

✿ 日本数学会

2024年度年会

# 英文サマリ集

2024年3月

於 大阪公立大学



# 2024 日本数学会 年会プログラム

期 日 2024年3月17日(日)～3月20日(水)

会 場 大阪公立大学杉本キャンパス  
大阪府大阪市住吉区杉本3-3-138

連絡先 大阪公立大学大学院理学研究科  
〒558-8585

大阪府大阪市住吉区杉本3-3-138

E-mail omu24mar@mathsoc.jp

一般社団法人 日本数学会

	第I会場 全学共通教育棟 1階810教室	第II会場 全学共通教育棟 1階811教室	第III会場 全学共通教育棟 1階812教室	第IV会場 全学共通教育棟 1階813教室	第V会場 全学共通教育棟 1階814教室	第VI会場 全学共通教育棟 1階815教室	第VII会場 全学共通教育棟 2階820教室	第VIII会場 全学共通教育棟 2階821教室	第IX会場 全学共通教育棟 2階822教室
17日 (日)	代 数 学 9:00～10:30 14:15～18:00	関数方程式論 9:30～12:00 14:15～16:15	統 計 数 学 9:30～11:40	幾 何 学 9:30～11:45 14:15～16:10	トポロジー 9:30～11:10 15:40～17:30	函 数 論 9:50～11:20 15:35～16:30	関数解析学 9:30～11:00	数学基礎論 および歴史 9:30～11:30 14:30～17:00	応 用 数 学 9:00～12:00 14:15～16:50
	企画特別講演 13:00～14:00								
	特別講演 10:45～11:45	特別講演 16:30～17:30	特別講演 14:15～15:15 15:30～16:30	特別講演 16:25～17:25	特別講演 14:20～15:20	特別講演 14:15～15:15	特別講演 14:15～15:15		特別講演 17:00～18:00
18日 (月)	代 数 学 9:30～12:00	関数方程式論 9:30～12:00	統 計 数 学 9:30～11:40	幾 何 学 13:00～14:00	トポロジー 9:30～10:00 13:00～14:00	函 数 論 9:50～11:20	関数解析学 9:30～11:00	数学基礎論 および歴史 9:15～12:00	応 用 数 学 9:00～12:00 13:00～14:00
	特別講演 13:00～14:00	特別講演 13:00～14:00		特別講演 10:30～11:30		特別講演 13:00～14:00	特別講演 13:00～14:00	特別講演 13:00～14:00	
	日本数学会賞授賞式(基礎教育実験棟 1階 階段教室) ..... (14:30～15:00)								
	総 合 講 演 ( " ) 日本数学会賞春季賞受賞者 ..... (15:15～16:15) 吉川 謙一(京大 理) ..... (16:30～17:30) 懇 親 会 (学術情報総合センター 野のはなハウス) ..... (18:00～20:00)								
19日 (火)	代 数 学 9:30～12:00	関数方程式論 9:45～12:00 14:15～16:00	統 計 数 学 10:00～11:10	幾 何 学 9:30～11:45 14:15～17:10	トポロジー 9:30～12:00	実関数論 9:30～12:00 14:15～16:15	関数解析学 9:30～11:30 14:15～15:45	無限可積分系 9:30～11:30	応 用 数 学 9:50～12:00 14:50～16:30
	企画特別講演 13:00～14:00								
	特別講演 14:40～15:40 16:00～17:00	特別講演 16:15～17:15			特別講演 14:20～15:20	特別講演 16:30～17:30	特別講演 16:00～17:00	特別講演 14:15～15:15	特別講演 16:45～17:45
20日 (水)	代 数 学 9:00～12:00 14:15～18:00	関数方程式論 10:00～12:00 14:15～15:15	統 計 数 学 10:00～11:40	幾 何 学 9:20～10:15		実関数論 9:30～12:00 14:15～15:40		無限可積分系 9:30～11:30	応 用 数 学 9:50～12:00 14:15～15:25
	企画特別講演 13:00～14:00								
		特別講演 15:30～16:30	特別講演 14:15～15:15 15:30～16:30	特別講演 10:30～11:30		特別講演 15:45～16:45 17:00～18:00		特別講演 14:15～15:15	特別講演 15:40～16:40



## 目次

総合講演	1
企画特別講演	2
数学基礎論および歴史	5
3月17日(日)	5
3月18日(月)	7
代数学	11
3月17日(日)	11
3月18日(月)	16
3月19日(火)	18
3月20日(水)	20
幾何学	26
3月17日(日)	26
3月18日(月)	29
3月19日(火)	30
3月20日(水)	34
函数論	35
3月17日(日)	35
3月18日(月)	37
函数方程式論	39
3月17日(日)	39
3月18日(月)	43
3月19日(火)	45
3月20日(水)	49
実函数論	53
3月19日(火)	53
3月20日(水)	57
函数解析学	62
3月17日(日)	62
3月18日(月)	63
3月19日(火)	64
統計数学	68
3月17日(日)	68
3月18日(月)	70
3月19日(火)	72

3月20日(水) . . . . .	73
応用数学 . . . . .	76
3月17日(日) . . . . .	76
3月18日(月) . . . . .	82
3月19日(火) . . . . .	85
3月20日(水) . . . . .	90
トポロジー . . . . .	94
3月17日(日) . . . . .	94
3月18日(月) . . . . .	97
3月18日(月) . . . . .	97
3月18日(月) . . . . .	97
3月19日(火) . . . . .	98
無限可積分系 . . . . .	101
3月19日(火) . . . . .	101
3月20日(水) . . . . .	102

## 総 合 講 演

3月18日(月) 総合講演会場

日本数学会賞春季賞受賞者 ..... (15:15~16:15)

Spring Prize Winner

吉川 謙一 (京大 理) カラビ・ヤウ型多様体に対する正則解析的振率 ..... (16:30~17:30)

Ken-ichi Yoshikawa (Kyoto Univ.) Holomorphic analytic torsion for manifolds of Calabi–Yau type

概要 Holomorphic analytic torsion is a spectral invariant of compact Kähler manifolds introduced by Ray–Singer in 1973. In the 1990s, as a consequence of mirror symmetry and string duality, two remarkable conjectures concerning the holomorphic analytic torsion of Calabi–Yau threefolds and Enriques surfaces were proposed by physicists. One is an equivalence of the analytic torsion of Calabi–Yau threefolds and certain curve counting invariants at genus-one of its mirror manifold (Bershadsky–Cecotti–Ooguri–Vafa), and the other is the coincidence of the analytic torsion of Enriques surfaces and the Borcherds  $\Phi$ -function, the automorphic form on the moduli space characterizing the discriminant locus (Harvey–Moore). Following these conjectures, holomorphic torsion invariants of 2-elementary  $K3$  surfaces and Calabi–Yau threefolds were introduced and studied by the speaker in the former case and by Fang, Lu and the speaker in the latter case. In the 2000s, those predictions by physicists concerning the analytic torsion of Enriques surfaces and quintic mirror threefolds were confirmed. In the late 2010s and beyond, there have been significant advances in the theory of holomorphic torsion invariants, such as the structure theorem of the invariant for 2-elementary  $K3$  surfaces (S. Ma and the speaker), the construction of a holomorphic torsion invariant for Calabi–Yau manifolds (BCOV invariant) in higher dimensions and the proof of the genus-one mirror symmetry for Calabi–Yau hypersurfaces of the projective space of arbitrary dimension (Eriksson–Freixas i Montplet–Mourougane), and the birational invariance of the BCOV invariant (Fu–Zhang) etc. In the talk, I would like to give an overview of the developments of holomorphic torsion invariants mentioned above, focusing on 2-elementary  $K3$  surfaces and possibly mirror symmetry at genus one. If time permits, I will also discuss some recent works in progress.

# 企 画 特 別 講 演

3月17日(日)

## 第I会場

特別招待講演 (日本応用数学会)

関川 浩 (東京理大理) 数値数式融合計算 ..... (13:00~14:00)

Hiroshi Sekigawa (Tokyo Univ. of Sci.) Symbolic-numeric computation

**概要** Symbolic-numeric computation is a computing methodology that combines ideas from symbolic and numeric computation. Symbolic computation (a.k.a. computer algebra) is very reliable, but it has the following issues: algorithms in symbolic computation demand significant resources, including time and memory; usual algorithms in symbolic computation break down when applied to inexact values. Symbolic-numeric computation addresses these issues by combining ideas from symbolic and numeric computation. In this talk, I will explain how to solve algebraic problems with inexact values by using symbolic-numeric computation through several examples.

## 第II会場

宗政 昭弘 (東北大情報) 等角直線族の組合せ論 ..... (13:00~14:00)

Akihiro Munemasa (Tohoku Univ.) Combinatorics of equiangular lines

**概要** The problem of equiangular lines asks how many lines through the origin can be placed in the Euclidean space while maintaining the pairwise angle of lines to be constant. This problem of metric geometry is seemingly easier than packing problems in the sphere or the Euclidean spaces, but it is in general open except for some small dimensions. By Lemmens and Seidel (1973), the problem can be reformulated as a purely combinatorial problem in terms of switching classes of graphs. In this talk, I will survey recent development on this problem in connection with root systems and integral lattices. I will also briefly touch on its complex analogue, where “lines” mean complex 1-dimensional subspaces, and “angles” mean the absolute values of the inner product of representing unit vectors. This analogue has been investigated by quantum physicists under the name SIC-POVM, yet its existence problem is unsolved in general.

## 第IV会場

Junguk Lee Survey on a geography of Model Theory ..... (13:00~14:00)  
(Changwon National Univ.)

Junguk Lee (Changwon National Univ.) Survey on a geography of Model Theory

**概要** In this survey talk, we will explore a geography of Model Theory under the guidance of Classification Theory. First, we review basic first-order logic and several dividing lines developed in Classification Theory. Second, we will focus on Classification Theory for fields and examine some interactions between Field Arithmetic and dividing lines.



3月19日(火)

## 第II会場

仙葉 隆 (福岡大理) 対数関数を知覚関数を持つ走化性方程式系の解の挙動について  
 ..... (13:00~14:00)

Takasi Senba (Fukuoka Univ.) Behavior of solutions to chemotaxis systems with logarithmic sensitivity functions

概要 In this talk, we consider behavior of solutions to chemotaxis systems with logarithmic sensitivity functions. In particular, we will talk about blowup and global existence of those solutions. The behavior of solutions to classical chemotaxis systems is well known. The systems are chemotaxis systems with linear sensitivity function. The classical chemotaxis systems have Lyapunov functions, which are often used for the study of solutions to classical chemotaxis system. However, we do not still find Lyapunov functions of chemotaxis system with nonlinear sensitivity functions. This obstacles to the study of those systems. We will talk some results on blowup and global existence of those solutions.

## 第IV会場

石川 剛郎 (北大\*) サブリーマン空間の特異曲線とその周辺 ..... (13:00~14:00)

Goo Ishikawa (Hokkaido Univ.\*) Singular curves of sub-Riemannian spaces and related topics

概要 A sub-Riemannian structure is given by a Riemannian metric on a vector subbundle of the tangent bundle (distribution) over a manifold. Then the notion of geodesics or length minimisers are naturally defined on sub-Riemannian spaces. Unlike Riemannian case, there appear *abnormal geodesics* or *singular curves*, as sub-Riemannian geodesics, in addition to normal geodesics. It turns out that *singular curves* are defined, depending just on the distribution, as critical points of end-point mapping in the context of control theory, and they are significant objects also in geometry and topology in their own right. In this talk, several topics and results on *singular curves* of distributions will be explained for specific cases, say, (2, 3, 4)-distributions (Engel), in terms of the growth of ranks by taking Lie brackets, (2, 3, 5)-distributions (Cartan), (3, 5)-distributions, (4, 5)-distributions, (3, 6)-distributions, (4, 7)-distributions and so on, with some perspectives.

3月20日(水)

## 第I会場

千田 雅隆 (東京電機大未来)  $p$ 進 Gross-Zagier 公式の高次元化について ..... (13:00~14:00)

Masataka Chida (Tokyo Denki Univ.) On generalizations of  $p$ -adic Gross-Zagier formula

概要 Gross and Zagier showed a remarkable formula which relates the first derivatives of  $L$ -functions for modular forms of weight two and heights of Heegner points on modular curves. Perrin-Riou proved a  $p$ -adic analogue of the Gross-Zagier formula. They have many important arithmetic applications including the conjecture of Birch and Swinnerton-Dyer (BSD conjecture). Subsequently, Gan-Gross-Prasad formulated a conjecture on a generalization of the Gross-Zagier formula to higher dimensional unitary and orthogonal Shimura varieties, which is known by the arithmetic Gan-Gross-Prasad conjecture. Wei Zhang proposed an approach to the arithmetic Gan-Gross-Prasad conjecture using relative trace formulas and he also formulated the arithmetic fundamental lemma (conjecture). Recently, Disegni-Zhang proved a  $p$ -adic analogue of arithmetic Gan-Gross-Prasad conjecture for unitary groups using this approach. On the other hand, Bertolini-Darmon-Prasanna introduced a slightly different kind of  $p$ -adic Gross-Zagier formula which is a special value formula for  $p$ -adic  $L$ -functions at a point outside of the interpolation range. It is known that this kind of formula has some interesting applications to BSD conjecture (more generally, Bloch-Kato conjecture). For example, Darmon-Rotger proved a BDP type formula for triple products of elliptic modular forms and it has an application to the equivariant BSD conjecture. In this talk, we will discuss some possible generalizations of these formulas to higher dimensional cases.

## 第IV会場

梶原健司 (九大IMI) 可積分幾何による美的形状の生成 ..... (13:00~14:00)

Kenji Kajiwara (Kyushu Univ.) Generation of aesthetic shape by integrable geometry

概要 We consider log-aesthetic curves (LAC), a family of planar curves developed in industrial design, as curves that car designers regard as “aesthetic.” We present a new mathematical framework of LAC on the theory of integrable systems and similarity geometry. Using this framework, LAC is shown to be a similarity geometry analogue of Euler’s *Elastica*. Based on this mathematical setting, we present generalizations of LAC to discrete curves, space curves and surfaces, which may be useful for generating aesthetic shapes. The surfaces will be regarded as the similarity geometry analogue of the pseudospherical surfaces. We will mention on some interesting results in the formulation of the 3D space curve and surfaces, such as explicit formulas and symmetry structure. An interesting example of a classical truss structure called the Michell structure in architecture in which mechanical optimality, integrability, and aesthetic nature coexist will be discussed, together with the relationship with the discrete harmonic functions.

# 数学基礎論および歴史

3月17日(日) 第VIII会場

## 9:30~11:30

- 1 静岡 莊 司 (阪 府 大 理) 非同時発言な帽子パズルの一般定理 ..... 15  
Souji Shizuma (Osaka Pref. Univ.) General theorem for nonsimultaneous hat puzzles

概要 The prisoner and hat puzzle, also known as the hat problem, is divided into two depending on whether the prisoners' statements are simultaneous or non-simultaneous. In this presentation, we will focus on puzzles with non-simultaneous type and introduce the general theorem.

- 2 津久浦 健太 (法 政 大 理 工) Prikry 拡大での Namba 強制法の準適性性について ..... 15  
Kenta Tsukuura (Hosei Univ.) On semiproperness of Namba forcings in Prikry extensions

概要 It is known that many kinds of reflection principles fail in the extension by Prikry forcing. In particular, the semistationary reflection principle fails, which in turn implies non-semiproperness of some Namba forcings. We ask what cardinal such that Namba forcing over its is not semiproper in Prikry extension is. In this talk, we introduce  $\mathcal{P}_\kappa\lambda$ -variations of Namba forcings and show that every Namba forcing above the target of Prikry forcing is not semiproper in the extension.

- 3 依岡 輝幸 (静 岡 大 理) モデルをサイドコンディションとして組み込んだ強制法に関する強制法的保存則 ..... 15  
Teruyuki Yorioka (Shizuoka Univ.) Some preservation theorems for forcing notions with models as side conditions

概要 The side condition method is a general framework of constructions of proper forcing notions defined by Stevo Todorćević. These forcing notions equip with models as side conditions. In this talk, some preservation theorems for forcing notions with models as side conditions are introduced.

- 4 薄葉 季路 (早 大 理 工) Uniform ultrafilters in a choiceless context ..... 15  
Toshimichi Usuba (Waseda Univ.) Uniform ultrafilters in a choiceless context

概要 We study uniform ultrafilters in a choiceless context. We prove that  $\aleph_{\omega+1}$  can be the least cardinal which carries a uniform ultrafilter. We also show that  $\aleph_\omega$  can be the least cardinal which does not carry a uniform ultrafilter.

