小林俊行 (KOBAYASHI Toshiyuki)

A. 研究概要

1.**D 型極小表現の幾何・解析的研究**
極小表現は、ユニタリ表現の中で根源的な対象であると考えられ、90 年代より多くの代数的研究がなされている (古典的な Weil 表現は C 型単純群の極小表現である)。同じ対象を解析的に捉えて新しいモデルを構成することを目指し、[1] では D 型極小表現の共形幾何による新構成を行い、超双曲型微分方程式の解の共形保存量を具体的に構成してユニタリ化の別証明を与え、加えて、Schrödinger モデルの存在を証明した。さらに錐上の L^2 解析において “フーリエ変換”に相当する基本的な作用素であるユニタリ反転変換を群論的に定義し、その形を決定した [4,6,10]。

2. **可視的作用と無重複表現**
複素多様体における**可視的な作用**という概念と**無重複性の伝播**という視点を導入し，無限次元の場合および（組合せ論が絡む）有限次元の場合を同時に含む，無重複表現の統一的な理論をめざしている。論文 [5,8] は可視的作用の分類,[7] は表現論への応用である。

3. **不連続群**
私の長年のモチーフである非リーマン空間における不連続群の研究を続けた。特に、変形中に不連続性が破れる様子を調べるために、**局所剛性**の概念に加えて、**安定性**の概念を導入した (IJM2006 及び preprint)。また、不定符号の空間形の接対称空間における余コンパクトな不連続群が存在するための必要十分条件を決定した [3].

4. **実解析**
Riesz 変換のように対称性の高いマルティプライヤー作用素を全て捕捉する代数的枠組みを与え、その L^p 有界性を研究した [9]。

1.**Analysis on minimal representations**
Minimal representations are building blocks of unitary representations. Classic examples are the Weil representation, and intensive algebraic studies have been made since 1990s by many people. Aiming for yet another *geometric approach* to minimal representations, in particular of type D, we applied conformal techniques, got a new construction of minimal representations, found conserved quantities for ultra-hyperbolic equations that led us to their unitarizability, and also proved the existence of a *Schrödinger model* (L^2-model) with B.Ørsted [1]. With G. Mano [4,6,10], we determined an explicit form of the *unitary inversion operator* on the L^2-model on the isotropic cones, that generalizes the Euclidean Fourier transform.

2. **Multiplicity-free representations**
I made in [7] systematic and synthetic applications of the original theory of *visible actions* on complex manifolds to multiplicity-free theorems, in particular, branching problems to symmetirc pairs. Papers [5,8] are on visible actions.

3. **Discontinuous groups** Developing my conituing motif on discontinuous groups for non-Riemannian homogeneous spaces, I introduced the notion of *stability* for the study of *local deformation/rigidity* of discontinuous groups [IJM2006], and determined when the tangential space forms of general signature admits compact forms by means of the Radon-Hurwicz number with Yoshino [3].

4. **Real analysis - L^p multipliers**
Inspired by the idea of prehomogeneous spaces, we studied multipliers with high symmetries with Nilsson [9].

B. 発表論文

1. T. Kobayashi and B. Ørsted: “Analysis on the minimal representations of $O(p,q)$, I.—Realization and conformal geometry”, Adv. Math. **180** (2003), 486–512; “II.—Branching laws”, Adv. Math. **180** (2003), 513–550; “III.—Ultra-hyperbolic equations on $\mathbb{R}^{p-1,q-1}$”, Adv. Math. **180** (2003), 551–595.

2. 小林俊行, 大島利雄, 『リー群と表現論』, 岩波書店, 2005, 610 pp. ISBN 978-4000061429.

3. T. Kobayashi and T. Yoshino, “Compact Clifford–Klein forms of symmetric spaces—revisited”, Pure and Appl. Math. Quarterly **1** (2005), 603–684 (Borel 教授追悼号).

4. T. Kobayashi and G. Mano, “The inversion formula and holomorphic extension of the minimal representation of the conformal group”, Harmonic Analysis, Group

Representations, Automorphic Forms and Invariant Theory (Howe 教授 60 歳記念号), 2007, pp. 159–223. ISBN 978-9812770783.

