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A. 研究概要

α -induction は, Q -system 付きの unitary modular tensor category から新しい fusion category を作る tensor functor である. 去年は, Q -system の局所性 (可換性) と, これによって生じる α -induced bi-unitary connection の flatness が同値であることを示したが, さらに Böckenhauer-Evans の意味での Q -system の可換部分と, α -induced bi-unitary connection の flat part が対応していることを今年度示した.

また有理的な 2 次元共形場理論に現れる coupling matrix が modular invariant であることと, その 2 次元共形場理論の表現論が自明であることとの同値性を示し, その物理的な意味を Haag 双対性の欠如, Rényi entropy の計算との関連で解明した.

α -induction is a tensor functor producing a new fusion category from a unitary modular tensor category and a Q -system in it. Last year, we proved equivalence of locality (commutativity) of the Q -system and flatness of the α -induced bi-unitary connection. We further showed correspondence between the local part of the Q -system in the sense of Böckenhauer-Evans and the flat parts of the α -induced bi-unitary connection in this year.

We also proved equivalence of modular invariance of the coupling matrix appearing in a rational 2-dimensional conformal field theory and triviality of its representation theory. We further clarified its physical meaning in connection to violation of the Haag duality and computations of the Rényi entropy.

B. 発表論文

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2. Y. Kawahigashi, Projector matrix product operators, anyons and higher relative com-

mutants of subfactors, *Math. Ann.* **387** (2023), 2157–2172.

3. Y. Kawahigashi, Two-dimensional topological order and operator algebras, *Internat. J. Modern Phys. B* **35** (2021), 2130003 (16 pages).
4. Y. Kawahigashi, A characterization of a finite-dimensional commuting square producing a subfactor of finite depth, *Internat. Math. Res. Notices.* **2023** (2023), 8419–8433.
5. Y. Kawahigashi, α -induction for bi-unitary connections, *Quantum Topol.* **15** (2024), 503–536.
6. D. E. Evans and Y. Kawahigashi, Subfactors and mathematical physics, *Bull. Amer. Math. Soc.* **60** (2023), 459–482.
7. V. Benedetti, H. Casini, Y. Kawahigashi, R. Longo, and J. M. Magan, Modular invariance as completeness, *Phys. Rev. D* **110** (2024), 125004.
8. Y. Kawahigashi, Flatness of α -induced bi-unitary connections and commutativity of Frobenius algebras, preprint arXiv:2408.05501

C. 口頭発表

1. Flatness for α -induced bi-unitary connections and locality of Frobenius algebras, Quantum Topology, Quantum Information, and Connections to Mathematical Physics, Texas A&M University (U.S.A.), May 2024.
2. Operator algebras, tensor categories and tensor networks, International Congress on Basic Science, Beijing Institute of Mathematical Sciences and Applications (China), July 2024.
3. Flatness of α -induced bi-unitary connections and commutativity of Frobenius algebras, Seminar at Simons Laufer Mathematical Sciences Institute (U.S.A.), July 2024.
4. Subfactors, tensor categories and tensor

networks, China-Japan-Korea Conference on Functional Analysis, Harbin (China), August 2024.

5. Quantum $6j$ -symbols and α -induction, Conference on Recent Developments in Topological Quantum Field Theory, Beijing Institute of Mathematical Sciences and Applications (China), September 2024.
6. Quantum $6j$ -symbols, tensor categories and operator algebras, Operator Algebras in High Energy Physics, NORDITA (Sweden), October 2024.
7. Operator algebras and conformal field theory, Seminar at Perimeter Institute (Canada), November 2024.
8. Operator algebras, tensor networks and quantum $6j$ -symbols, Mathematical Aspects of Quantum Theory 2025, Beijing Institute of Mathematical Sciences and Applications (China), January 2025.
9. Topological physics and operator algebras, East Asian Core Doctoral Forum on Mathematics, Tsinghua University (China), January 2025.
10. Modular invariance in conformal field theory, 100 Years of Matrix Mechanics, Tsinghua Sanya International Mathematics Forum (China), January 2025.

D. 講義

1. 数理科学の研究フロンティア：宇宙，物質，生命，情報：理研の若手研究者によるオムニバス講義のコーディネート．（教養学部 1,2 年生講義）

E. 修士・博士論文

1. (博士) 向原 未帆 (MUKOHARA Miho): On a Galois correspondence for compact group actions on simple C^* -algebras
2. (修士) CHOI Ikhan: Positive Hahn-Banach separation theorems in operator algebras
3. (修士) 佐藤 ふたば (SATO Futaba): Haar semigroups on quantum automorphism groups of finite dimensional C^* -algebras
4. (修士) 鈴木 裕介 (SUZUKI Yusuke): On

Cuntz's picture of equivariant KK theory

F. 対外研究サービス

1. *Communications in Mathematical Physics* の editor.
2. *International Journal of Mathematics* の chief editor.
3. *Japanese Journal of Mathematics* の managing editor.
4. *Journal of Mathematical Physics* の associate editor.
5. *Journal of Mathematical Sciences, the University of Tokyo* の editor-in-chief.
6. *Journal of Topology and Analysis* の editor.
7. *Letters in Mathematical Physics* の editor.
8. *Mathematics Open* の editor.
9. *Reviews in Mathematical Physics* の associate editor.
10. *Taiwan Journal of Mathematics* の editor.
11. *Mathematical Physics Studies* (Springer) の editor.
12. China-Japan-Korea Conference on Functional Analysis (Harbin Institute of Technology, China, August 12–16, 2024) のオーガナイザー
13. East Asian Core Doctoral Forum on Mathematics (Tsinghua University, China, January 8–10, 2025) のオーガナイザー