- 5 吉信 康夫 (名 大 情 報) Convex sets and the axiom of choice ..... 15  
Yasuo Yoshinobu (Nagoya Univ.) Convex sets and the axiom of choice

概要 For an  $\mathbb{R}$ -vector space  $V$ , let  $MC(V)$  denote the statement that every subset of  $V$  has a maximal convex subset and  $MC$  the statement that  $MC(V)$  holds for all  $V$ . Under ZF, we observe that  $MC$  is equivalent to the axiom of choice, and that  $MC(\mathbb{R}^3)$  is strictly stronger than  $MC(\mathbb{R}^2)$ , which is equivalent to the axiom of countable choice for sets of reals.

- 6 坪井 明人 (筑 波 大\*) Dividing and forking in random structures ..... 15  
Akito Tsuboi (Univ. of Tsukuba\*) Dividing and forking in random structures

概要 Dividing and forking are important concepts in model theory, both of which are related to abstract independence. Although these two concepts are not equivalent in general, in simple theories, they are equivalent. We demonstrate that these concepts differ in random hypergraphs omitting a certain kind of sub-hypergraphs. This work is a continuation of the study on which I presented at the 2022 fall meeting of the MSJ.

- 7 桔 梗 宏 孝 (神戸大システム情報) ランダム超グラフと軌道が1つの自己同型について ..... 15  
 坪 井 明 人 (筑 波 大\*)  
 Hirotaka Kikyo (Kobe Univ.) On random hypergraphs and automorphisms with a single orbit  
 Akito Tsuboi (Univ. of Tsukuba\*)

概要 Let  $\mathcal{H}(m, l, s)$  be the class of all finite  $m$ -hypergraphs  $A$  such that for any substructure  $X$  of  $A$  with  $|X| = l$  has less than  ${}_l C_m - s$   $m$ -hyperedges. Suppose  $0 \leq s < {}_l C_m$ .  $\mathcal{H}(m, l, s)$  has the free amalgamation property if and only if  $s < {}_{l-2} C_{m-2}$ .

Let  $M$  be the random structure for  $\mathcal{H}(m, l, s)$  (in the case that it exists). Then  $M$  has an automorphism with a single orbit.

#### 11:45~12:00 数学基礎論および歴史分科会総会

#### 14:30~17:00

- 8 池田宏一郎 (法政大経営) A note on  $\omega$ -categorical stable theories ..... 15  
 Koichiro Ikeda (Hosei Univ.) A note on  $\omega$ -categorical stable theories

概要 We show that if  $\alpha$  is in  $(0, 1)$  with  $index(\alpha) = \infty$  and  $K_\alpha$  is a class of finite graphs which is generated by an edge graph then a  $K_\alpha$ -generic graph is  $\omega$ -categorical and strictly stable.

- 9 小 峰 航 (筑波大数理物質) On prime models of definably complete locally o-minimal theories ..... 15  
 Wataru Komine (Univ. of Tsukuba) On prime models of definably complete locally o-minimal theories

概要 Pillay and Steinhorn showed that every o-minimal theory has a prime model and it is unique up to isomorphism. We are interested in definably complete locally o-minimal theory which is generalization of o-minimal theory, and investigate existence and uniqueness of prime models in definably complete locally o-minimal theory. We give an counterexample to existence and some conditions for uniqueness.

- 10 大 倉 昂 貴 (筑波大数理物質)  $p$ 進体の拡張構造における Poincaré 級数の有理性 ..... 15  
 Koki Okura (Univ. of Tsukuba) On rationality of Poincaré series in expansions of the  $p$ -adic fields

概要 We associate each subset of  $p$ -adic integers with a formal power series, which is called its Poincaré series. Denef showed that the Poincaré series of every set definable in the  $p$ -adic field structure is a rational function. In this talk, we examine the relationship between the rationality of Poincaré series in various expansions of the  $p$ -adic fields and their stability-theoretic properties. Especially, we will give an example of NIP expansions without such rationality.

- 11 米 田 郁 生 (徳山工高専) Weak one-basedness in the eq-structure and the existences of weak canonical bases in rosy theories ..... 15  
 Ikuo Yoneda (Tokuyama Coll. of Tech.) Weak one-basedness in the eq-structure and the existences of weak canonical bases in rosy theories

概要 Weak one-basedness is defined in the real sort by Berenstein and Vassiliev. We define weak one-basedness in the eq-structure, and we show that, in rosy theories, one-basedness is equivalent to weak one-basedness in the eq-structure with the existences of weak canonical bases.

- 12 神 谷 徳 昭 (会 津 大\*) リー代数という本のタイトルについて ..... 15  
 Noriaki Kamiya (Univ. of Aizu\*) On the title "Lie algebra" of books published in Japan

概要 In this talk, we exhibit the books of Lie algebra published in Japan, that is, about 1950 2023. It seems that the notation of Lie algebra is appeared from PRINCETON (USA) of 1934, and soon after, that came to JAPAN.

- 13 平田 浩一 (松山大経営・愛媛大\*) 算変座標の幾何学的基礎 ..... 15  
 Koichi Hirata Geometric foundations of inversive coordinates of circles  
 (Matsuyama Univ./Ehime Univ.\*)

概要 The inversive coordinates of circles are defined as a coordinate system for studying problems where many circles touch each other. This coordinate system is suitable for application to Wasan problems, and we have introduced such applications so far. On the other hand, the geometric foundation of the coordinate system is also important. In this study, we present the results of the foundation for both  $\sigma > 0$  and  $\sigma < 0$  cases. We will also introduce the differences between the two cases.

- 14 田中 紀子 (奈良学園人間教育) 宅間流「省約術」と善光寺算額の関係について ..... 15  
 小川 東  
 (四日市大関孝和数学研)

Noriko Tanaka (Naragakuen Univ.) A study on the relationship of Takuma school's book Shouyaku-jutsu  
 Tsukane Ogawa (Yokkaichi Univ.) and a mathematical plate dedicated to the Zenkouji temple

概要 The Takuma school is a school in Osaka, and an important person in the Takuma school is Oka Shichibei-Yukitada (1791–). Oka left behind many documents. This paper discusses the solution to question 12 of Shouyaku-jutsu[Simplifying method of equations] (14 questions total). It also investigates and analyzes the same figure drawn on the existing Takuma school's mathematical plate of the Zenkouji temple.

- 15 小川 東 宅間流岡之只『起術解路法』における整式の処理 (2) ..... 15  
 (四日市大関孝和数学研)

田中 紀子 (奈良学園人間教育)  
 Tsukane Ogawa (Yokkaichi Univ.) Treatment of polynomials in Oka Yukitada's "*Kijutsu Kairohō* (A  
 Noriko Tanaka (Naragakuen Univ.) *method to solve the path to create a formula*)" in the Takuma School (2)

概要 The five (or six) volumes of *Kijutsu Kairohō* by Oka Yukitada of the Takuma School contain a variety of techniques for processing polynomials. We have already presented the "senshiki (transformation of polynomials)" and "ryakushiki (simplification of polynomials)." This presentation will discuss "shouyaku (removal of factors of polynomials)" in the *Art of shouyaku*. Since "shouyaku" is nothing more than the factorization of an equation from today's point of view, it has not received much attention so far. However, "shouyaku" shows a remarkable characteristic in the history of pre-modern Japanese mathematics in that it actively utilizes the separation of solutions to equations.

### 17:15~17:30 歴史部門懇談会

3月18日(月) 第VIII会場

### 9:15~12:00

- 16 熊澤 昌明 (箕面自由学園高) BCK-代数の中のド・モルガン代数について ..... 15  
 Masaaki Kumazawa On De Morgan algebras in BCK-algebras  
 (Mino-Jiyu Gakuen High School)

概要 We are well known that a bounded commutative BCK-algebra is a De Morgan algebra. In this presentation, we will define a new class in BCK-algebras: *Involutive bounded BCK-algebras with Condition (I)*. This class is a proper large class than the class of bounded commutative BCK-algebras. Moreover, we would like to show that an algebra of this class is also a De Morgan algebra. We predict that this class is the largest class that is a De Morgan algebra in BCK-algebras.

- 17 小暮晏佳 (金沢大理工) 局所反映原理に関する保存性について ..... 15  
 倉橋太志 (神戸大システム情報)  
 Haruka Kogure (Kanazawa Univ.) On the conservation results for local reflection principles  
 Taishi Kurahashi (Kobe Univ.)

概要 For a class  $\Gamma$  of formulas,  $\Gamma$  local reflection principle  $\text{Rfn}_\Gamma(T)$  for a theory  $T$  of arithmetic is a scheme formalizing the  $\Gamma$ -soundness of  $T$ . Beklemishev proved that for every  $\Gamma \in \{\Sigma_n, \Pi_{n+1} \mid n \geq 1\}$ , the full local reflection principle  $\text{Rfn}(T)$  is  $\Gamma$ -conservative over  $T + \text{Rfn}_\Gamma(T)$ . We firstly proved that the second condition **D2** of the derivability conditions is a sufficient condition for the conservation theorem to hold. We secondly investigate the conservation theorem in terms of Rosser provability predicates. We construct Rosser predicates for which the conservation theorem holds and Rosser predicates for which the theorem does not hold.

- 18 佐藤雄太 (神戸大システム情報) 必然化の論理  $\mathbf{N}$  の拡張論理の有限フレーム性 ..... 15  
 倉橋太志 (神戸大システム情報)  
 Yuta Sato (Kobe Univ.) The finite frame property of some extensions of the pure logic of necessitation  
 Taishi Kurahashi (Kobe Univ.)

概要 We study the finite frame property of some extensions of Fitting, Marek, and Truszczyński's pure logic of necessitation  $\mathbf{N}$ . For any natural numbers  $m, n$ , we introduce the logic  $\mathbf{N}^+ \mathbf{A}_{m,n}$  by adding the axiom scheme  $\Box^n \varphi \rightarrow \Box^m \varphi$  and the rule  $\frac{\neg \Box \varphi}{\neg \Box \Box \varphi}$  into  $\mathbf{N}$ . We proved the finite frame property of  $\mathbf{N}^+ \mathbf{A}_{m,n}$  with respect to Fitting, Marek, and Truszczyński's relational semantics. We also proved that the rule  $\frac{\neg \Box \varphi}{\neg \Box \Box \varphi}$  is necessary for the completeness of  $\mathbf{N}^+ \mathbf{A}_{0,n}$  for  $n \geq 2$ .

- 19 高瀬理人 (神戸大システム情報) 証明可能性-強制様相論理 ..... 15  
 倉橋太志 (神戸大システム情報)  
 Rihito Takase (Kobe Univ.) The modal logic of provability and forcing  
 Taishi Kurahashi (Kobe Univ.)

概要 So far, various kinds of models of set theory have been constructed, and recently many set theorists are interested in the structure of the *multiverse* consisting of these models. Modal logic is very useful to analyze this structure. Hamkins–Löwe studied the forcing accessibility relation on the multiverse. More precisely, they introduced *the modal logic of forcing* and proved that it corresponds to the modal logic S4.2. On the other hand, Solovay proved that *the modal logic of provability* corresponds to the modal logic GL. In this talk, we discuss the bimodal logic obtained by combining these two modal logics. We introduce a bimodal logic PF and prove that *the modal logic of provability and forcing* corresponds to PF.

- 20 倉橋太志 (神戸大システム情報) 理論の不完全性, 決定不能性, 分離不能性 ..... 15  
 A. Visser (Utrecht Univ.)  
 Taishi Kurahashi (Kobe Univ.) Incompleteness, undecidability, and inseparability of theories  
 Albert Visser (Utrecht Univ.)

概要 We studied several notions related to incompleteness, undecidability and inseparability with the purpose of giving a clear overview of these notions. Firstly, we summarized the historical background of these notions. Secondly, we gave alternative proofs of known old results by Cobham, Vaught, and Pour-El. Finally, we proved that for any consistent RE theory, effective essential hereditary creativity and strong effective inseparability are equivalent.

- 21 L. Pacheco ( TU Wien ) A constructive variation of GL ..... 15  
 Leonardo Pacheco (TU Wien) A constructive variation of GL

概要 We describe a constructive variation of the provability logic GL. The logic CGL is based on Mendler and de Paiva's constructive modal logic CK. The system CGL is obtained by adding Löb's axiom  $\Box(\Box P \rightarrow P) \rightarrow \Box P$  to CK; the CGL models are obtained by adding a reverse well-foundedness condition to the CK models. We show that CGL is complete over CGL models via a canonical model construction. We also describe ongoing work on non-classical varieties of GL based on the intuitionistic modal logic IK and the Gödel modal logic GK.

- 22 L. Pacheco ( TU Wien ) Higher-order feedback computation ..... 15  
 Leonardo Pacheco (TU Wien) Higher-order feedback computation

概要 Feedback Turing machines are Turing machines which can query a halting oracle  $h : \subseteq \omega \times \omega \rightarrow \{\downarrow, \uparrow\}$ , which has information on the convergence or divergence of *feedback* computations. To avoid a contradiction by diagonalization, feedback Turing machines have two ways of not halting: they can diverge as standard Turing machines, or they can freeze. A natural question to ask is: what if we iterate the feedback construction? We define  $\alpha$ th order feedback Turing machines for each computable ordinal  $\alpha$  and describe the semi-computable sets using inductive definitions and Gale–Stewart games. (Joint work with Juan P. Aguilera and Robert S. Lubarsky.)

- 23 鈴木登志雄 (都立大理) 自由な形の AND-OR 木における均衡値 (2) ..... 15  
 Toshio Suzuki (Tokyo Metro. Univ.) Equilibria of AND-OR trees without assumptions on tree shapes (2)

概要 The goal of this research is to show nontrivial equations and inequalities on equilibria of AND-OR trees without assumptions on tree shapes. In the previous meeting, we proved that two equilibria of randomized directional algorithms coincide. In the current talk, we discuss subsequent development. This work was done in collaboration with Fuki Ito.

- 24 河村彰星 (京大数理研) 初等的に追跡される数 ..... 10  
 廣島佳汰 (京大理)  
 Akitoshi Kawamura (Kyoto Univ.) Elementarily traceable numbers  
 Keita Hiroshima (Kyoto Univ.)

概要 A function is called *elementary* if it can be computed in time bounded by a tower of powers of constant height. A *trace function* for an irrational number  $\alpha$  is a function that maps each rational number  $r$  to a rational number that is closer to  $\alpha$  than  $r$  is. We show, as was conjectured by Kristiansen, that there exists an irrational number that has an elementary trace function but whose continued fraction expansion is not elementary. We also show that there exists an irrational number that has an elementary trace function but whose *sum approximation*, i.e., the function that maps each positive integer  $n$  to the index of the  $n$ th 1 in the binary expansion of the number, is not elementary.



- 25 只木孝太郎 (中部大工) アルゴリズム的ランダムネスによる量子情報理論の精密化 VIII ..... 15  
 Kohtaro Tadaki (Chubu Univ.) A refinement of quantum information theory by algorithmic randomness  
 VIII

**概要** The notion of probability plays a crucial role in quantum mechanics. It appears as the Born rule. In modern mathematics which describes quantum mechanics, however, probability theory means nothing other than measure theory, and therefore any operational characterization of the notion of probability is still missing in quantum mechanics. In our former works, based on the toolkit of algorithmic randomness, we presented an operational refinement of the Born rule, called the principle of typicality, for specifying the property of the results of quantum measurements in an operational way. In this talk, we refine and reformulate the security proof of the BB84 quantum key distribution protocol based on the principle of typicality, in order to demonstrate how properly our framework works in practical problems in quantum mechanics.

