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A. 研究概要

頂点作用素代数と(作用素環の)局所共形ネットはカイラル共形場理論を数学的に扱うための二つの枠組みであり, 両者の間に様々な類似性はあるものの, これまで直接的な関係は見つかっていなかった. Carpi, Longo, Weiner と共に, 強局所性という条件を付ければ頂点作用素代数から局所共形ネットを構成することができ, この局所共形ネットから元の頂点作用素代数が復元できることを示した. さらに共局所性が成り立つための簡単な十分条件も示した. これは十数年来の懸案を解決するものである. さらに頂点作用素代数としての自己同型群と局所共形ネットとしての自己同型群が同じであることも示した. この結果は, (すでに分かっていた) ムーンシャイン頂点作用素代数を含め多くの例に適用できる.

物質のトポロジカル相の間の gapped domain wall というものが物性物理で研究されているが, その数学的定義を与え, 2015 年の Lan, Wang, Wen の予想は正しくないことを示した.

Vertex operator algebras and local conformal nets (of operator algebras) are two mathematical frameworks to study chiral conformal field theory. Many analogies between the two have been known, but no direct relations were known so far. With Carpi, Longo and Weiner, we have proved that we can construct a local conformal net from a strongly local vertex operator algebra and we can also recover the original vertex operator algebra from this resulting local conformal net. We have further given a simple sufficient condition for strong locality. This gives a solution to an important problem studied over more than ten years. We have also shown that the automorphism group of a vertex operator algebra and that of the corresponding local conformal net coincide. This result applies to many examples including the Moonshine vertex operator algebra. (The case of the Moonshine vertex operator algebra was known before.)

Gapped domain walls between topological phases of matters have been studied in con-

densed matter physics. We have given their mathematical definition and proved that a conjecture of Lan, Wang and Wen in 2015 is not true.

B. 発表論文

1. S. Carpi, Y. Kawahigashi and R. Longo: “How to add a boundary condition”, *Commun. Math. Phys.* **322** (2013), 149–166.
2. S. Carpi, R. Hillier, Y. Kawahigashi, R. Longo, F. Xu: “ $N = 2$ superconformal nets”, *Commun. Math. Phys.* **336** (2015), 1285–1328.
3. Y. Kawahigashi, N. Suthichitranont: “Construction of holomorphic local conformal framed nets”, *Internat. Math. Res. Notices.* **2014** (2014), 2924–2943.
4. Y. Kawahigashi, Y. Ogata, E. Størmer: “Normal states of type III factors”, *Pac. J. Math.* **267** (2014), 131–139.
5. M. Bischoff, Y. Kawahigashi, R. Longo, K.-H. Rehren, “Phase boundaries in algebraic conformal QFT”, *Commun. Math. Phys.* **342** (2016), 1–45.
6. 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.
7. 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.
8. S. Carpi, Y. Kawahigashi, R. Longo, M. Weiner, “From vertex operator algebras to conformal nets and back”, to appear in *Mem. Amer. Math. Soc.*
9. Y. Kawahigashi, “Conformal field theory, tensor categories and operator algebras”, *J. Phys. A* **48** (2015), 303001 (57 pages).

10. Y. Kawahigashi, “A remark on gapped domain walls between topological phases”, *Lett. Math. Phys.* **105** (2015), 893–899.

C. 口頭発表

1. From vertex operator algebras to operator algebras, Probabilistic Operator Algebra Seminar, UC Berkeley (U.S.A.), February 2015.
2. Phase boundaries in conformal field theory and subfactors, Seminar, II Università di Roma (Italy), March 2015.
3. From vertex operator algebras to local conformal nets and back, Seminare über Quantenfeldtheorie, Universität Göttingen (Germany), March 2015.
4. From vertex operator algebras to local conformal nets and back, International Conference on Subfactor Theory in Mathematics and Physics, Qinhuangdao (China), July 2015.
5. From vertex operator algebras to operator algebras and back, Calabi-Yau Varieties: Arithmetic, Geometry and Physics, Tsuda College (Japan), August 2015.
6. From vertex operator algebras to operator algebras and back, Lie Algebras, Vertex Operator Algebras, and Related Topics, University of Notre Dame (U.S.A.), August 2015.
7. A remark on gapped domain walls between topological phases, Seminar, II Università di Roma (Italy), September 2015.
8. Moonshine, conformal field theory and operator algebras, Colloquium, the University of Iowa (U.S.A.), November 2015.
9. From vertex operator algebras to operator algebras and back, Functional Analysis Seminar, UCLA (U.S.A.), November 2015.
10. Moonshine, conformal field theory and operator algebras, TQFT seminar, University of Lisbon (Portugal), February 2016.

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. (数学化 3 年生演習)

E. 修士・博士論文

1. (博士) 寫田 洸一 (SHIMADA Koichi) : Actions of locally compact abelian groups on factors with the Rohlin property
2. (博士) 鈴木 悠平 (SUZUKI Yuhei) : Constructions of amenable dynamical systems and its applications to nuclearity of C^* -algebras
3. (博士) 武石 拓也 (TAKEISHI Takuya) : Primitive ideals of Bost-Connes systems
4. (修士) ALEXIOU Carolina: Cyclic vectors as maximally entangled pure states
5. (修士) 早瀬友裕 (HAYASE Tomohiro) : De Finetti theorems for a Boolean analogue of easy quantum groups
6. (修士) 東瀬智明 (TOSE Tomoaki) : Real rank of trivial $C(X)$ -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. 日本数学会「第 15 回高木レクチャー」(東北大学, 2015 年 6 月 27, 28 日) のオーガナイザー.
9. サマースクール数理物理「ホログラフィー原理と量子エンタングルメント」(東京大学大学院数理科学研究科, 2015 年 8 月 28–30 日) のオーガナイザー.
10. 日本数学会「第 16 回高木レクチャー」(東京大学, 2015 年 11 月 28, 29 日) のオーガナイザー.
11. International Conference on Non-commutative Geometry and K-Theory (Chongqing, China, 2015 年 12 月 18–21 日) のオーガナイザー.
12. East Asian Core Doctorial Forum on Mathematics (Fudan University, China, 2016 年 1 月 8–12 日) のオーガナイザー.