5. T. Kobayashi, "A generalized Cartan decomposition for the double coset space $(U(n_1) \times U(n_2) \times U(n_3))\backslash U(n)/(U(p) \times U(q))$", Jour. Math. Soc. Japan **59** (2007), 669–691.

6. T. Kobayashi and G. Mano, "Integral formula of the unitary inversion operator for the minimal representation of $O(p,q)$", Proc. Japan Acad. Ser. A **83** (2007), 27–31.

7. T. Kobayashi, "Multiplicity-free theorems of the restrictions of unitary highest weight modules with respect to reductive symmetric pairs", Representation Theory and Automorphic Forms, Progr. Math., vol. 255, Birkhäuser, 2007, pp. 45–109. ISBN 978-0817645052.

8. T. Kobayashi, "Visible actions on symmetric spaces", Transformation Groups **12** (2007), 671–694.

9. T. Kobayashi and A. Nilsson, "Group invariance and L^p-bounded operators", Math. Z., 2007. 29 pp. (published online first, on 22 November 2007).

10. T. Kobayashi and G. Mano, "The Schrödinger model for the minimal representation of the indefinite orthogonal group $O(p,q)$", preprint. 167 pp. arXiv:0712.1769v1 [math.RT].

C. 口頭発表

1. Visible Actions on Complex Manifolds and Multiplicity One Theorems (opening lecture), Finite and Infinite Dimensional Complex Geometry and Representation Theory, Oberwolfach, Germany, February 2004; (invited address) The Asian Mathematical Conference (AMC2005), Singapore, July 2005.

2. Restriction of Unitary Representations—Discrete and continuous spectrum (plenary address), Sixth Pan-African Congress of Mathematicians (PACOM2004), Institut National des Sciences Appliquées et de la Technologie (INSAT), Tunis, Tunisia, September 2004.

3. Analysis on Homogeneous Spaces Revisited—From Viewpoint of Branching Laws of Unitary Representations, Harmonic Analysis on Lie Groups and Symmetric Spaces (Faraut 教授退官記念研究集会), Joint meeting of Seminar Sophus Lie, Nancy, France, June 2005.

4. Restrictions of Unitary Representations of Real Reductive Groups, International Conference on Representations of Real Reductive Groups (Parthasarathy 教授 60 歳記念研究集会), Mumbai, India, January 2006.

5. Multiplicity-free Representations and Visible Actions on Complex Manifolds (opening lecture), International Conference on Harmonic Analysis, Group Representations, Automorphic Forms and Invariant Theory (Howe 教授 60 歳記念研究集会), Singapore, January 2006.

6. Branching Problems of Unitary Representations , Sackler Distinguished Lectures in Pure Mathematics, Tel Aviv University, Israel, May 2007.

7. Existence Problem of Compact Locally Symmetric Spaces, Journées Solstice d'été 2007: Theorie de Lie, Geometrie et Representations, Institut de Mathématiques de Jussieu, Paris, France, June 2007.

8. Multiplicities in the Decomposition of Unitary Representations of Reductive Lie Groups (opening lecture), Lie Groups, Algebraic Groups and Transformation Groups (Vinberg 教授 70 歳記念研究集会), Universität Bielefeld, Germany, July 2007.

9. On Locally Symmetric Spaces (closing lecture), Representation Theory, Complex

Analysis and Integral Geometry, Max-Planck-Institut für Mathematik, Bonn, Germany, July 2007.

10. Branchings to Symmetric Pairs and Analysis on Symmetric Spaces, International Conference on Integral Geometry, Harmonic Analysis and Representation Theory (Helgason 教授 80 歳記念研究集会), Reykjavik, Iceland, August 2007.