**13:00~14:00 特別講演**

石原 哉 (東邦大理) 構成的・可述的集合論における逆数学

Hajime Ishihara (Toho Univ.) Reverse mathematics in constructive and predicative set theory

**概要** After quickly reviewing intuitionistic logic and classical Zermelo-Fraenkel set theory (**ZF**), we look into constructive Zermelo-Fraenkel set theory (**CZF**) and its subsystems **BCST** (Basic constructive set theory) and **ECST** (Elementary constructive set theory). Those constructive set theories are predicative without Powerset and with Separation being restricted, and we see that elementary constructions of sets can be performed in the theories. We introduce the notions of a set-generated class and NID (Non-deterministic Inductive Definition) principles. A class  $X$  of subsets of a set  $S$  is *set-generated* if there exists a *subset*  $G$  of  $X$  such that  $\alpha = \bigcup\{\beta \in G \mid \beta \subseteq \alpha\}$  for all  $\alpha \in X$ . A *rule* on a set  $S$  is a pair  $(a, b)$  of subsets  $a$  and  $b$  of  $S$ ; it is *nullary* if  $a$  is empty, *elementary* if  $a$  is a singleton and *finitary* if  $a$  is finitely enumerable. For a set  $R$  of rules on  $S$ , a subset  $\alpha$  of  $S$  is *R-closed* if for each rule  $(a, b)$  in  $R$ ,  $a \subseteq \alpha$  implies  $\exists x(x \in b \cap \alpha)$ . The principle NID is that for each set  $S$  and each set  $R$  of rules on  $S$ ,

the class of  $R$ -closed subsets of  $S$  is set-generated;

NID<sub>0</sub>, NID<sub>1</sub> and NID<sub>< $\omega$</sub>  denote NID restricting  $R$  to a set of nullary, elementary and finitary rules, respectively. We first show (over **ECST**) that NID<sub>0</sub> is equivalent to Fullness, an axiom of **CZF**, and that NID<sub>1</sub> implies NID<sub>0</sub>. Then we show (over **ECST**) that NID<sub>1</sub>, “the category **Rel** of sets and relations has weak equalisers” and “the category **BP** of basic pairs and relation pairs has equalisers” are equivalent. Finally, we show (over **ECST**) that NID<sub>< $\omega$</sub>  is equivalent to “the class of models of a geometric theory is set-generated”.



## 代 数 学

3月17日(日) 第I会場

## 9:00~10:30

- 1 田 島 慎 一 (新 潟 大\*) Jordan 鎖の構造の厳密で効率的な計算 ..... 10  
 小 原 功 任 (金 沢 大 理 工)  
 照 井 章 (筑波大数理物質)  
 Shinichi Tajima (Niigata Univ.\*) Efficient symbolic computation of the structure of Jordan chains  
 Katsuyoshi Ohara (Kanazawa Univ.)  
 Akira Terui (Univ. of Tsukuba)

概要 An efficient method for computing the structure of Jordan chains of a matrix of integers or rational numbers by exact computation is proposed. We have given a method for computing Jordan chains of a matrix with exact computation. However, for deriving just the structure of Jordan chains, the algorithm can be reduced to increase its efficiency. We propose a modification of the algorithm for that purpose.

- 2 辻 栄 周 平 (北 教 大 旭 川) ゲイングラフから定まる 2 種類の超平面配置の自由性の一致について .. 10  
 陶 山 大 輔 (日本文理大経営経済)  
 M. Torielli  
 (Northern Arizona Univ.)  
 Shuhei Tsujie (Hokkaido Univ. of Edu.) On the coincidence of freeness of two types of hyperplane arrangements  
 Daisuke Suyama (Nippon Bunri Univ.) determined from gain graphs  
 Michele Torielli  
 (Northern Arizona Univ.)

概要 Two kinds of hyperplane arrangements can be obtained from a gain graph, a graph whose edges are labeled by elements in a group. Athanasiadis and Bailey have shown that freeness of these hyperplane arrangements sometimes coincide. In this talk, We will report what we know so far about when these coincidences occur.

- 3 中 島 規 博 (名 工 大) Weyl 配置を変形して得られる配置の特性準多項式 ..... 10  
 森 友 祐  
 Norihiro Nakashima Characteristic quasi-polynomials for deformations of Weyl arrangements  
 (Nagoya Inst. of Tech.)  
 Yusuke Mori

概要 The characteristic quasi-polynomial is the numbers of elements in the complement of hyperplane arrangements modulo positive integers which is introduced by Kamiya, Takemura, and Terao. In this talk, we compute the characteristic quasi-polynomials for arrangements which contain the Coxeter arrangement of types A, B, C, and D described by the orthonormal basis. In addition, by using this formulas, we also compute characteristic quasi-polynomials of arrangements obtained by deleting some hyperplanes from the Coxeter arrangements of types B, C, and D.

- 4 小笠原 匠 (横浜国大環境情報) 楕円曲線の二重被覆曲線として得られる種数 4 の超特別曲線 . . . . . 15  
原下 秀士 (横浜国大環境情報)  
大橋 亮 (東大情報理工)  
坂田 康亮 (東大情報理工)  
Takumi Ogasawara Superspecial genus-4 double covers of elliptic curves  
(Yokohama Nat. Univ.)  
Shushi Harashita  
(Yokohama Nat. Univ.)  
Ryo Ohashi (Univ. of Tokyo)  
Kosuke Sakata (Univ. of Tokyo)

概要 In this talk, we study genus-4 curves obtained as double covers of elliptic curves. Firstly we provide explicit defining equations of such curves with explicit criterion for whether it is nonsingular. We also show the irreducibility of the singular locus in any characteristic that is not 2 or 3. Secondly as an application we enumerate the isomorphism classes of superspecial genus-4 double covers of elliptic curves in small characteristic  $p$  (more precisely  $p$  is less than or equal to 23). We accomplish this by implementing our algorithm in the computer algebra system Magma and executing it. This work deals with a broader class of curves than the case of Howe curves studied by Kudo, Harashita and Howe in 2020.

- 5 山本 侑也 (横浜国大環境情報) The multiplicity-one theorem for the superspeciality of curves of genus  
原下 秀士 (横浜国大環境情報) two . . . . . 15  
Yuya Yamamoto The multiplicity-one theorem for the superspeciality of curves of genus  
(Yokohama Nat. Univ.) two  
Shushi Harashita  
(Yokohama Nat. Univ.)

概要 Igusa proved in 1958 that the polynomial determining the supersingularity of elliptic curves in Legendre form is separable. In this talk, we get an analogous result for curves of genus two in Rosenheim form. More precisely we show that the ideal determining the superspeciality of the curve has multiplicity one at every superspecial point. Igusa used a Picard–Fuchs differential operator annihilating a Gauss hypergeometric series. We use Lauricella’s system (of type D) of hypergeometric differential equations in three variables. We prove that each entry of the Cartier–Manin matrix satisfies the same partial differential equations and also various contiguity relations.

- 6 大橋 亮 (東大情報理工) On the Rosenhain forms of superspecial genus-2 curves . . . . . 15  
Ryo Ohashi (Univ. of Tokyo) On the Rosenhain forms of superspecial genus-2 curves

概要 In this talk, we examine superspecial genus-2 curves  $C : y^2 = x(x-1)(x-\lambda)(x-\mu)(x-\nu)$  in characteristic  $p \geq 3$ . As a main result, we show that the difference between any two elements in  $\{0, 1, \lambda, \mu, \nu\}$  is a square in  $\mathbb{F}_{p^2}$ . In addition, we show that  $C$  is maximal or minimal over  $\mathbb{F}_{p^2}$  without taking its  $\mathbb{F}_{p^2}$ -form (we also give a criterion in terms of  $p$  that tells whether  $C$  is maximal or minimal). As these applications, we study the maximality of superspecial hyperelliptic curves of genus 3 and 4 whose automorphism groups contain  $\mathbb{Z}/2\mathbb{Z} \times \mathbb{Z}/2\mathbb{Z}$ .

**10:45~11:45 特別講演**

宮崎 誓 (熊本大先端) Castelnuovo–Mumford regularity of polynomial ideals and syzygy theoretic approach to vector bundles

Chikashi Miyazaki (Kumamoto Univ.) Castelnuovo–Mumford regularity of polynomial ideals and syzygy theoretic approach to vector bundles

**概要** The Castelnuovo–Mumford regularity introduced by Mumford generalizing an idea of Castelnuovo is one of the most important invariants measuring the complexity of the minimal free resolution of polynomial ideals. In 1980s, the Eisenbud–Goto conjecture, which says the Castelnuovo–Mumford regularity is bounded by degree and codimension of nondegenerate projective variety  $V$ , that is,  $\text{reg } V \leq \deg V - \text{codim } V + 1$ , as crossroads of algebraic geometry and commutative algebra, has interested mathematician working in related fields.

My talk begins with regularity basics and surveys epoch-making results of 1980s and 1990s, especially works of Gruson–Lazarsfeld–Peskine, Lazarsfeld and Kwak, if possible, in some details of linear projections—secant lines, Mather’s theory etc. Surprisingly, in 2018, McCullough–Peeva settled down to give counterexamples of the conjecture.

Focusing on the commutative algebra technique, I have been working from a joint paper with Hoa in 1995,  $\text{reg } R \leq a(R) + \dim R + 1$  for a Buchsbaum graded ring  $R$ , which had driven us to study the  $k$ -Buchsbaum property. The uniform position principle immediately implies  $\text{reg } V \leq \lceil (\deg V - 1)/\text{codim } V \rceil + 1$  for a nondegenerate ACM variety. In order to extend our framework, I will explain the relationship between  $a$ -invariant and the Castelnuovo–Mumford regularity, and to get Castelnuovo-type bounds on the regularity even towards a classification of projective varieties—rational normal scroll, del Pezzo variety.

Finally I am going to talk on the splitting of vector bundles closely related to the syzygy theory from my point of view. Several proofs are known for the Horrocks theorem, a vector bundle on the projective space having ACM property is isomorphic to a direct sum of line bundles. The one using the Castelnuovo–Mumford regularity is my favorite. Arising from this idea, we investigate the nonvanishing intermediate cohomologies and their relation with the regularity to get a characterization of some vector bundles.

**14:15~18:00**

7 毛利 健太 (関西学院大理工) Toric rings of perfectly matchable subgraph polytopes ..... 10  
Kenta Mori (Kwansei Gakuin Univ.) Toric rings of perfectly matchable subgraph polytopes

**概要** The perfectly matchable subgraph polytope of a graph is a  $(0,1)$ -polytope associated with the vertex sets of matchings in the graph. We study algebraic properties (compressedness, Gorensteinness) of the toric rings of perfectly matchable subgraph polytopes. In particular, we give a complete characterization of a graph whose perfectly matchable subgraph polytope is compressed.

8 宮下 空 (阪大情報) 半標準的次数付き環における Gorenstein 性の一般化の比較 ..... 15  
Sora Miyashita (Osaka Univ.) Comparing generalizations of Gorensteinness in semi-standard graded rings

**概要** Semi-standard graded rings are a generalized notion of standard graded rings. In this talk, we compare generalized notions of the Gorenstein property in semi-standard graded rings. We discuss the commonalities between standard graded rings and semi-standard graded rings, as well as elucidate distinctive phenomena present in semi-standard graded rings that are absent in standard graded rings.

- 9 松下光虹 (阪大情報) 重複度に関する条件と almost Gorenstein 性について ..... 15  
 宮下空 (阪大情報)  
 Koji Matsushita (Osaka Univ.) Conditions for multiplicities and almost Gorensteinness  
 Sora Miyashita (Osaka Univ.)

概要 Almost Gorenstein rings have been introduced as a generalization of Gorenstein rings and have been well studied. In this talk, we show that if Cohen–Macaulay graded rings  $R_1$ ,  $R_2$  and  $R$  satisfy appropriate conditions regarding multiplicity, then almost Gorenstein property of  $R$  implies Gorenstein properties for all of  $R_1$ ,  $R_2$  and  $R$ . Moreover, we provide its application to semi-standard graded rings.

- 10 東谷章弘 (阪大情報) 斉次アフィン半群環とその正規化のヒルベルト級数の差について ..... 15  
 Akihiro Higashitani (Osaka Univ.) Difference of Hilbert series of homogeneous affine semigroup ring and its normalization

概要 Let  $Q$  be an affine semigroup,  $k[Q]$  the associated semigroup ring, and  $k[\overline{Q}]$  its normalization, where  $k$  is a field. In this talk, in the case where  $k[Q]$  is homogeneous, a difference of the Hilbert series of  $k[Q]$  and  $k[\overline{Q}]$  is discussed. More precisely, we prove that if  $k[Q]$  satisfies Serre’s condition  $(S_2)$ , then the degree of the  $h$ -polynomial of  $k[Q]$  is always greater than or equal to that of  $k[\overline{Q}]$ . Moreover, we also show counterexamples of this statement if we drop the assumption  $(S_2)$ .

- 11 木村海渡 (名大多元数理) 加群の Bass 数の漸近挙動 ..... 15  
 Kaito Kimura (Nagoya Univ.) Asymptotic behavior of Bass numbers of modules

概要 Let  $R$  be a commutative noetherian ring,  $I$  an ideal of  $R$ , and  $M$  a finitely generated  $R$ -module. The asymptotic behavior of the quotient modules  $M/I^n M$  of  $M$  for large integers  $n$  has been actively studied in commutative algebra. We consider the asymptotic Bass numbers of localizations of  $M/I^n M$  at prime ideals of  $R$ . The main result asserts that these have polynomial growth for large integers  $n$  that do not depend on the prime ideals when  $R$  is local.

- 12 大竹優也 (名大多元数理) 複体に対する Auslander–Bridger 理論 ..... 15  
 Yuya Otake (Nagoya Univ.) Auslander–Bridger theory for complexes

概要 Let  $R$  be a two-sided noetherian ring. Auslander and Bridger developed the theory of the projective stabilization of the category of finitely generated  $R$ -modules, which is called the stable module theory. Recently, Yoshino established the stable “complex” theory, i.e., the theory of a certain stabilization of the homotopy category of complexes of finitely generated projective  $R$ -modules. We introduce higher versions of several notions introduced by Yoshino, such as the  $*$ torsionfreeness and the  $*$ reflexivity for complexes. Also, we prove the Auslander–Bridger approximation theorem for complexes.

- 13 三船裕輝 (名大多元数理) 分解部分圏および MCM 加群のなす圏の半径の有限性について ..... 15  
 Yuki Mifune (Nagoya Univ.) On the finiteness of resolving subcategories and the category of MCM modules

概要 Let  $R$  be a commutative noetherian ring. Denote by  $\text{mod } R$  the category of finitely generated  $R$ -modules. The concept of the radius of a full subcategory of  $\text{mod } R$  has been introduced by Dao and Takahashi in 2014. It has been linked to many well-studied notions such as the dimension of the stable category of maximal Cohen–Macaulay modules, finite/countable Cohen–Macaulay representation type and the uniform Auslander condition. This time we give a partial positive answer to a conjecture of Dao and Takahashi on the finiteness of radii of resolving subcategories.

- 14 若杉直樹 (名大多元数理) 余有限加群のなす圏と局所コホモロジー加群 ..... 15  
 高橋亮 (名大多元数理)  
 Naoki Wakasugi (Nagoya Univ.) On the category of cofinite modules and local cohomology modules  
 Ryo Takahashi (Nagoya Univ.)

概要 Let  $R$  be a commutative noetherian ring and  $I$  be an ideal of  $R$ . In 2021, Bahmanpour proved if the local cohomology modules of any finitely generated  $R$ -modules are  $I$ -cofinite, then the subcategory of  $\text{Mod } R$  consisting of  $I$ -cofinite modules is an abelian subcategory when  $R$  is semi-local. We show the converse under certain assumptions.

- 15 荒谷督司 (岡山理大理) On the vanishing of DHKK complexities for singularity categories ..... 15  
 飯間圭一郎 (奈良工高専)  
 高橋亮 (名大多元数理)  
 Tokuji Araya (Okayama Univ. of Sci.) On the vanishing of DHKK complexities for singularity categories  
 Kei-ichiro Iima  
 (Nara Nat. Coll. of Tech.)  
 Ryo Takahashi (Nagoya Univ.)

概要 Let  $R$  be a commutative noetherian ring. In this talk, we study, for the singularity category of  $R$ , the vanishing of the complexity in the sense of Dimitrov, Haiden, Katzarkov and Kontsevich.

- 16 遠藤直樹 (明大政治経済) Sally modules of extended canonical ideals and Goto rings ..... 15  
 Naoki Endo (Meiji Univ.) Sally modules of extended canonical ideals and Goto rings

概要 The aim of this talk is, as part of stratification of Cohen–Macaulay rings, to introduce the notion of Goto rings, generalizing the notion of almost Gorenstein rings defined by Barucci and Fröberg for one-dimensional analytically unramified local rings; Goto, Matsuoka, and Phuong for one-dimensional Cohen–Macaulay local rings; and Goto, Takahashi, and the speaker of this talk for Cohen–Macaulay graded/local rings of arbitrary dimension. What has dominated the series of researches on almost Gorenstein rings is the fact that the reduction numbers of extended canonical ideals are at most 2; we define Goto rings as Cohen–Macaulay rings admitting such extended canonical ideals.

