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A. 研究概要

Jones の部分因子環論において，深さ有限の部分因子環を生み出す bi-unitary connection は，Bultinck-Mariëna-Williamson-Şahinoğlu-Haegeman-Verstraete らの 2 次元トポロジカル秩序に関する最近の論文における 4-tensor を与える．彼らは projector matrix product operator と呼ばれる射影作用素を考えた．我々は長さ k のこの射影作用素の値域が，bi-unitary connection の生み出す部分因子環の k 次の higher relative commutant に一致することを示した．これは 2 次元トポロジカル秩序と部分因子環の関係をさらに深めるものである．

A bi-unitary connection in subfactor theory of Jones producing a subfactor of finite depth gives a 4-tensor appearing in a recent work of Bultinck-Mariëna-Williamson-Şahinoğlu-Haegemana-Verstraete on 2-dimensional topological order and anyons. In their work, they have a special projection called a projector matrix product operator. We prove that the range of this projection of length k is naturally identified with the kth higher relative commutant of the subfactor arising from the bi-unitary connection. This gives a further connection between 2-dimensional topological order and subfactor theory.

B. 発表論文

1. M. Bischoff, Y. Kawahigashi, R. Longo, K.-H. Rehren, "Phase boundaries in algebraic conformal QFT", Commun. Math. Phys. **342** (2016), 1–45.

2. Y. Kawahigashi, "A relative tensor product of subfactors over a modular tensor category", Lett. Math. Phys. **107** (2017), 1963-1970.

3. S. Carpi, Y. Kawahigashi, R. Longo, M. Weiner, "From vertex operator algebras to conformal nets and back", Mem. Amer. Math. Soc. **254** (2018), no. 1213, vi+85 pp.

4. Y. Kawahigashi, "Conformal field theory, vertex operator algebras and operator algebras", Proceedings of the International Congress of Mathematicians, Vol. III, 2597–2616, World Scientific, Rio de Janeiro, 2018.

5. Y. Kawahigashi, The relative Drinfeld commutant of a fusion category and α-induction, Internat. Math. Res. Notices. **2019** (2019), 6304–6316.

6. Y. Kawahigashi, A remark on matrix product operator algebras, anyons and subfactors, Lett. Math. Phys. **110** (2020), 1113–1122.

7. Y. Kawahigashi, Projector matrix product operators, anyons and higher relative commutants of subfactors, arXiv:2102.04562.

8. Y. Kawahigashi, Two-dimensional topological order and operator algebras arXiv:2102.10953.

C. 口頭発表

1. Matrix product operator algebras, anyons and subfactors, "C^*-algebras", Oberwolfach (Germany), August 2019.

2. Matrix product operator algebras, anyons and subfactors, Functional Analysis Seminar, UCLA (U.S.A.), October 2019.

3. Matrix product operator algebras, anyons and subfactors, Operator algebra seminar, Fields Institute (Canada), November 2019.

4. Mathematics of topological quantum computing and operator algebras, "Indo-Japan Joint Workshop on Quantum Computing and Quantum Information", Indian Statistical Institute, Kolkata (India), January 2020.

5. Topological phases of matter, tensor categories and operator algebras, "Noncommutative Geometry and its Applications", National Institute of Science, Education and Research (India), January 2020.

6. Topological phases of matter and operator algebras, (Five lectures), Università di Roma "Tor Vergata" (Italy), February 2020.

7. Topological order, tensor networks and subfactors, "Topological Orders and Higher Structures", Erwin Schrödinger Institute, Vienna (Austria) [Online], August 2020.

8. Topological order, tensor networks and subfactors, Mathematical Picture Language Project Seminar, Harvard University (U.S.A.) [Online], December 2020.

9. Topological order, operator algebras and topological quantum field theory, Category seminar, Universidad Nacional Autónoma de México (Mexico) [Online], December 2020.

10. Topological order, tensor networks and operator algebras, "Quantum Math, Singularities and Applications", Okinawa Institute of Science and Technology (Japan) [Online], February 2021.

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)

2. 解析学 XD・スペクトル理論：自己共役作用素のスペクトル分解．(数理大学院・4 年生共通講義)

E. 修士・博士論文

1. (修士) 及川瑞稀 (OIKAWA Mizuki): Nonunitarity of a free fermion Segal conformal field theory

2. (修士) 北村侃 (KITAMURA Kan): On induction along a homomorphism of compact quantum groups

3. (修士) 朱浩哲 (ZHU Haozhe): Ultrapower algebras and central sequence subfactors

4. (博士) 森迪也 (MORI Michiya): On the geometry of projections of von Neumann algebras

F. 対外研究サービス

1. *Communications in Mathematical Physics* の editor.

2. *International Journal of Mathematics* の 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. *Reviews in Mathematical Physics* の associate editor.

7. Mathematical Physics Studies (Springer) の editor.

8. サマースクール数理物理「指数定理の数理」(東京大学大学院数理科学研究科，オンライン，2020 年 8 月 28–30 日) のオーガナイザー．

9. Theoretical studies of topological phases of matter (京都大学基礎物理学研究所, ハイブリッド，2020 年 12 月 17–18 日) のオーガナイザー．

10. Quantum math, singularities and applications (沖縄科学技術大学院大学，オンライン，2021 年 2 月 8–12 日) のオーガナイザー．

11. 「物質のトポロジカル相の理論的探究」(東京大学大学院数理科学研究科，オンライン，2021 年 2 月 15–17 日) のオーガナイザー．