D. 講義

1. 現代数学入門, 数理科学 IV : 高校で習う数学と現代数学との差を埋めるためのいくつかの重要な基礎概念, 近似, さまざまな評価式, 情報量, 初等整数論, 暗号論の変遷と数学. (教養学部前期課程講義)
2. 対称性の数学, 数学の現在・過去・未来 (数理・情報一般) : 文様の分類, 不連続群, 離散的な対称性と連続的な対称性. (教養学部前期課程講義, organized by 坪井俊教授) 2007 年 11 月 12, 19 日
3. Mathematics 275: Multiplicity-Free Representations: Complex Geometric Methods in Representation Theory: 複素多様体における可視的作用の概念と無重複表現の理論. (ハーバード大学, 37 回, 大学院学生, 専門家向け)

E. 修士・博士論文

1. (課程博士) 手塚勝貴 (TEDUKA Katsuki): Proper action of $SL(2,\mathbb{R})$ on irreducible complex symmetric spaces.
2. (課程博士, 早稲田大学) 笹木集夢 (SASAKI Atsumu): Visible actions on multiplicity-free spaces.
3. (課程博士, 広島大学) 森脇政泰 (MORIWAKI Masayasu): Multiplicity-free decompositions of the minimal representation of the indefinite orthogonal group.

F. 対外研究サービス

1. Managing Editor, Japanese Journal of Mathematics (日本数学会) (2005–)
2. Editor, Geometriae Dedicata (Springer) (2000–)
3. Editor, International Mathematics Research Notices (Oxford 大学出版) (2002–)
4. Editor, International Journal of Mathematics (World Scientific) (2004–)
5. Editor, International Mathematics Research Papers (Oxford 大学出版) (2005–)
6. Editor, Journal of Mathematical Sciences, The University of Tokyo (2007–)
7. Editor, Advances in Pure and Applied Mathematics (Heldermann Verlag) (2008–)
8. Editor in Chief, Journal of Mathematical Society of Japan (日本数学会) (2002–2004; 2004–2006), Editor (1998–2006)
9. Editor, Publications RIMS (2003–2007)
10. 日本学術会議連携会員 (2006–)
11. 日本数学会評議員 (2003–2005; 2005–2007)
12. 日本数学会理事 (2003–2005; 2005–2007)
13. 京都大学数理解析研究所専門委員 (2007–)
14. Jury, Habilitation, Reims University, France (2006)
15. オーガナイザー, Symposium on Representation Theory, 淡路島, 2004 年 11 月 16–19 日 (with H. Ochiai and H. Tagawa)
16. オーガナイザー, International Symposium on Representation Theory and Automorphic Forms, Seoul National University, Korea, 14–17 February 2005 (with W. Schmid and J.-H. Yang)
17. オーガナイザー, 高木レクチャー, 第 1 回 (京都大学数理研, 2006 年 11 月), 第 2 回 (東京大学, 2007 年 5 月), 第 3 回 (東京大学, 2007 年 11 月)
18. オーガナイザー, リー群論・表現論セミナー (1987–2001 東大; 2003–2007 RIMS; 2007– 東大)

19. オーガナイザー, Harmonische Analysis und Darstellungstheorie Topologischer Gruppen, Oberwolfach, Germany, 14–20 October 2007

20. Scientific Committee, Hermitian Symmetric Spaces, Jordan Algebras and Related Problems (conference in honor of Prof. Jean-Louis Clerc), Centre International de Recherches Mathématiques, Luminy, France, 23–27 June, 2008

G. 受賞

1. 大阪科学賞 (2006)「リーマン幾何の枠組を超えた不連続群論の創始とリー群の無限次元表現における離散的分岐則の発見」

2. 日本学術振興会賞 (2007)「代数・幾何・解析にまたがるリー群の無限次元表現の理論と不連続群の研究」

3. Sackler Distinguished Lecturer (2007)

H. 海外からのビジター

1. Professor Dr. Pablo Ramacher (2007 Fall)

2. Professor Misha Pevzner (2007–2008.1), JSPS fellow

3. Professor Salma Nasrin (2007.12)

4. Professor Dr. Karl-Hermann Neeb (2007.5)

5. Professor Dr. Martin Olbrich (2007.9)