- 17 吉田健一 (日大文理) Normal tangent cone for the maximal ideal of a certain hypersurface  
 奥間智弘 (山形大理) ..... 15  
 渡辺敬一  
 (日大文理・明大研究・知財)  
 Ken-ichi Yoshida (Nihon Univ.) Normal tangent cone for the maximal ideal of a certain hypersurface  
 Tomohiro Okuma (Yamagata Univ.)  
 Kei-ichi Watanabe  
 (Nihon Univ./Meiji Univ.)

概要 In this talk, we prove that the normal tangent cone for the maximal ideal of a certain hypersurface is Cohen–Macaulay. Furthermore, we determine the normal reduction numbers and give a numerical criterion for Gorensteinness of such a normal tangent cone.

## 3月18日(月) 第I会場

## 9:30~12:00

- 18 飯高 茂 (学習院大\*) 新世代完全数について ..... 10  
 齋藤 之理 (麻布中)  
 Shigeru Iitaka (Gakushuin Univ.\*) Perfect numbers of new kind  
 Yukimasa Saito  
 (Azabu Junior High School)

概要 Let  $h$  denote a prime and  $m$  an integer.

If a positive integer  $\alpha$  satisfies  $X = \alpha - 2\phi(\alpha), \alpha = X(2hX + m - 1)X$ , then  $\alpha$  is said to be a perfect number of new type by Y.Saito.

- 19 菅野 隼 (東北大理) 2-1 公式の類似と深さ無限の  $t$ -多重ゼータ値 ..... 10  
 Hayato Kanno (Tohoku Univ.) A certain analogue of 2-1 formula and  $t$ -MZV of infinite depth

概要 2-1 formula is an important family of relations between multiple zeta-star values(MZSVs) and half multiple zeta values(1/2-MZVs). In this talk, we introduce an analogue of 2-1 formula for MZSVs of 2-3-2-1 indices. We also give some special values of  $t$ -multiple zeta values of infinite depth.

- 20 大塚 瑛介 (東北大理) 2 次のフェルマー曲線上の反復積分によって得られる周期について .... 15  
 Eisuke Otsuka (Tohoku Univ.) On the periods obtained by iterated integrals on the Fermat curve of degree 2

概要 In this talk, we define the periods obtained by iterated integrals on the Fermat curve of degree 2 and discuss their arithmetic properties. The definition is based on and extended from the iterated integral representation of multiple zeta values, and includes several other well-known periods. In particular, by using the theory of motivic iterated integrals given by Deligne, Goncharov et al., it is possible to give a motivic interpretation of our periods, and we can investigate the  $\mathbb{Q}$ -linear space spanned by our periods. I would like to explain this.

- 21 田沼 優佑 (慶大理工) Algebraic independence of the values of a certain family of power series ..... 10  
 Yusuke Tanuma (Keio Univ.) Algebraic independence of the values of a certain family of power series

概要 In this talk, we study the algebraic independence of the values of a certain family of power series including  $\sum_{k=0}^{\infty} z^{d^k \pm k}$  and  $\sum_{k=1}^{\infty} [k\omega]z^k$ , where  $d$  is an integer greater than 1,  $\omega$  is a real quadratic irrational number, and  $[\cdot]$  denotes the integral part.

- 22 行田 康晃 (東大数理) 一般化マルコフ方程式の一意性予想とその部分的解決 ..... 15  
 丸山 修平 (金沢大理工)  
 Yasuaki Gyoda (Univ. of Tokyo) Uniqueness conjecture of generalized Markov equation and its partial solutions  
 Shuhei Maruyama (Kanazawa Univ.)

概要 The Markov equation  $x^2 + y^2 + z^2 = 3xyz$  has an open problem called the uniqueness conjecture, which was introduced by Frobenius in 1913. In this talk, we will introduce a similar conjecture considered in the generalized Markov equation  $x^2 + y^2 + z^2 + k(yz + zx + xy) = (3 + 3k)xyz$  with nonnegative integer  $k$  as a parameter and discuss its partial solutions.

- 23 島田了輔 (東大数理) Beyond the cases of Coxeter type ..... 15  
 Ryosuke Shimada (Univ. of Tokyo) Beyond the cases of Coxeter type

概要 The notion of affine Deligne–Lusztig variety (ADLV) was first introduced by Rapoport, which has been applied to number theory such as the study of Shimura varieties and a realization of the local Langlands correspondence. Many of these applications make use of the special cases where the ADLV admits a simple description. One large class of such cases is the ADLV of Coxeter type, which has been already classified by Görtz–He–Nie. However, many people (Chan–Ivanov, Howard–Fox–Imai, Trentin,...) have found examples which are not of Coxeter type but admit a simple description. In this talk, I will explain about recent progress on this kind of new examples, including my recent work for  $GL_n$ .

- 24 中井啓太 (名大多元数理) Discrete universality theorem for Matsumoto zeta-functions and non-trivial zeros of the Riemann zeta-function ..... 15  
 Keita Nakai (Nagoya Univ.) Discrete universality theorem for Matsumoto zeta-functions and non-trivial zeros of the Riemann zeta-function

概要 In 2017, Garunkštis, Laurinćikas and Macaitienė proved the discrete universality theorem for the Riemann zeta-function sifted by imaginary part of nontrivial zeros of the Riemann zeta-function. This discrete universality has been extended in various zeta-functions and  $L$ -functions. In this talk, we generalize this discrete universality for Matsumoto zeta-functions.

- 25 鈴木正俊 (東工大) Weil分布が定めるエルミート形式について ..... 15  
 Masatoshi Suzuki (Tokyo Tech) On the Hermitian form attached to the Weil distribution

概要 We study the Hilbert space obtained by completing the space consisting of all smooth and compactly supported functions on the real line with respect to the Hermitian form attached to the Weil distribution. As a result, we obtain one novel equivalence condition for the Riemann hypothesis.



**13:00~14:00 特別講演**

越川 皓永 (京大数理研) 志村多様体のコホモロジーの消滅定理

Teruhisa Koshikawa (Kyoto Univ.) Vanishing theorems for the cohomology of Shimura varieties

概要 Shimura varieties are certain type of locally symmetric spaces, and have canonical structures of algebraic varieties. The cohomology of locally symmetric spaces are closely related to automorphic forms, and it has very rich structure and has been playing an important role for decades in the Langlands program, which connects automorphic forms and Galois representations. For such study, several types of vanishing theorems have been proved by several people with many different techniques from algebraic geometry, arithmetic geometry and the theory of automorphic representations, and these results are not just interesting, but also useful and often essential in the application. Some highlights in recent years are the proofs of the (potential) modularity and the Sato–Tate conjecture for elliptic curves over CM fields, and new cases of the generalized Ramanujan conjecture. These are generalizations of a lot of previous works starting with the proof of the last theorem of Fermat by Wiles and Taylor–Wiles. Such a generalization was first outlined by Calegari and Geraghty based on some new conjectures related to the cohomology of locally symmetric spaces. The progresses in recent years basically started by proving variants of their conjectures in several settings. A key ingredient is a certain vanishing theorem of torsion cohomology classes for Shimura varieties associated with quasi-split unitary groups. This was first proved by Caraiani and Scholze with several assumptions. I introduced a new technique based on the work of Fargues and Scholze on the geometrization of the local Langlands correspondence, and was able to drop many assumptions. These are now further generalized or enhanced by works of Santos, Hamann, Lee, and Zhang. People expect even more general forms of vanishing theorems, and their conjectural forms are related to the classification of automorphic representations and the categorical local Langlands conjecture. There are some works in progress in such directions. I will survey these results and ideas.

3月19日(火) 第I会場

**9:30~12:00**

- 26 星 明考 (新潟大理) Birational classification for algebraic tori (II) ..... 10  
 山崎 愛一 (京大理)  
 Akinari Hoshi (Niigata Univ.) Birational classification for algebraic tori (II)  
 Aiichi Yamasaki (Kyoto Univ.)

概要 As a continuation of Part (I) (dimension 3 case), we state main theorems of [HY] which give a stably birational classification of algebraic  $k$ -tori of dimension 4.

- 27 星 明考 (新潟大理) Rationality problem of two-dimensional quasi-monomial group actions  
 北山 秀隆 (和歌山大教育) ..... 10  
 Akinari Hoshi (Niigata Univ.) Rationality problem of two-dimensional quasi-monomial group actions  
 Hidetaka Kitayama (Wakayama Univ.)

概要 The rationality problem of two-dimensional purely quasi-monomial actions was solved completely by Hoshi, Kang and Kitayama (2014, J. Algebra). As a generalization, we solve the rationality problem of two-dimensional quasi-monomial actions under the condition that the actions are defined within the base field. In order to prove the theorem, we give a brief review of the Severi-Brauer variety with some examples and rationality results. We also use a rationality criterion for conic bundles of  $\mathbb{P}^1$  over non-closed fields.



- 28 星 明考 (新潟大理) Rationality problem for norm one tori for dihedral extensions ..... 7  
山崎 愛一 (京大理)  
Akinari Hoshi (Niigata Univ.) Rationality problem for norm one tori for dihedral extensions  
Aiichi Yamasaki (Kyoto Univ.)

概要 We give a complete answer to the rationality problem (up to stable  $k$ -equivalence) for norm one tori  $R_{K/k}^{(1)}(\mathbb{G}_m)$  of  $K/k$  whose Galois closures  $L/k$  are dihedral extensions with the aid of Endo and Miyata [EM75, Theorem 1.5, Theorem 2.3] and Endo [End11, Theorem 2.1]. By using a similar technique, we give refinements of the proof of stably rational cases of Endo and Miyata's theorems.

- 29 星 明考 (新潟大理) Rationality problem for norm one tori for  $A_5$  and  $\mathrm{PSL}_2(\mathbb{F}_8)$  extensions ..... 8  
山崎 愛一 (京大理)  
Akinari Hoshi (Niigata Univ.) Rationality problem for norm one tori for  $A_5$  and  $\mathrm{PSL}_2(\mathbb{F}_8)$  extensions  
Aiichi Yamasaki (Kyoto Univ.)

概要 We give a complete answer to the rationality problem (up to stable  $k$ -equivalence) for norm one tori  $T = R_{K/k}^{(1)}(\mathbb{G}_m)$  of  $K/k$  whose Galois closures  $L/k$  are  $A_5 \simeq \mathrm{PSL}_2(\mathbb{F}_4)$  and  $\mathrm{PSL}_2(\mathbb{F}_8)$  extensions. In particular, we prove that  $T$  is stably  $k$ -rational for  $G = \mathrm{Gal}(L/k) \simeq \mathrm{PSL}_2(\mathbb{F}_8)$ ,  $H = \mathrm{Gal}(L/K) \simeq (C_2)^3$  and  $H \simeq (C_2)^3 \rtimes C_7$  where  $C_n$  is the cyclic group of order  $n$ . Based on the result, we conjecture that  $T$  is stably  $k$ -rational for  $G \simeq \mathrm{PSL}_2(\mathbb{F}_{2^d})$ ,  $H \simeq (C_2)^d$  and  $H \simeq (C_2)^d \rtimes C_{2^d-1}$ . Some other cases  $G \simeq A_n, S_n, \mathrm{GL}_n(\mathbb{F}_{p^d}), \mathrm{SL}_n(\mathbb{F}_{p^d}), \mathrm{PGL}_n(\mathbb{F}_{p^d}), \mathrm{PSL}_n(\mathbb{F}_{p^d})$  and  $H \leq G$  are also investigated for small  $n$  and  $p^d$ .

- 30 丹原 大介 (弘前大\*) 有限体上の3次元可除代数  $A$  の  $A^2$  への作用 ..... 15  
Daisuke Tambara (Hirosaki Univ.\*) Intersection of subspaces  $Av$  in  $A^2$  for a three-dimensional division algebra  $A$  over a finite field

概要 Let  $A$  be a three-dimensional nonassociative division algebra over a finite field. Let  $A$  act on  $A^2$  by left multiplication. One of our results states that there exist  $v, v' \in A^2$  such that  $Av \cap Av'$  is two-dimensional if and only if  $A$  is isotopic to a commutative algebra.

- 31 上山 健太 (信州大理) 可算 Cohen–Macaulay 表現型非可換次数付き超曲面について ..... 15  
Kenta Ueyama (Shinshu Univ.) On noncommutative graded hypersurfaces of countable Cohen–Macaulay representation type

概要 We compute the stable categories of graded maximal Cohen–Macaulay modules over  $R_\varepsilon^1$  and  $R_\varepsilon^\infty$ , which are skew versions of  $R^1 = k[x_1, \dots, x_n]/(x_1^2 + \dots + x_n^2)$  with the standard grading and  $R^\infty = k[x_1, \dots, x_n]/(x_1^2 + \dots + x_{n-1}^2)$  with the standard grading, respectively. As a corollary we obtain that  $R_\varepsilon^1$  has finite Cohen–Macaulay representation type and  $R_\varepsilon^\infty$  has countably infinite Cohen–Macaulay representation type.

- 32 松野 仁樹 (東京理大教養教育) S型の3次元2次 Calabi–Yau AS 正則多元環の次数付き Ore 拡大 ..... 15  
板場 綾子 (東京理大教養教育)  
Masaki Matsuno (Tokyo Univ. of Sci.) Graded Ore extensions of 3-dimensional quadratic Calabi–Yau AS-regular algebras of Type S  
Ayako Itaba (Tokyo Univ. of Sci.)

概要 In noncommutative algebraic geometry, classification of 4-dimensional Artin–Schelter regular (AS-regular) algebras is one of the main interests. It is known that a graded Ore extension of a 3-dimensional quadratic AS-regular algebra is a 4-dimensional quadratic AS-regular algebra. In this talk, we show that every graded Ore extension  $\Lambda$  of a 3-dimensional quadratic AS-regular algebra satisfies (G1) condition about the point scheme of  $\Lambda$ . In particular, for Type S, we give a list of geometric pairs of graded Ore extensions of 3-dimensional quadratic Calabi–Yau AS-regular algebras. Also, we investigate whether  $\Lambda$  is geometric or not.

- 33 浅井聡太 (東大数理) 実 Grothendieck 群における  $M$ -TF 同値 ..... 15  
 伊山修 (東大数理)  
 Sota Asai (Univ. of Tokyo)  $M$ -TF equivalence in the real Grothendieck group  
 Osamu Iyama (Univ. of Tokyo)

概要 Let  $A$  be a finite dimensional algebra over a field. Then, the real Grothendieck group  $K_0(\text{proj}A)_{\mathbb{R}}$  of the category of finitely generated projective  $A$ -modules is an Euclidean space whose canonical basis is given by the isoclasses of indecomposable projective modules. By using semistable torsion pairs defined by Baumann–Kamnitzer–Tingley, Asai introduced an equivalence relation on  $K_0(\text{proj}A)_{\mathbb{R}}$  called TF equivalence. For each finitely generated module  $M \in \text{mod}A$ , we have found a method coarsening TF equivalence, and obtained a new equivalence relation on  $K_0(\text{proj}A)_{\mathbb{R}}$  called  $M$ -TF equivalence. We will talk about the definition and some important properties of  $M$ -TF equivalence.

14:15~14:30 2024年度(第27回)日本数学会代数学賞授与式

14:40~15:40 2024年度(第27回)日本数学会代数学賞受賞特別講演

浅芝秀人 有限次元代数の表現論とその応用 (導来同値の被覆および区間近似を中心)  
 (静岡大\*・京大高等研・阪公大数学研)  
 Hideto Asashiba Representation theory of finite-dimensional algebras and its applications  
 (Shizuoka Univ./Kyoto Univ./Osaka Metro. Univ.) (with a focus on coverings of derived equivalences and interval approximations)

概要 In the first part of the lecture, as a topic of representation theory of finite-dimensional algebras, I will start with an overview of the derived equivalence classification of self-injective algebras, and then outline the 2-categorical covering theory and its applications to derived equivalences. In the second part, as an application of the representation theory to topological data analysis, the interval resolutions and interval replacements of persistence modules (modules over a finite poset) will be outlined.

16:00~17:00 2024年度(第27回)日本数学会代数学賞受賞特別講演

中村健太郎 (佐賀大理工) 階数2の  $p$  進ガロア表現の岩澤理論について  
 Kentaro Nakamura (Saga Univ.) Iwasawa theory for rank two  $p$ -adic Galois representations

概要 In this talk, I will explain our main results on Kazuya Kato's conjectures on the local and the global Iwasawa main conjecture for rank two  $p$ -adic Galois representations. One result concerns with the existence of zeta elements for the universal deformations of rank two global  $p$ -adic Galois representations. The other one concerns with the existence of local zeta elements for the universal deformations of rank two local  $p$ -adic Galois representations. For both results, the theory of  $p$ -adic (local and global) Langlands correspondence for  $GL_2$  is crucial. I'd like to explain that there exist deep relationships between  $p$ -adic Langlands correspondence and Kato's conjectures.

