 太田 泰弘

Rogue wave に関する最近の話題

10:30–11:20 長谷部 高広

Eigenvalues of the principal submatrix of a random matrix

11:40–12:30 瀬川 悦生

量子ウォークとグラフの閉曲面埋め込みについて

13:40–14:30 千葉 逸人

A generalized spectral theory of linear operators and its applications

14:40–15:30 鈴木 貴雄

$q$ -ガルニエ系の  $q$ -超幾何級数解と連続極限

15:50–16:40 竹縄 知之

梶原-野海-山田の楕円曲線表示を利用した Quispel-Roberts-Thompson 写像の解法

#### September 6 (Wed)

10:30–11:20 中園 信孝

CAC property を用いた高階のパネルヴェ型常差分方程式系の研究

11:30–12:20 北川 宗詢

分配束で記述される時間発展方程式について

13:40–14:30 西田 優樹

Max-plus 行列の固有値問題と固有値保存変形

14:40–15:30 岡本 和也

群衆における対向流の表現に向けた ASEP の拡張とその基本図について

## Contents

<b>Preface</b> .....	i
<b>Program</b> .....	ii
<b>Cluster mutation and 3D integrability</b> .....	1
井上 玲 (REI INOUE)	
<b>The Volterra lattice, Abel's equation of the first kind, and the SIR epidemic models</b> .....	11
ATSUSHI NOBE	
<b>A 型単純特異点と関係する振動積分の満たす微分方程式に対する完全 WKB 解析</b> <b>Exact WKB analysis of a differential system satisfied by an oscillatory integral related to a simple singularity of type <math>A</math></b> .....	35
廣瀬 三平 (SAMPEI HIROSE)	
<b>A recent topic on rogue wave</b> .....	55
YASUHIRO OHTA	
<b>The eigenvalues of the principal minor of a Hermitian random matrix</b> .	65
TAKAHIRO HASEBE	
<b>The generalized spectral theory and its application to the Kuramoto conjecture</b> .....	71
HAYATO CHIBA	
<b>A continuous limit of the <math>q</math>-Garnier system</b> .....	101
KAZUYA MATSUGASHITA AND TAKAO SUZUKI	
<b>Space of initial conditions for the four-dimensional Garnier system revisited</b> .....	117
TOMOYUKI TAKENAWA	
<b>On evolution equations described by distributive lattices</b> .....	131
SOUJUN KITAGAWA	
<b>Similarity and isospectral transformation of max-plus matrices</b> .....	149
YUKI NISHIDA, SENNOSUKE WATANABE AND YOSHIHIDE WATANABE	

群衆における対向流の表現に向けた ASEP の拡張とその基本図について

Extended ASEP to represent bidirectional pedestrian flow and its fundamental diagram ..... 169

岡本 和也 (KAZUYA OKAMOTO), 友枝 明保 (AKIYASU TOMOEDA)

## RIMS Kôkyûroku Bessatsu

- B 8 0 Regularity, singularity and long time behavior for  
partial differential equations with conservation law
- B 8 1 Study of the History of Mathematics 2019
- B 8 2 Regularity and Asymptotic Analysis for Critical Cases of  
Partial Differential Equations
- B 8 3 Algebraic Number Theory and Related Topics 2017
- B 8 4 Inter-universal Teichmüller Theory Summit 2016
- B 8 5 Study of the History of Mathematics 2020
- B 8 6 Algebraic Number Theory and Related Topics 2018
- B 8 7 Mathematical structures of integrable systems,  
its deepening and expansion
- B 8 8 Harmonic Analysis and Nonlinear Partial Differential Equations
- B 8 9 Study of the History of Mathematics 2021
- B 9 0 Theory and Applications of Supersingular Curves and  
Supersingular Abelian Varieties
- B 9 1 Various aspects of integrable systems
- B 9 2 Study of the History of Mathematics 2022
- B 9 3 Research on preserver problems on Banach algebras and related  
topics
- B 9 4 Mathematical structures of integrable systems,  
their developments and applications
- B 9 5 Harmonic Analysis and Nonlinear Partial Differential Equations

RIMS Kôkyûroku Bessatsu  
Vol. B96

---

---

2024年7月発行

発行所 京都大学数理解析研究所  
印刷所 明文舎印刷株式会社

---

---





Research Institute for Mathematical Sciences

Kyoto University

Kitashirakawa-oiwakecho, Sakyo-ku, Kyoto 606-8502, Japan Tel:+81-75-753-7256

<https://www.kurims.kyoto-u.ac.jp> E-mail [400kyodo@mail2.adm.kyoto-u.ac.jp](mailto:400kyodo@mail2.adm.kyoto-u.ac.jp)