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A. 研究概要

完全有理的な局所共形ネット2つからできるフル共形場理論のカップリング行列について, モジュラー不変性が成り立つのはフル共形場理論の表現論が自明な時であり, またその時に限ることが知られている. 一方2つの局所共形ネットが同じ場合, モジュラー不変行列を二つかけてもモジュラー不変性が保たれることは自明であり, その分解規則はモジュラー不変行列のフュージョンルールとして知られている. これについては, Evans-Pinto, Fuchs-Runkel-Schweigert の研究があり, フル共形場理論と, カイラル共形場理論の局所的とは限らない延長の関係に基づき, Q -system の braided product としての解釈が知られている. この「テンソル積」とその直和分解の構成を, 二つの局所共形ネットが同じとは限らない場合に一般化した. また物質のトポロジカル相の文脈では, これは gapped domain wall の合成にあたるものとなっている.

For a full conformal field theory arising from two completely rational conformal nets, its coupling matrix has modular invariant if and only if the full conformal field theory has a trivial representation theory. When the two conformal nets coincide, a product of two modular invariants clearly satisfies the modular invariance property, and its decomposition rules are known under the name of fusion rules of modular invariants. Due to works of Evans-Pinto and Fuchs-Runkel-Schweigert, its interpretation as a braided product of Q -systems is known based on a relation between a full conformal field theory and a not necessarily local extension of a chiral conformal field theory. We have generalized this “tensor product” and its decomposition to the case where the two conformal nets are different. In the context of topological phase, this gives a composition of two gapped domain walls.

B. 発表論文

1. S. Carpi, R. Hillier, Y. Kawahigashi, R. Longo, F. Xu: “ $N = 2$ superconformal nets”, *Commun. Math. Phys.* **336** (2015),

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2. Y. Kawahigashi, N. Suthichitranont: “Construction of holomorphic local conformal framed nets”, *Internat. Math. Res. Notices.* **2014** (2014), 2924–2943.
3. Y. Kawahigashi, Y. Ogata, E. Størmer: “Normal states of type III factors”, *Pac. J. Math.* **267** (2014), 131–139.
4. M. Bischoff, Y. Kawahigashi, R. Longo, K.-H. Rehren, “Phase boundaries in algebraic conformal QFT”, *Commun. Math. Phys.* **342** (2016), 1–45.
5. M. Bischoff, Y. Kawahigashi, R. Longo, K.-H. Rehren, “Tensor categories and endomorphisms of von Neumann algebras (with applications to Quantum Field Theory)”, *SpringerBriefs in Mathematical Physics Vol. 3*, 2015.
6. M. Bischoff, Y. Kawahigashi, R. Longo, “Characterization of 2D rational local conformal nets and its boundary conditions: the maximal case”, *Doc. Math.* **20** (2015), 1137–1184.
7. S. Carpi, Y. Kawahigashi, R. Longo, M. Weiner, “From vertex operator algebras to conformal nets and back”, to appear in *Mem. Amer. Math. Soc.*
8. Y. Kawahigashi, “Conformal field theory, tensor categories and operator algebras”, *J. Phys. A* **48** (2015), 303001 (57 pages).
9. Y. Kawahigashi, “A remark on gapped domain walls between topological phases”, *Lett. Math. Phys.* **105** (2015), 893–899.
10. Y. Kawahigashi, “A relative tensor product of subfactors over a modular tensor category”, arXiv:1612.03549.

C. 口頭発表

1. From vertex operator algebras to local conformal nets and back, Station Q seminar, Microsoft Research Station Q (U.S.A.), March 2016.

2. Subfactors and gapped domain walls between topological phases, Noncommutative Geometry and Operator Algebras Spring Institute 2016, Universität Bonn (Germany), May 2016.
3. A relative tensor product of subfactors over a modular tensor category, Operator Algebras and Quantum Field Theory, Istituto Nazionale di Fisica Nucleare, Frascati (Italy), June 2016.
4. Relative tensor products of heterotic full conformal field theories, Recent Mathematical Developments in Quantum Field Theory, Oberwolfach (Germany), July 2016.
5. Subfactors, conformal field theory and modular tensor categories, Modular Categories—Their Representations, Classification, and Applications, Casa Matemática Oaxaca (Mexico), August 2016.
6. Conformal field theory and operator algebras, Statistics, Quantum Information and Gravity, IPMU (Japan), September 2016.
7. Gapped domain walls between topological phases and subfactors, Mathematical Physics Seminar, Harvard University (U.S.A.), October 2016.
8. Topological phases and subfactors, Subfactors and Mathematical Physics, Tsinghua Sanya International Mathematics Forum (China), December 2016.
9. Subfactors, tensor categories and conformal field theory (4 lectures), Primer on subfactors and applications, Isaac Newton Institute for Mathematical Sciences (U.K.), January 2017.
10. Relative tensor products of full conformal field theories, Seminar, Cardiff University (U.K.), January 2017.

D. 講義

1. 解析学 IV: Lebesgue 積分論の入門講義 . (数学科 3 年生講義)
2. 解析学特別演習 I: Lebesgue 積分論の演習 . (数学科 3 年生演習)

E. 修士・博士論文

1. (博士) 荒野 悠輝 (ARANO Yuki) : Representation Theory of Drinfeld Doubles
2. (博士) OTANI Yul: Entanglement Entropy in Algebraic Quantum Field Theory
3. (博士) 窪田 陽介 (KUBOTA Yosuke) : A Categorical Approach for Freeness of Group Actions on C^* -algebras
4. (博士) 増本 周平 (MASUMOTO Shuhei) : Applications of Fraïssé Theory to Operator Algebras
5. (修士) 下條 絵利加 (SHIMOJO Erika) : Rohlin Flows on Irrational Rotation C^* -algebras
6. (修士) 野島 遼 (NOJIMA Ryo) : Structure of Hypergroups Associated with Holomorphic Framed Nets

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. 日本数学会「第 17 回高木レクチャー」(京都大学, 2016 年 6 月 18 日) のオーガナイザー .

9. MSJ-SI “Operator Algebras and Mathematical Physics” (東北大学, 2016 年 8 月 1–12 日) のオーガナイザー .
10. サマースクール数理物理「ミラーシンメトリーの数理と物理」(東京大学大学院数理科学研究科, 2016 年 8 月 26–29 日) のオーガナイザー .
11. 日本数学会「第 18 回高木レクチャー」(東京大学, 2016 年 11 月 5, 6 日) のオーガナイザー .
12. Berkeley-Tokyo Autumn School — Quantum Field Theory and Subfactors (UC Berkeley, U.S.A., 2016 年 11 月 14–23 日) のオーガナイザー .
13. East Asian Core Doctorial Forum on Mathematics (Seoul National University, Korea, 2017 年 1 月 6–10 日) のオーガナイザー .
14. Operator Algebras: Subfactors and their Applications (Isaac Newton Institute for Mathematical Sciences, U.K., 2017 年 1–6 月) の scientific advisory committee のメンバー .