3月20日(水) 第I会場

9:00~12:00

- 34 助永真之 (広島大先進理工)  $\mathbb{R}^3$  内の種数3の滑らかな完全交叉空間トポカル曲線 ..... 15  
 Masayuki Sukenaga (Hiroshima Univ.) Smooth tropical complete intersection curves of genus 3 in  $\mathbb{R}^3$

概要 We develop a method for describing the tropical complete intersection of a tropical hypersurface and a tropical plane in  $\mathbb{R}^3$ . This involves a method for determining the topological type of a complete intersection by using a polyhedral complex. As an application, we show that there are no smooth tropical complete intersection curves in  $\mathbb{R}^3$  whose skeletons are the lollipop graph of genus 3. This gives a partial answer to the open question of whether a lollipop graph of genus 3 appears in the skeleton of a tropical curve on a tropical plane in  $\mathbb{R}^3$ .

- 35 澤原 雅知 (弘前大教育) Cylindricity of Du Val del Pezzo surfaces ..... 15  
 Masatomo Sawahara (Hirosaki Univ.) Cylindricity of Du Val del Pezzo surfaces

概要 A cylinder in an algebraic variety means its open subset, which is isomorphic to the direct product of the affine line and an algebraic variety. In this talk, we will present the existing condition of polarized cylinders in Du Val del Pezzo surfaces of degree at least 2 defined over an algebraically closed field of characteristic 0. Moreover, we will also explain the existence criterion of cylinders in Du Val del Pezzo surfaces defined over an algebraically closed field of characteristic 2.

- 36 渡邊 健太 (日大理工) K3 曲面に含まれる曲線上の直線束の持ち上げに関する Donagi–Morrison  
 の予想とその応用 ..... 15  
 Kenta Watanabe (Nihon Univ.) Donagi–Morrison conjecture concerning lifts of line bundles on curves  
 contained in a K3 surface and its applications

概要 Let  $X$  be a K3 surface, and let  $L$  be a base point free and big line bundle of sectional genus  $g$  on  $X$ . Then the polarized K3 surface  $(X, L)$  is called Brill–Noether special if there exists a non-trivial line bundle  $M$  on  $X$  with  $M \neq L$  such that  $h^0(M)h^0(L \otimes M^\vee) \geq h^0(L) = g + 1$ . If  $(X, L)$  is Brill–Noether special, then any smooth curve  $C \in |L|$  is Brill–Noether special. Because, the Brill–Noether number of  $M \otimes \mathcal{O}_C$  is negative. However, the converse is still open. In this talk, I would like to focus on the Donagi–Morrison conjecture concerning the existence of lifts of line bundles on curves on a K3 surface and its applications.

- 37 渡邊 究 (中大理工) Contractions and non-free rational curves on Fano varieties ..... 15  
 Kiwamu Watanabe (Chuo Univ.) Contractions and non-free rational curves on Fano varieties

概要 Let  $X$  be a complex smooth Fano variety whose minimal anticanonical degree of non-free rational curves on  $X$  is at least  $\dim X - 2$ . We give a classification of extremal contractions of such varieties. As applications, we obtain a classification of Fano fourfolds whose pseudoindex and Picard number are greater than one and study the structure of Fano varieties with nef third exterior power of the tangent bundle.

- 38 鈴木 香織 (横浜国大経営) 複素 3 次元 Fano 多様体の Graded Ring Database と Bogomolov 境界条  
 件 ..... 15  
 Kaori Suzuki (Yokohama Nat. Univ.) Graded Ring Database of Fano 3-folds with Bogomolov condition

概要 I will talk about the classification of Fano 3-fold in Graded Ring Database with some examples.

- 39 岡村 郁弥 (名大多元数理) Rational curves on Fano threefolds with terminal factorial singularities  
 ..... 15  
 Fumiya Okamura (Nagoya Univ.) Rational curves on Fano threefolds with terminal factorial singularities

概要 We would like to discuss the space of rational curves on Fano threefolds with terminal factorial singularities. The project is motivated by the result of the paper by Roya Beheshti, Brian Lehmann, Eric Riedl, and Sho Tanimoto, regarding the Geometric Manin’s conjecture (GMC) for smooth Fano threefolds. GMC predicts the asymptotic formula for the number of irreducible components of the Hom scheme  $\text{Hom}(\mathbb{P}^1, X, \alpha)$  as  $\alpha \in \overline{\text{Eff}}_1(X)$  grows positively. One of the main theorems is that GMC holds for terminal factorial del Pezzo threefolds of Picard rank 1 and  $(-K_X)^3 \geq 24$ .

- 40 高 潤 宣 (名大多元数理) The geometric exceptional set in Manin’s conjecture for Batyrev and Tschinkel’s example ..... 15  
 Runxuan Gao (Nagoya Univ.) The geometric exceptional set in Manin’s conjecture for Batyrev and Tschinkel’s example

概要 Batyrev and Tschinkel’s example is a Fermat cubic surface bundle  $X$  which is a Fano 5-fold. It is the first example for which Manin’s conjecture can never hold for a proper closed exceptional set. Over a field  $F$  of characteristic 0, we give the minimal subset  $Z$  of  $X(F)$  that contains every rational point coming from a thin map  $f : Y \rightarrow X$  with equal or higher  $a$ - and  $b$ -values in lexicographical order, which is conjectured to be the correct exceptional set in Manin’s conjecture. The set  $Z$  is a thin set defined by finitely many thin maps. Over a number field  $F$ , we show that every such thin map  $f$  factors through the finitely many ones.

- 41 野 間 淳 (横浜国大環境情報) Duality for projective morphisms finite in codimension one and the positivity of double point divisors of general inner projections ..... 15  
 Atsushi Noma (Yokohama Nat. Univ.) Duality for projective morphisms finite in codimension one and the positivity of double point divisors of general inner projections

概要 The purpose of this paper is to prove the positivity of double point divisors of general inner projections for projective  $S_2$ -varieties with invertible dualizing sheaves, without assuming the smoothness or the normality of varieties. As applications, we characterize two types of projective varieties: varieties with trivial double point divisors and varieties with  $d - e - 1 \leq n$  for dimension  $n$ , degree  $d$  and codimension  $e$ .

- 42 岩 見 智 宏 (九 工 大 工) Canonical embedding of Clemens–Griffiths–Kuznetsov components via three-dimensional Miyaoka–Yau type inequality with the associated third Chern classes ..... 15  
 Tomohiro Iwami (Kyushu Inst. of Tech.) Canonical embedding of Clemens–Griffiths–Kuznetsov components via three-dimensional Miyaoka–Yau type inequality with the associated third Chern classes

概要 Based on our serial works ([I. 2018 Mar; 2020 Sep]) about three-dimensional Miyaoka–Yau type inequality with the associated third Chern classes ( $(MY)_{3,c_3}$ ), and its variant form with driven by symmetric 2-forms ( $(MY)_{3,c_3,S^2}$ ), on an (extended) three-dimensional extremal neighborhood  $(X, C) \subset \mathbb{C}^4$  ([Mori-Prokhorov 2021], [I. 2019 Sep]) with  $C$  reducible, in this talk, we mainly will give: i) to justify “Clemens–Griffiths–Kuznetsov (CGK) component”  $\mathcal{C}_{CGK}$  corresponding to Artin–Mumford or Clemens–Griffiths properties related to  $(X, C)$  via several properties of  $(MY)_{3,c_3}, (MY)_{3,c_3,S^2}$  ([I. 2019 Sep; 2020 Sep; 2021 Sep; 2022 Mar,Sep; 2023 Mar]), and ii) to give “canonical” embedding  $\Phi$  of  $\mathcal{C}_{CGK}$  by  $(MY)_{3,c_3,S^2}$ , which is an answer to the sect. (2.3) of [Li-Pertushi-Zhao, 2022], on which they mention to need three-dimensional Bogomolov type inequality with  $c_3$  for embedding CGK component, and they use bounded derived category without it. Here, the word “canonical” means: other than categorical embedding, the target of  $\Phi$  is not necessary bounded derived category, but occurs to be  $n(\geq 3)$ -angulated category with “selective” topologicality given by  $(MY)_{3,c_3,S^2}$ , which seem to be more flexible than [Li-Pertushi-Zhao,2022].

## 14:15~18:00

- 43 金井和貴(呉工高専) 有限群の一様巡回群分解とカードベース暗号 ..... 15  
 宮本賢伍(茨城大工)  
 縫田光司(九大IMI)  
 品川和雅(茨城大工)  
 Kazuki Kanai (Kure Nat. Coll. of Tech.) Uniform cyclic group factorization of finite groups and card-based cryp-  
 Kengo Miyamoto (Ibaraki Univ.) tography  
 Koji Nuida (Kyushu Univ.)  
 Kazumasa Shinagawa (Ibaraki Univ.)

概要 In this talk, we introduce a kind of factorization of finite groups called a uniform cyclic group factorization. It has an application to card-based cryptography, which is a research field that uses a deck of physical cards like playing cards to implement cryptographic techniques. If a group admits a uniform cyclic group factorization, then a card shuffle operation associated with the group can be implemented by random cyclic shifts. We believe that our research combines mathematical research on the factorization of finite groups with cryptographic research on card-based cryptography, providing a new perspective on both fields.

- 44 安東雅訓(奈良学園大人間教育) 対称群と交代群の被覆群における原田予想 II ..... 10  
 青影一哉(有明工高専)  
 Masanori Ando (Naragakuen Univ.) Harada conjecture II in the covering groups of symmetric groups and  
 Kazuya Aokage alternating groups  
 (Ariake Nat. Coll. of Tech.)

概要 Harada conjectured that the product of the sizes of all conjugacy classes is divided by the product of the degrees of all irreducible characters for any finite group. When the group is the symmetric group  $S_n$  and the alternating group  $A_n$ , this conjecture is presented by the hook length properties of the Young diagram. We show the conjecture for the covering groups of symmetric groups and alternating groups.

- 45 田邊顕一郎(東京都市大共通教育) 頂点代数上の加群のシュアー・ワイル型双対性 ..... 15  
 Kenichiro Tanabe (Tokyo City Univ.) A Schur–Weyl type duality for twisted weak modules over a vertex al-  
 gebra

概要 Let  $V$  be a vertex algebra of countable dimension,  $G$  a subgroup of  $\text{Aut}V$  of finite order,  $V^G$  the fixed point subalgebra of  $V$  under the action of  $G$ . We show a Schur–Weyl type duality for the actions of an associative algebra and  $V^G$ .

- 46 川節和哉(熊本大先導機構)  $A_1$ 型格子頂点代数の主部分空間の中心化代数について ..... 10  
 Kazuya Kawasetsu (Kumamoto Univ.) On the commutant of the principal subalgebra in the  $A_1$  lattice vertex  
 algebra

概要 The coset (commutant) construction is a fundamental tool to construct vertex operator algebras from known vertex operator algebras. The aim of this talk is to provide a fundamental example of the commutants of vertex algebras outside vertex operator algebras. Namely, the commutant  $C$  of the *principal subalgebra*  $W$  of the  $A_1$  lattice vertex operator algebra  $V_{A_1}$  is investigated. An explicit minimal set of generators of  $C$ , which consists of infinitely many elements and strongly generates  $C$ , is introduced. It implies that the algebra  $C$  is not finitely generated. Furthermore, Zhu's Poisson algebra of  $C$  is shown to be isomorphic to an infinite-dimensional algebra  $\mathbb{C}[x_1, x_2, \dots]/(x_i x_j | i, j = 1, 2, \dots)$ . In particular, the associated variety of  $C$  consists of a point. Moreover,  $W$  and  $C$  are verified to form a dual pair in  $V_{A_1}$ .

- 47 功刀直子 (東京理大理) 有限群の主ブロックの森田型相対安定同値と森田同値 ..... 15  
 鈴木香一 (東京理大理)  
 Naoko Kunugi (Tokyo Univ. of Sci.) Relative stable equivalences of Morita type and Morita equivalences for  
 Kyoichi Suzuki (Tokyo Univ. of Sci.) the principal blocks of finite groups

概要 Let  $p$  be a prime. We consider finite groups  $G$  and  $G'$  having a common central  $p$ -subgroup. In 2018, Wang and Zhang introduced the notion of relative stable equivalence of Morita type for blocks of finite groups. In this talk, we give a method of constructing a Morita equivalence between the principal  $p$ -blocks of  $G$  and  $G'$  using this notion.

- 48 小境雄太 (東京理大理) ブリックに関するクリフォードの定理 ..... 10  
 酒井嵐士 (名大多元数理)  
 Yuta Kozakai (Tokyo Univ. of Sci.) Clifford's theorem for bricks  
 Arashi Sakai (Nagoya Univ.)

概要 Let  $G$  be a finite group,  $N$  a normal subgroup and  $k$  an algebraically closed field of characteristic  $p > 0$ . Clifford's theorem states that the restricted module of arbitrary simple  $kG$ -module to  $kN$  is a semisimple module. In this talk, we introduce the brick version of Clifford's theorem.

- 49 M. Forsberg Conde New homomorphisms between Specht modules of the symmetric group ..... 15  
 (沖縄科学技術大)  
 Martín Forsberg Conde New homomorphisms between Specht modules of the symmetric group  
 (Okinawa Inst. of Sci. and Tech. Grad. Univ.)

概要 Describing the homomorphism spaces between Specht modules of the symmetric groups in positive characteristic is an important open problem in representation theory. Carter and Payne gave a remarkable result describing homomorphisms between Specht modules whose associated partitions differ by a single row. We describe the use of techniques from quiver Hecke algebras to achieve a generalization of the Carter–Payne theorem.

- 50 L. Speyer (沖縄科学技術大) Graded decomposition matrices for type  $C$  KLR algebras ..... 15  
 Liron Speyer Graded decomposition matrices for type  $C$  KLR algebras  
 (Okinawa Inst. of Sci. and Tech. Grad. Univ.)

概要 Outside of type A, the cyclotomic KLR algebras are still quite mysterious, and have not been studied in great detail. They have been gaining attention in type C recently, and we now have several useful tools with which we may study their representation theory. These include a theory of Specht modules, underpinned by combinatorics of multipartitions and tableaux, analogous to the type A situation, and Evseev and Mathas's recent proof that these algebras are graded cellular. Building on these ideas, in joint work with Chris Chung and Andrew Mathas, we have calculated graded decomposition matrices in small ranks. We will explain the techniques used in this endeavour, and point to some interesting examples whose behaviour look very different to what we see in type A.



- 51 河野隆史 (早大理工)  $C$ 型旗多様体の同変量子  $K$ 環の Borel 表示 ..... 15  
 内藤 聡 (東工大理工)  
 Takafumi Kouno (Waseda Univ.) The Borel-type presentation of the equivariant quantum  $K$ -ring of the  
 Satoshi Naito (Tokyo Tech) flag manifold in type  $C$

概要 We give the Borel-type presentation of the equivariant quantum  $K$ -ring of the flag manifold in type  $C$ . The Borel-type presentation is an explicit quotient of a Laurent polynomial ring which is isomorphic to the equivariant quantum  $K$ -ring as rings. By specializing the Novikov variables in the Borel-type presentation of the equivariant quantum  $K$ -ring to 0, we can obtain the well-known Borel presentation of the equivariant  $K$ -ring of the flag manifold. In this sense, our presentation can be viewed as a quantum analogue of the classical Borel presentation.

- 52 木村雄太 (阪公大理) 変形前射影代数の傾イデアル ..... 15  
 Yuta Kimura (Osaka Metro. Univ.) Tilting ideals for deformed preprojective algebras

概要 Let  $K$  be a field and  $Q$  a finite acyclic quiver with  $n$  vertices. For an element  $\lambda$  of  $K^n$ , the deformed preprojective algebra  $\Pi(Q, \lambda)$  was introduced and studied by Crawley-Boevey and Holland to study deformations of Kleinian singularities. If  $\lambda = 0$ , then  $\Pi(Q, 0)$  is the preprojective algebra introduced by Gelfand–Ponomarev, and appears in many areas of mathematics. Among interesting properties of  $\Pi(Q, 0)$ , the classification of tilting ideals of  $\Pi(Q, 0)$  is fundamental and important. In this talk, we classify tilting ideals of  $\Pi(Q, \lambda)$  by using a Coxeter group. This is joint work with William Crawley-Boevey.

- 53 浅芝秀人 Relative Koszul coresolutions and relative Betti numbers ..... 15  
 (静岡大\*・京大高等研・阪公大数学研)  
 Hideto Asashiba Relative Koszul coresolutions and relative Betti numbers  
 (Shizuoka Univ.\* / Kyoto Univ. / Osaka Metro. Univ.)

概要 Let  $G$  be a generator and a cogenerator in the category of finitely generated right  $A$ -modules for a finite-dimensional algebra  $A$  over a field  $\mathbb{k}$ , and  $\mathcal{I}$  the additive closure of  $G$ . We will define a  $\mathcal{I}$ -relative Koszul coresolution  $\mathcal{K}^\bullet(V)$  of an indecomposable direct summand  $V$  of  $G$ , and show that for a finitely generated  $A$ -module  $M$ , the  $\mathcal{I}$ -relative  $i$ -th Betti number for  $M$  at  $V$  is given as the  $\mathbb{k}$ -dimension of the  $i$ -th homology of the  $\mathcal{I}$ -relative Koszul complex  $\mathcal{K}_V^\bullet(M) := \text{Hom}_A(\mathcal{K}^\bullet(V), M)$  of  $M$  at  $V$  for all  $i \geq 0$ . This is applied to investigate the minimal interval resolution/coresolution of a persistence module  $M$ , e.g., to check the interval decomposability of  $M$ , and to compute the interval replacement of  $M$ .

- 54 谷本龍二 (静岡大教育) Fundamental representations of  $\mathbb{G}_a$  into  $\text{SL}(3, k)$  in positive character-  
 istic ..... 15  
 Ryuji Tanimoto (Shizuoka Univ.) Fundamental representations of  $\mathbb{G}_a$  into  $\text{SL}(3, k)$  in positive character-  
 istic

概要 Let  $k$  be an algebraically closed field of positive characteristic  $p$  and let  $\mathbb{G}_a$  denote the additive group of  $k$ . A representation  $u : \mathbb{G}_a \rightarrow \text{SL}(n, k)$  is said to be fundamental if  $u$  factors through a representation of  $\text{SL}(2, k)$ . In the case where  $p \geq 3$ , Fauntleroy (1977) gave a representation  $u : \mathbb{G}_a \rightarrow \text{SL}(3, k)$  so that  $u$  is not fundamental. In this talk, we classify fundamental representations of  $\mathbb{G}_a$  into  $\text{SL}(3, k)$  in positive characteristic.

## 幾何学

3月17日(日) 第IV会場

9:30~11:45

- 1 上野 龍 (北大理) 統計2重調和写像 ..... 15  
 古畑 仁 (北大理)  
 Ryu Ueno (Hokkaido Univ.) Statistical biharmonic map  
 Hitoshi Furuhata (Hokkaido Univ.)

概要 We present statistical biharmonic maps, a new class of mappings between statistical manifolds derived from a natural variation problem. We give the Euler–Lagrange equation of this problem, and prove that improper affine spheres induce examples of such maps.

- 2 本田 淳史 (横浜国大理工) 特異点をもつ閉曲線の絶対全曲率 ..... 15  
 田中 千紗  
 (NTT データフロンティア)  
 山内 優太 (横浜国大理工)  
 Atsufumi Honda The total absolute curvature of closed curves with singularities  
 (Yokohama Nat. Univ.)  
 Chisa Tanaka  
 (NTT DATA Frontier Corp.)  
 Yuta Yamauchi (Yokohama Nat. Univ.)

概要 In this talk, we give a generalization of Fenchel's theorem for wave fronts in the  $n$ -dimensional Euclidean space  $R^n$ . We prove that, for a closed non-co-orientable 1-dimensional frontal in  $R^n$ , its total absolute curvature is greater than or equal to  $\pi$ . The equality holds if and only if the frontal is a planar L-convex closed frontal whose rotation index is  $\frac{1}{2}$  or  $-\frac{1}{2}$ . Furthermore we show that, if the total absolute curvature is  $\pi$  and if the frontal admits at most cusps, the number  $N$  of cusps is an odd integer greater than or equal to 3, and  $N = 3$  holds if and only if the wave front is a simple closed curve.

- 3 古賀 勇 3次元球面から複素射影空間への全実調和写像の分類 ..... 15  
 (産業数理研 Calc・広島大理)  
 長友 康行 (明大理工)  
 Isami Koga Harmonic totally real maps of the 3-sphere into the complex projective  
 (Math. Res. Inst. Calc for Industry/Hiroshima Univ.) spaces  
 Yasuyuki Nagatomo (Meiji Univ.)

概要 I would like to introduce a classification result of harmonic totally real maps with constant energy density of the 3-sphere into the complex projective spaces.

- 4 岸田 陸 玖 (東工大情報理工) 共形平坦な多様体の光錐内における体積の変分について ..... 15  
 Riku Kishida (Tokyo Tech) The volume of conformally flat manifolds as hypersurfaces in the light-  
 cone

概要 In this talk, we focus on a conformally flat Riemannian manifold  $(M^n, g)$  isometrically immersed into the light-cone  $\Lambda^{n+1}$  as a hypersurface. We compute the first and the second variational formulas on the volume of such hypersurfaces. Such a hypersurface  $M^n$  is not only immersed in  $\Lambda^{n+1}$  but also isometrically realized as a hypersurface of a certain null hypersurface  $N^{n+1}$  in the Minkowski spacetime, which is different from  $\Lambda^{n+1}$ . Moreover,  $M^n$  has a volume-maximizing property in  $N^{n+1}$ .



- 5 佐々木 優 (宇都宮大教育) 四元数対称空間のイソトロピー群作用の軌道 ..... 15  
 Yuuki Sasaki (Utsunomiya Univ.) Orbits of the isotropy group action on quaternionic symmetric spaces

概要 A symmetric space which is a quaternionic Kahler manifold is called a quaternionic symmetric space. We study some properties of orbits of the isotropy group action on a compact quaternionic symmetric space with respect to the quaternionic structure. In particular, an orbit is a totally complex submanifold or a quaternionic submanifold if and only if the orbit is a polar. Moreover, many orbits containing principal orbits satisfy some property which is an analogy of a totally complex submanifolds.

- 6 梶ヶ谷 徹 (東京理大理) 非負曲率等質多様体への安定離散写像の非存在 ..... 15  
 Toru Kajigaya (Tokyo Univ. of Sci.) Nonexistence of stable discrete maps into some homogeneous spaces of nonnegative curvature

概要 We consider stabilities for the weighted length or energy functional of a discrete map from a finite weighted graph  $(X, m_E)$  into a smooth Riemannian manifold  $(M, g)$ . We prove the non-existence of a stable discrete minimal immersion or a non-constant stable discrete harmonic map from a finite weighted graph into certain homogeneous spaces, such as Kähler  $C$ -spaces of positive holomorphic sectional curvature and some simply-connected compact Riemannian symmetric spaces.

- 7 大野 優 (北大理)  $\mathbb{S}^2 \times \mathbb{R}$  と  $\mathbb{H}^2 \times \mathbb{R}$  の等質構造 ..... 15  
 Yu Ohno (Hokkaido Univ.) Homogeneous Structures on  $\mathbb{S}^2 \times \mathbb{R}$  and  $\mathbb{H}^2 \times \mathbb{R}$

概要 We determine all the homogeneous structure tensors on  $\mathbb{S}^2 \times \mathbb{R}$  and  $\mathbb{H}^2 \times \mathbb{R}$ . This work together with previous articles yields a complete classification of all the homogeneous structure tensors on three-dimensional homogeneous Riemannian manifolds.

#### 14:15~16:10

- 8 池田 憲明 (立命館大理工) Hamilton Lie algebroids over Dirac structures ..... 15  
 Noriaki Ikeda (Ritsumeikan Univ.) Hamilton Lie algebroids over Dirac structures

概要 We propose a Hamiltonian Lie algebroid and a momentum section over a Dirac structure as a generalization of a Hamiltonian Lie algebroid over a pre-symplectic manifold and one over a Poisson manifold. A Hamiltonian Lie algebroid and a momentum section are generalizations of a Hamiltonian G-space and a momentum map over a symplectic manifold.

- 9 廣田 祐士 (麻布大獣医) 運動量写像の拡張と四元ケーラー対称性 ..... 15  
 池田 憲明 (立命館大理工)  
 Yuji Hirota (Azabu Univ.) Expansion of momentum maps, and quaternionic Kähler symmetries  
 Noriaki Ikeda (Ritsumeikan Univ.)

概要 We expand the notion of homotopy momentum sections in multisymplectic geometry to the one for bundle-valued multisymplectic manifolds with Lie algebroids. We focus on the momentum map for quaternionic Kähler manifolds introduced by K. Galicki and H. B. Lawson, and describe the condition for it to be the expanded homotopy momentum section.

- 10 西田安寿菜 (千葉大融合理工) モースホモトピーを用いた重み付き射影空間のホモロジー的ミラー対称性について ..... 15  
 Azuna Nishida (Chiba Univ.) Homological mirror symmetry for weighted projective spaces via Morse homotopy

概要 We discuss homological mirror symmetry for weighted projective spaces (WPS) based on SYZ construction. We consider WPS with a moment map on the complex side and the open dense torus as the torus fibration over the interior of the moment polytope. On the mirror symplectic side, we consider the dual torus fibration with the same base and a generalization of Fukaya–Oh category of Morse homotopy of the polytope on it.

- 11 山口健太郎 (都立大理) アフィン部分空間から定まるトーリック多様体のトーラス同変埋め込みについて ..... 15  
 Kentaro Yamaguchi (Tokyo Metro. Univ.) Torus-equivalently embedded toric manifolds associated to affine subspaces

概要 We study the closure of a complex subtorus in a toric manifold. If the closure of the complex subtorus is a smooth complex submanifold in the toric manifold, then the subtorus action on such submanifold is Hamiltonian. In this case, we may think of the embedding of the submanifold as a torus-equivalent embedding. We show that the image of the moment map for the Hamiltonian subtorus action on our submanifold coincides with the image of the Delzant polytope of the ambient toric manifold under the pullback of the inclusion of the tori. The submanifolds constructed in our talk are called torus-equivalently embedded toric manifolds with respect to the subtorus action.

- 12 中西隼斗 (千葉大融合理工) ヒルツェブルフ曲面  $\mathbb{F}_k$  の SYZ ミラーとモースホモトピー ..... 15  
 Hayato Nakanishi (Chiba Univ.) SYZ mirror of Hirzebruch surface  $\mathbb{F}_k$  and Morse homotopy

概要 We study homological mirror symmetry for Hirzebruch surface  $\mathbb{F}_k$  as a complex manifold by using the Strominger–Yau–Zaslow construction of mirror pair and Morse homotopy. For the Hirzebruch surface  $\mathbb{F}_1$ , Futaki–Kajiura proved homological mirror symmetry by using SYZ construction and Morse homotopy. We extend Futaki–Kajiura’s result of Hirzebruch surface  $\mathbb{F}_1$  to  $\mathbb{F}_k$ . In this talk, we construct a quasi-isomorphism from the category of Morse homotopy to the DG category of the complex side and discuss the minimality of the category of Morse homotopy.

- 13 米原修平 (阪大理) coKähler 多様体上の Hamilton 作用と簡約定理 ..... 15  
 Shuhei Yonehara (Osaka Univ.) Hamiltonian actions on coKähler manifolds and a reduction theorem

概要 The notion of cosymplectic manifolds is an odd-dimensional analogue of symplectic manifolds. Albert introduced the concept of Hamiltonian actions on cosymplectic manifolds and proved a reduction theorem. In this talk, we refine this theorem in the case of coKähler manifolds, that is, normal almost contact metric manifolds which have a compatible cosymplectic structure.

**16:25~17:25 特別講演**

植田 一石 (東大数理) ミラー対称性と退化

Kazushi Ueda (Univ. of Tokyo) Mirror symmetry and degeneration

概要 Mirror symmetry is a mysterious relationship between complex geometry and symplectic geometry, which is inspired by string theory. It suggests that strings perceive the world fundamentally differently from particles. Since every compact symplectic manifold comes in a family with varying volumes, a mirror of a compact symplectic manifold is not a single complex manifold but a degenerating family of complex manifolds. Studying the limits of degenerating families in various contexts is one of the central problems in geometry, related to compactifications of moduli spaces and localization (or concentration) of information near singular points. In the talk, I will discuss degenerations from the perspective of mirror symmetry.

3月18日(月) 第IV会場

**10:10~10:25 2023年度日本数学会幾何学賞授賞式****10:30~11:30 2023年度日本数学会幾何学賞受賞特別講演 (トポロジー分科会と合同)**藤田 健人 (阪大理) ファノ多様体の  $K$  安定性の判定法についてKento Fujita (Osaka Univ.) On criteria for the  $K$ -stability of Fano varieties概要 We survey recent progress on  $K$ -stability of Fano varieties.**13:00~14:00**

- 14 青木 侑省 (名工大) ケーラー多様体上の特性磁性焦値の評価 ..... 15  
足立 俊明 (名工大)

Yusei Aoki (Nagoya Inst. of Tech.) Estimates on characteristic magnetic focal value on Kähler manifold

Toshiaki Adachi (Nagoya Inst. of Tech.)

概要 A Kähler magnetic fields on a Kähler manifold is a constant multiple of the Kähler form. We study magnetic Jacobi fields which are obtained as derivatives of variations of trajectories for Kähler magnetic fields. In this talk, we consider a “special” magnetic Jacobi field along trajectory. Since velocity vector and acceleration vector span a complex line, we study “special” magnetic Jacobi fields which are related with such directions. We take auxiliary magnetic Jacobi field to estimate. We get estimates of “special” magnetic Jacobi field by comparing magnetic Jacobi field on complex space forms.

- 15 佐藤 健治 (玉川大工) 球面三角形と双曲三角形の新しい重心二種 ..... 15  
Kenzi Satô (Tamagawa Univ.) Two kinds of new centroids of spherical and hyperbolic triangles

概要 The centroid of a planar triangle satisfies many properties, but the points with each property are different for a spherical or hyperbolic triangle. In this talk, the point trisecting the area and the concurrent point of 3 arcs bisecting the area are considered.

- 16 V. Pérez-Valdés (東大数理) 対  $(SO(4,1), SO(3,1))$  の主系列表現に対する微分対称性破れ作用素について ..... 15

Victor Pérez-Valdés (Univ. of Tokyo) Differential symmetry breaking operators for principal series representations of the pair  $(SO(4,1), SO(3,1))$ 

概要 In this talk, we discuss about the problem of constructing and classifying all differential symmetry breaking operators for principal series representations of the pair  $(SO(4,1), SO(3,1))$

## 3月19日(火) 第IV会場

9:30~11:45

- 17 濱中翔太 (三菱電機先端技術総合研) Limit theorems for the total scalar curvature ..... 15

Shota Hamanaka (Mitsubishi Electric Corp. Adv. Tech. R&D Center) Limit theorems for the total scalar curvature

概要 In this talk, we give some  $W^{1,p}$  limit theorems for total scalar curvatures. More precisely, we show that the lower bound of the total scalar curvatures on a closed  $n$ -manifold is preserved under the  $W^{1,p}$  convergence of the Riemannian metrics for  $p > n$  provided that each scalar curvature is nonnegative. We also give an example which suggests that the  $W^{1,p}$  ( $p > n$ ) convergence is almost optimal.

- 18 藤岡禎司 (阪大理) 曲率の上界と曲率積分の下界 ..... 15  
Tadashi Fujioka (Osaka Univ.) Upper curvature bound and the curvature integral

概要 We prove that the integral of scalar curvature over a Riemannian manifold is uniformly bounded below in terms of its dimension, upper bounds on sectional curvature and volume, and a lower bound on injectivity radius. This is an analogue of an earlier result of Petrunin for Riemannian manifolds with sectional curvature bounded below. Both proofs rely on the convergence theory of Riemannian manifolds with one-sided curvature bounds. The parallel structure comes from that of the limit spaces, i.e., Alexandrov spaces and GCBA spaces.

- 19 只野 誉 (山口大理) Improved oscillation estimates and the Hitchin–Thorpe inequality on compact Ricci solitons ..... 15

Homare Tadano (Yamaguchi Univ.) Improved oscillation estimates and the Hitchin–Thorpe inequality on compact Ricci solitons

概要 Stimulated by improved oscillation estimates of the potential function and the scalar curvature on compact gradient Ricci solitons introduced in a recent work by X. Cheng, E. Ribeiro Jr., and D. Zhou (Proc. Amer. Math. Soc. Ser. B **10** (2023), 33–45), we give several new sufficient conditions for compact four-dimensional normalized shrinking Ricci solitons to satisfy the Hitchin–Thorpe inequality. Our new conditions refine the validity of the Hitchin–Thorpe inequality obtained by the author (J. Math. Phys. **58** (2017), 023503 & J. Math. Phys. **59** (2018), 043507 & Differential Geom. Appl. **66** (2019), 231–241).

- 20 只野 誉 (山口大理) Gradient estimates and Harnack inequalities for porous medium and fast diffusion equations via  $m$ -Bakry–Émery Ricci curvature with  $\varepsilon$ -range · 15

Homare Tadano (Yamaguchi Univ.) Gradient estimates and Harnack inequalities for porous medium and fast diffusion equations via  $m$ -Bakry–Émery Ricci curvature with  $\varepsilon$ -range

概要 We derive some new local gradient estimates of Li–Yau, Hamilton, Li–Xu types for positive solutions to porous medium and fast diffusion equations associated with the Witten Laplacian on a complete Riemannian manifold via  $m$ -Bakry–Émery Ricci curvature with  $\varepsilon$ -range. As applications, we give some Harnack inequalities for positive solutions to porous medium and fast diffusion equations associated with the Witten Laplacian on a complete non-compact Riemannian manifold via  $m$ -Bakry–Émery Ricci curvature with  $\varepsilon$ -range.

- 21 見村万佐人 (東北大理)  $\flat$  拡張不能な不変擬準同型のなす空間 ..... 15

川崎盛通 (北大理)

木村満晃 (京大理)

松下尚弘 (信州大理)

丸山修平 (金沢大理工)

Masato Mimura (Tohoku Univ.) The space of non-extendable invariant quasimorphisms

Morimichi Kawasaki (Hokkaido Univ.)

Mitsuaki Kimura (Kyoto Univ.)

Takahiro Matsushita (Shinshu Univ.)

Shuhei Maruyama (Kanazawa Univ.)

概要 We study the space of non-extendable invariant quasimorphisms.

- 22 見村万佐人 (東北大理)  $\flat$  scl と粗い群 ..... 15

川崎盛通 (北大理)

木村満晃 (京大理)

松下尚弘 (信州大理)

丸山修平 (金沢大理工)

Masato Mimura (Tohoku Univ.) scl and coarse groups

Morimichi Kawasaki (Hokkaido Univ.)

Mitsuaki Kimura (Kyoto Univ.)

Takahiro Matsushita (Shinshu Univ.)

Shuhei Maruyama (Kanazawa Univ.)

概要 We initiate coarse group theoretic study of scl (stable commutator length).

- 23 大島 駿 (東北大理) 測度距離空間のオブザーバブル直径と正の測度を持つ点の存在 ..... 15

Shun Oshima (Tohoku Univ.) The observable diameter of metric measure spaces and the existence of points with positive measures.

概要 A metric measure space is a metric space with a Borel measure. This concept was defined when considering the limit of a sequence of Riemannian manifolds. Currently, there are several definitions of metric measure spaces, and one of them is a metric measure space with a probability measure considered by Gromov. In the theory of this metric measure space, the invariants called the partial diameter and the observable diameter are often used. We obtained the result that the partial diameter or the observable diameter equals zero if and only if there exist points that have positive measures (called the atoms).

#### 14:15~17:10

- 24 伊敷喜斗 (理化学研RAP) 距離関数の空間の中の強リジット距離関数 ..... 15

Yoshito Ishiki (RIKEN) Strongly rigid metrics in spaces of metrics

概要 A metric space is said to be strongly rigid if no positive distance is taken twice by the metric. In 1972, Janos proved that a separable metrizable space has a strongly rigid metric if and only if it is zero-dimensional. As a development of this result, for a zero-dimensional metrizable space, we prove that the set of all strongly rigid metrics is dense in the space of metrics. Moreover, if the space is the union of countably many compact subspaces, then that set is comeager. As a consequence, we show that for a strongly zero-dimensional metrizable space, the set of all metrics possessing no nontrivial (bijective) self-isometry is comeager in the space of metrics.

- 25 清 智 也 (東大情報理工) Stein identity and Poincaré inequality for a discrete metric measure  
田 中 潮 (阪 公 大 理) space ..... 15  
Tomonari Sei (Univ. of Tokyo) Stein identity and Poincaré inequality for a discrete metric measure  
Ushio Tanaka (Osaka Metro. Univ.) space

概要 A Gaussian random variable is characterised in terms of a differentiable real-valued function. The characterisation is referred to as Stein identity. Stein identity implies Poincaré inequality in terms of a random variable. We observe the implication from the point of view of a discrete distribution via quantification. This observation enables us to show Stein identity and Poincaré inequality in terms of the quantification. We also argue them to obtain their results on geometric analysis.

- 26 田代賢志郎 (東 北 大 理) Measure contraction property of the  $\ell^p$ -Heisenberg group ..... 15  
S. Borza ( SISSA )  
Kenshiro Tashiro (Tohoku Univ.) Measure contraction property of the  $\ell^p$ -Heisenberg group  
Samuël Borza (SISSA)

概要 We consider the problem whether sub-Finsler manifolds satisfy the measure contraction property  $MCP(K, N)$ , and if so, what is the optimal  $K$  and  $N$ . It has been considered for sub-Riemannian Heisenberg groups (and its generalizations), and the optimal  $N$  was relevant to the geodesic dimension. We consider the  $\ell^p$ -Heisenberg group. We show that for  $1 < p < 2$ , it satisfies  $MCP(K, N)$  with non-positive  $K$  and some  $N$  which is strictly greater than the geodesic dimension. On the other hand, for  $2 < p \leq \infty$ , it has finite geodesic dimension, but it does not satisfies  $MCP(K, N)$  for any numbers.

- 27 N. Evseev (沖縄科学技術大) Sobolev curves in an arbitrary metric space ..... 15  
Nikita Evseev Sobolev curves in an arbitrary metric space  
(Okinawa Inst. of Sci. and Tech. Grad. Univ.)

概要 We show that Sobolev curves in a dual Banach space can be characterized in terms of weak derivatives in a weak\* sense. Since every metric space embeds isometrically into a dual Banach space, this implies a characterization of metric space valued Sobolev curves in terms of such derivatives. Furthermore, we investigate for which target spaces Sobolev curves are weak\* differentiable almost everywhere.

- 28 張 頁 (沖縄科学技術大) Semiconcavity results of squared sub-Riemannian distance on ideal Carnot  
groups ..... 15  
Ye Zhang Semiconcavity results of squared sub-Riemannian distance on ideal Carnot  
(Okinawa Inst. of Sci. and Tech. Grad. Univ.) groups

概要 On Euclidean spaces, the squared distance function  $|\cdot|^2$  is a convex function as well as a semiconcave function. When it comes to Heisenberg group, due to the appearance of the cut locus and the abnormal set, the squared sub-Riemannian distance cannot be locally semiconcave nor locally semiconvex. However, if we consider the corresponding weaker horizontal convexity (or  $h$ -convexity in short) on Heisenberg group instead, the  $h$ -semiconcavity holds for the squared sub-Riemannian distance on Heisenberg group. This result can be generalized to the case of so-called ideal Carnot groups.

- 29 成田 知 将 (名大多元数理) コンパクトケーラー多様体のラプラシアン固有値の最大化問題 ..... 15  
 Kazumasa Narita (Nagoya Univ.) An extremal eigenvalue problem for the Laplacian on a compact Kähler manifold

概要 We study an eigenvalue problem for the Laplacian on a compact Kähler manifold. Considering the  $k$ -th eigenvalue  $\lambda_k$  as a functional on the space of Kähler metrics with fixed volume on a compact complex manifold, we introduce the notion of  $\lambda_k$ -extremal Kähler metric. We deduce a condition for a Kähler metric to be  $\lambda_k$ -extremal. As examples, we consider product Kähler manifolds and flat complex tori. The condition for the flat metric on a complex torus to be  $\lambda_k$ -extremal is also a necessary condition for the flat complex torus to admit an isometric minimal immersion into a Euclidean sphere by first eigenfunctions.

- 30 高橋 雄 也 (名大多元数理) Riemann 面上の  $SU(2)$ -平坦接続のモジュライ空間の幾何学的量子化とオペラッド構造 ..... 15  
 Yuya Takahashi (Nagoya Univ.) Operad structures in geometric quantization of the moduli space of flat  $SU(2)$ -connections on a Riemann surface

概要 The moduli space of flat  $SU(2)$ -connections on a Riemann surface is known to contain an open dense subset which is a symplectic manifold equipped with both Kähler and real polarizations. In this talk, we will construct morphisms of modular operads  $f_{K\ddot{a}h}$  and  $f_{re}$  by using the quantum spaces  $\mathcal{H}_{K\ddot{a}h}$  and  $\mathcal{H}_{re}$  associated to the Kähler and real polarizations respectively. Moreover, we will relate the two morphisms  $f_{K\ddot{a}h}$  and  $f_{re}$ , and prove the equality  $\dim \mathcal{H}_{K\ddot{a}h} = \dim \mathcal{H}_{re}$ , which is known as the result of Jeffrey and Weitsman (1992). This operadic structures are similar to those obtained by Takahashi (2023) in the case of the moduli space of spatial polygons.

- 31 瀬戸 樹 (明治薬科大)  $n$ 次元立方体上の自己相似集合における Fredholm 加群について ..... 15  
 丸山 貴志  
 (NEC Laboratories Europe)  
 Tatsuki Seto (Meiji Pharm. Univ.) A Fredholm module on self-similar sets built on  $n$ -cubes  
 Takashi Maruyama  
 (NEC Laboratories Europe)

概要 We construct a Fredholm module on self-similar sets such as the Cantor dust, the Sierpinski carpet and the Menger sponge. Our construction is a higher dimensional analogue of Connes' combinatorial construction of the Fredholm module on the Cantor set. We also calculate the Dixmier trace of operators induced by the Fredholm module.

- 32 奥田 太 夏 (東京理大理) Star product with separation of variables on  $G_{2,4}(\mathbb{C})$  ..... 15  
 佐古 彰 史 (東京理大理)  
 Taika Okuda (Tokyo Univ. of Sci.) Star product with separation of variables on  $G_{2,4}(\mathbb{C})$   
 Akifumi Sako (Tokyo Univ. of Sci.)

概要 Deformation quantization with separation of variables for Kähler manifolds has been proposed by Karabegov. Especially, locally symmetric cases have also been studied by Sako–Suzuki–Umetsu or Hara–Sako. On the other hand, deformation quantization with separation of variables for complex Grassmannians has not been explicitly constructed so far, except for  $\mathbb{C}P^N$ . In this work, we explicitly determined the star product with separation of variables on  $G_{2,4}(\mathbb{C})$  by using the solution of the recurrence relations given by Hara–Sako.



## 3月20日(水) 第IV会場

## 9:20~10:15

- 33 Joonhyung Kim (Chungnam Nat. Univ.) On the Kähler cone of the Heisenberg group ..... 15  
 I. D. Platis (Univ. of Crete)  
 孫立杰 (山口大創成)  
 Joonhyung Kim (Chungnam Nat. Univ.) On the Kähler cone of the Heisenberg group  
 Ioannis D. Platis (Univ. of Crete)  
 Li-Jie Sun (Yamaguchi Univ.)

概要 Starting from the Sasakian structure of the Heisenberg group we construct a Kähler structure of the Siegel domain. We also show other Kähler structures of the Siegel domain and all these are PCR-Kähler equivalent, that is, essentially the same when restricted to the CR structure.

- 34 竹内 有哉 (筑波大数理物質) 球面的 CR 多様体の Kohn–Rossi コホモロジー ..... 15  
 Yuya Takeuchi (Univ. of Tsukuba) Kohn–Rossi cohomology of spherical CR manifolds

概要 The Kohn–Rossi cohomology is a CR analog of the Dolbeault cohomology and is one of fundamental invariants in CR geometry. In this talk, we prove some vanishing theorems for the Kohn–Rossi cohomology of some spherical CR manifolds. To this end, we use a canonical contact form defined via the Patterson–Sullivan measure and Weitzenböck-type formulae.

- 35 宮武 夏雄 (東北大MathCCS) 巡回 Higgs 束の Hitchin 方程式の劣調和関数を用いた拡張とその Dirichlet 問題について ..... 15  
 Natsuo Miyatake (Tohoku Univ.) Extended Hitchin equation for cyclic Higgs bundles associated with a quasi-subharmonic function, and its Dirichlet problem

概要 We demonstrate the existence and uniqueness of the solution to the Dirichlet problem for a generalization of Hitchin’s equation for diagonal harmonic metrics on cyclic Higgs bundles. The generalized equations are formulated using subharmonic functions. In this generalization, the coefficient exhibits worse regularity than that in the original equation.

## 10:30~11:30 特別講演

- 糟谷 久矢 (阪大 理) 佐々木多様体上の Higgs 束, 現状とこれから  
 Hisashi Kasuya (Osaka Univ.) Vector bundles and Higgs bundles over Sasakian manifolds, present and future

概要 The speaker and his collaborators develop the theory of Higgs bundles over compact Sasakian manifolds as an odd-dimensional analogue of the great works of Corlette, Hitchin and Simpson on Higgs bundles over compact Kähler manifolds. Sasakian geometry is often qualified as an odd-dimensional analogy of Kähler geometry. An important theme on Sasakian geometry is to show that Sasakian geometry is not just an analogue. The purpose of this talk to give an overview of recent results on Higgs bundles over compact Sasakian manifolds and suggest future programs for going beyond an analogy of Kähler case.



# 函数論

3月17日(日) 第VI会場

9:50~11:20

- 1 田中清喜 (名城大理工) Little Hankel operators on Bloch type spaces ..... 15  
 山路哲史 (神戸工高専)  
 Kiyoki Tanaka (Meijo Univ.) Little Hankel operators on Bloch type spaces  
 Satoshi Yamaji  
 (Kobe City Coll. of Tech.)

概要 Axler gave a characterization for bounded or compact Hankel operators with anti holomorphic symbols on Bergman spaces. Based on Axler's results, Bonami-Luo gave a characterization for bounded little Hankel operators with anti holomorphic symbols from Bergman spaces to another Bergman spaces. In this talk, we announce a result of characterization for bounded little Hankel operator with anti holomorphic symbols on Bloch type spaces.

- 2 須川敏幸 (東北大情報) 超幾何函数の普遍凸性について ..... 15  
 Li-Mei Wang  
 (Univ. of Int. Business and Econ.)  
 Chengfa Wu (Shenzhen Univ.)  
 Toshiyuki Sugawa (Tohoku Univ.) On universal convexity of shifted hypergeometric functions  
 Li-Mei Wang  
 (Univ. of Int. Business and Econ.)  
 Chengfa Wu (Shenzhen Univ.)

概要 In this talk, we consider mainly the shifted hypergeometric function  $f(z) = {}_2F_1(a, b; c; z)$  for real parameters with  $0 < a \leq b \leq c$ . Ruscheweyh, Salinas and Sugawa developed in their 2009 paper the theory of universal prestarlike functions on the slit domain  $\mathbb{C} \setminus [1, +\infty)$  and showed universal starlikeness of  $f$  under some assumptions on the parameters. We will give conditions on the parameters which lead to universal convexity of  $f$ .

- 3 小森洋平 (早大教育) On the convergence of Thurston's hyperbolic circle packing algorithm ..... 15  
 Yohei Komori (Waseda Univ.) On the convergence of Thurston's hyperbolic circle packing algorithm

概要 In this talk we will show the convergence of Thurston's iterated algorithm for hyperbolic circle packing. Colin de Verdière proved the convergence for Euclidean case. We will also consider circle pattern case.

- 4 松崎克彦 (早大教育) 可積分タイヒミュラー空間の実解析的構造について ..... 15  
 Katsuhiko Matsuzaki (Waseda Univ.) On the real-analytic structure of integrable Teichmüller spaces

概要 For the  $p$ -integrable Teichmüller space  $T_p$  ( $p \geq 1$ ), which is given by  $p$ -integrable Beltrami coefficients with respect to the hyperbolic metric, we describe its real-analytic structure by using Besov spaces.

- 5 相川弘明 (中部大理工) Intrinsic ultracontractivity for planar domains with wide access property ..... 15  
 Hiroaki Aikawa (Chubu Univ.) Intrinsic ultracontractivity for planar domains with wide access property

概要 Utilizing capacity width and the parabolic box argument, we unveil analytic notions behind geometric characterizations of wide accessible planar domains, those are IU or have finite lifetime.

## 14:15~15:15 特別講演

- 大野 貴雄 (大分大教育福祉) 極大作用素の有界性と Riesz ポテンシャルに対する Sobolev 型の不等式  
 Takao Ohno (Oita Univ.) Boundedness of maximal operators and Sobolev-type inequalities for Riesz potentials

概要 The maximal operator is a classical tool in harmonic analysis and studying Sobolev functions and partial differential equations and plays a central role in the study of differentiation, singular integrals, smoothness of functions and so on. It is well known that the maximal operator is bounded on the Lebesgue space if  $p > 1$ . One of important applications of the boundedness of the maximal operator is Sobolev's inequality for Riesz potentials of functions in the Lebesgue space. My aim in this talk is to talk about the boundedness of the maximal operator on variable exponent Lebesgue spaces, variable exponent Morrey spaces, Musielak–Orlicz spaces, Musielak–Orlicz–Morrey spaces and so on. As an application of the boundedness of the maximal operator, we establish a generalization of Sobolev's inequality for Riesz potentials of functions in the above spaces.

## 15:35~16:30

- 6 濱田 英隆 (九州産大理工) Riesz type inequalities and a Hardy–Littlewood type theorem on bounded symmetric domains ..... 15  
 Shaolin Chen (Hengyang Normal Univ.)  
 Hidetaka Hamada (Kyushu Sangyo Univ.) Riesz type inequalities and a Hardy–Littlewood type theorem on bounded symmetric domains  
 Shaolin Chen (Hengyang Normal Univ.)

概要 The aim of this talk is to establish some Riesz type inequalities of pluriharmonic functions on bounded symmetric domains, which extend a theorem due to Kalaj. Also, we observe that similar Riesz type inequalities do not hold for the pluriharmonic Hardy space  $\mathcal{P}\mathcal{H}^p(\Omega)$  in the cases  $p = 1, \infty$ . We obtain a Hardy and Littlewood type theorem in the case  $p = 1$ .

- 7 濱田 英隆 (九州産大理工) Harmonic functions with smooth moduli ..... 10  
 Shaolin Chen (Hengyang Normal Univ.)  
 Hidetaka Hamada (Kyushu Sangyo Univ.) Harmonic functions with smooth moduli  
 Shaolin Chen (Hengyang Normal Univ.)

概要 Pavlović studied Lipschitz conditions with respect to  $\psi_\alpha(t) = t^\alpha$ ,  $0 < \alpha < 1$  on the modulus of real-valued harmonic functions on the Euclidean unit ball of  $\mathbb{R}^n$  with  $n \geq 2$ . The aim of this talk is to improve and extend a Pavlović's result to a general fast majorant  $\psi$  and to real-valued harmonic functions on an  $\mathcal{L}_\psi$ -extension domain of  $\mathbb{R}^n$ .

- 8 濱田 英隆 (九州産大理工) Holomorphic and pluriharmonic functions with smooth moduli and Hardy–Littlewood type theorems ..... 10  
 Shaolin Chen (Hengyang Normal Univ.)  
 Hidetaka Hamada (Kyushu Sangyo Univ.) Holomorphic and pluriharmonic functions with smooth moduli and Hardy–Littlewood type theorems  
 Shaolin Chen (Hengyang Normal Univ.)

概要 In this talk, we discuss the Hardy–Littlewood type theorems and smooth moduli of holomorphic and pluriharmonic functions. Our result improves and extends the corresponding results due to Dyakonov in 2004 and Hardy and Littlewood in 1932.

- 9 濱田 英隆 (九州産大理工) Pluriharmonic Lipschitz type spaces and composition operators ····· 15  
 Shaolin Chen  
 (Hengyang Normal Univ.)  
 Hidetaka Hamada Pluriharmonic Lipschitz type spaces and composition operators  
 (Kyushu Sangyo Univ.)  
 Shaolin Chen (Hengyang Normal Univ.)

概要 The main purpose of this talk is to develop some methods to study the composition operators between pluriharmonic Lipschitz type spaces. Some characterizations of boundedness and  $w$ -compactness of composition operators between the pluriharmonic Lipschitz type spaces will be given. The obtained results improve and extend some corresponding known results by Madigan in 1993 and Pavlović in 2008.

3月18日(月) 第VI会場

9:50~11:20

- 10 綾野 孝則 (阪公大数学研) テレスコピック曲線のシグマ関数のべき級数展開に関する改良 ····· 15  
 Takanori Ayano (Osaka Metro. Univ.) An improvement on the power series expansion of the sigma function  
 associated with the telescopic curves

概要 The sigma function is obtained by modifying the Riemann's theta function. The sigma function has some remarkable algebraic properties that it is directly related with the defining equations of an algebraic curve. Namely, the coefficients of the power series expansion of the sigma function around the origin become polynomials of the coefficients of the defining equations of the algebraic curve. It is an important problem to determine the coefficients of the power series expansion of the sigma function. In The Mathematical Society of Japan Autumn Meeting 2022, I made a presentation on the result of the power series expansion of the sigma function associated with the telescopic curves. In this talk, I will give an improvement of this result.

- 11 孫 立杰 (山口大創成) Geometric structures on the quaternionic Heisenberg group ····· 15  
 Li-Jie Sun (Yamaguchi Univ.) Geometric structures on the quaternionic Heisenberg group

概要 Analogous to the pseudohermitian manifold in CR geometry, there exists a quaternionic counterpart known as the quaternionic contact manifold. A well-known example is the quaternionic Heisenberg group. Our main focus is to explore the Sasakian 3-structure on the quaternionic Heisenberg group, which is important to investigate the geometry on its Riemannian cone.

- 12 都丸 正 (群馬大\*) Arnold の 14 例外型特異点と虚数乗法をもつ楕円曲線族 ····· 15  
 Tadashi Tomaru (Gunma Univ.\*) Arnold's 14 exceptional singularities and families of elliptic curves with  
 complex multiplications

概要 In my paper in 2013, I introduced the notion of  $C^*$ -pencil of curves, From the point of view, I will explain some relations between Arnold's 14 exceptional singularities and families of elliptic curves with complex multiplications.

- 13 小池 貴之 (阪公大理)  $\bar{\partial}$  cohomology of the complement of a semi-positive anticanonical divisor  
 of a compact surface ····· 15  
 Takayuki Koike (Osaka Metro. Univ.)  $\bar{\partial}$  cohomology of the complement of a semi-positive anticanonical divisor  
 of a compact surface

概要 Let  $X$  be a non-singular compact complex surface such that the anticanonical line bundle admits a smooth Hermitian metric with semi-positive curvature. For a non-singular hypersurface  $Y$  which defines an anticanonical divisor, we investigate the  $\bar{\partial}$  cohomology group  $H^1(M, \mathcal{O}_M)$  of the complement  $M = X \setminus Y$ .

- 14 大沢健夫 (名大多元数理) On the Levi problem for locally pseudoconvex bounded domains of regular type with a curvature negativity on the boundary ..... 15  
 Takeo Ohsawa (Nagoya Univ.) On the Levi problem for locally pseudoconvex bounded domains of regular type with a curvature negativity on the boundary

概要 Given a bounded locally pseudoconvex domain  $\Omega$  in a complex manifold  $M$  with a complete Kähler metric and a positive line bundle, it is proved that  $\Omega$  is holomorphically convex if the canonical bundle of  $M$  is negative on  $\partial\Omega$ , under a regularity condition on  $\partial\Omega$  which is satisfied if  $\partial\Omega$  is a  $C^2$ -smooth hypersurface.

### 13:00~14:00 特別講演

久本智之 (都立大理) Fano 多様体の最適退化について

Tomoyuki Hisamoto Optimal degeneration for a Fano manifold  
 (Tokyo Metro. Univ.)

概要 The existence problem of the Kähler–Einstein metric for Fano manifolds was solved by Chen–Donaldson–Sun and by many contributions of other people in the 2010s. In the proof, the uniform lower bound estimate of the Bergman kernel played a crucial role. While a general Fano manifold does not admit a Kähler–Einstein metric, its parabolic version, known as the Kähler–Ricci flow, has the long-time solution and converges to the Kähler–Einstein metric if it exists. In terms of the algebraic geometry the Kähler–Ricci flow corresponds to the optimal degeneration of the Fano manifold, which is characterized as the degeneration with minimal (non-Archimedean) entropy. In this talk I will explain the asymptotic construction of optimal degeneration using multiplier ideal sheaves. I would also like to touch upon the quantization of the Kähler–Ricci flow, in connection with the above construction.

# 函数方程式論

3月17日(日) 第II会場

9:30~12:00

- 1 朴 佳南 (鳥羽商船高専)  $E_6^{(1)}$  型  $q$  パンルヴェ方程式のラックス形式から得られるアフィンワイル群の双有理表現 ..... 15  
 Kanam Park (Toba Nat. Coll. of Maritime Tech.) Birational representations of affine Weyl groups related to a  $3 \times 3$  Lax formalism for the  $q$ -Painlevé equation of type  $E_6^{(1)}$

概要 The  $q$ -Painlevé equation of type  $E_6^{(1)}$  is given as a  $q$ -difference system with an affine Weyl group symmetry of type  $E_6^{(1)}$ . We obtained a  $3 \times 3$  Lax formalism for the equation as a new one. Our goal is to understand a birational representation of an affine Weyl group symmetry of type  $E_6^{(1)}$  as actions on the  $3 \times 3$  Lax formalism. In this talk, we talk about a relation between it and known birational actions of 3 kinds of affine Weyl group of type  $A_2^{(1)}$  as a partial result.

- 2 藤本 皓大 (島根大総合理工) Minimal set for solutions of ordinary differential equations involving  $p(t)$ -Laplacian ..... 15  
 Kodai Fujimoto (Shimane Univ.) Minimal set for solutions of ordinary differential equations involving  $p(t)$ -Laplacian

概要 We consider the nonlinear differential equation  $(a(t)|x'|^{p(t)-2}x')' = b(t)|x|^{q(t)-2}x$ , where  $a(t)$ ,  $b(t)$ , and  $q(t) > 1$  are positive continuous, and  $p(t) > 1$  is continuously differentiable. Nonoscillatory proper solutions of this equations are categorized into four classes, characterized by specific integral conditions. By leveraging these classes, we introduce a minimal set for solutions of this equation, thereby extending the concept of principal solutions of linear equations. This talk is based on a joint work with Professor Zuzana Došlá (Masaryk University, Czech Republic).

- 3 宇佐美 広介 (岐阜大 大工) 射的問題について ..... 15  
 前田 貴之 (岐阜大 自然)  
 Hiroyuki Usami (Gifu Univ.) On target shooting problems  
 Takayuki Maeda (Gifu Univ.)

概要 Mathematical Analysis for target shooting problems is given. We consider the differential systems describing the motion of an objective thrown at the target. We assume that the air resistance is proportional to the square of the magnitude of its velocity. We can determine whether or not the objective hits the target in some cases.

- 4 柴田 徹太郎 (広島大 先進理工) The first eigenvalue and eigenfunction of the nonlocal one-dimensional elliptic eigenvalue problem ..... 15  
 Tetsutaro Shibata (Hiroshima Univ.) The first eigenvalue and eigenfunction of the nonlocal one-dimensional elliptic eigenvalue problem

概要 We consider the one-dimensional nonlinear eigenvalue problem of Kirchhoff type. We obtain the first eigenvalue  $\mu_1$  of this problem explicitly by using a simple time map method. We also obtain the first eigenfunction associated with  $\mu_1$ .

- 5 西口純矢 (東北大 AIMR) 線型遅延微分方程式の「軟解」概念について ..... 15  
 Junya Nishiguchi (Tohoku Univ.) On the notion of “mild solutions” to linear delay differential equations

概要 The delay differential equations (DDEs), in which the time derivative of the unknown function also depends on the past information determine infinite-dimensional dynamical systems as the time evolution of the history segments of solutions, even when the independent variables of the unknown function are only time variable. While this infinite-dimensionality can cause complicated behavior of solutions to DDEs, the actual complexity of the dynamics depends on the “size of the time-lag.” To facilitate such an understanding, it is necessary to develop a treatment of DDEs. In this talk, for retarded functional differential equations (RFDEs), which give a mathematical formulation of DDEs, we introduce a notion of “mild solutions” to linear RFDEs for a purpose of dealing with “discontinuous history functions”, which is a barrier to the study of RFDEs.

- 6 西口純矢 (東北大 AIMR) 線型遅延微分方程式の解の基本系と基本行列解 ..... 15  
 Junya Nishiguchi (Tohoku Univ.) Fundamental systems of solutions and fundamental matrix solutions to linear delay differential equations

概要 For a non-homogeneous linear RFDE, we consider how the solutions are expressed by using the solutions to the homogeneous equation and the forcing term. By an analogy to non-homogeneous linear ODEs, we call such a formula the *variation of constants formula* and ask “What is the *fundamental matrix solutions* to the linear RFDE?” This is of course a fundamental question, and there is a long history of over fifty years. However, it is known that there is a conceptual difficulty which is peculiar to RFDEs. In this talk, we resolve the difficulty by defining fundamental matrix solutions to the linear RFDE as matrix-valued milds solutions having discontinuous matrix-valued functions in their initial histories.

- 7 濱本直樹 (阪公大理) 半平面上の渦なし場に対する Hardy 定数 ..... 12  
 Naoki Hamamoto (Osaka Metro. Univ.) The Hardy’s constant for curl-free vector fields on the half-plane

概要 The  $N$ -dimensional Hardy’s inequality  $\int_{\mathbb{R}^N} |\nabla \mathbf{u}|^2 dx \geq C \int_{\mathbb{R}^N} \frac{|\mathbf{u}|^2}{|x|^2} dx$  with the best constant  $C = (N-2)^2/4$  is well known when the test vector field  $\mathbf{u} : \mathbb{R}^N \rightarrow \mathbb{R}^N$  is in  $C_c^\infty(\mathbb{R}^N)$  and unconstrained. We are interested in how  $C$  can be improved when  $\mathbf{u}$  is constrained by the curl-free condition  $\text{curl} \mathbf{u} \equiv \mathbf{0}$ ; however, when  $N = 2$  such an improvement cannot be obtained. On the other hand, when the support of  $\mathbf{u}$  is contained in the half space  $\mathbb{R}_+^N$  the best constant is known to be  $N^2/4$  for unconstrained fields. In this situation we treat the problem how  $C$  can be improved when  $\mathbf{u}$  is a two-dimensional curl-free field whose support is contained in the half-plane  $\mathbb{R}_+^2$ .

- 8 勝呂剛志 (熊本大先端) ある拡張エントロピーに対する対数型 Sobolev の不等式の安定性評価と不確定性関係への応用について ..... 15  
 Takeshi Suguro (Kumamoto Univ.) Stability estimates for the logarithmic Sobolev inequality for a generalized entropy and an application to the uncertainty relation inequality

概要 We consider the logarithmic Sobolev inequality for the Tsallis entropy, which is a generalization of the Boltzmann–Shannon entropy. We show the stability estimate for the logarithmic Sobolev inequality via the Gagliardo–Nirenberg inequality. Moreover, we derive an extension of the uncertainty relation inequality.

## 14:15~16:15

- 9 只野之英 (東京理大理) Continuum limit for discretized elliptic operators on square lattice ... 15  
 中村 周 (学習院大理)  
 三上 溪太 (理化学研THEMS)  
 Yukihide Tadano (Tokyo Univ. of Sci.) Continuum limit for discretized elliptic operators on square lattice  
 Shu Nakamura (Gakushuin Univ.)  
 Keita Mikami (RIKEN)

概要 In this talk, we consider the discretization of elliptic operators  $P = -\sum_{j,k} \partial_{x_j} a_{j,k}(x) \partial_{x_k} + V(x)$  on  $\mathbb{R}^d$  onto the square lattice  $h\mathbb{Z}^d$  with mesh size  $h$ . We show that under the strictly ellipticity of  $a_{j,k}$  and a certain assumption where  $V$  is not necessarily bounded, the above discretized operators converge to  $P$  in the continuum limit. We also show that as an application the spectra and eigenfunctions of  $P$  can be approximated by those of its discretization.

- 10 鈴木 貴 (阪大 M M D S) 微分形式の界面消滅 ..... 5  
 渡辺 一雄 (北里大一般教育)  
 Takashi Suzuki (Osaka Univ.) Interface vanishing of differential forms  
 Kazuo Watanabe (Kitasato Univ.)

概要 We introduce  $d - \delta$  systems on differential forms in Euclidean spaces and show the interface vanishing of the solution. This result generalizes the previous theorems on stationary and non-stationary Maxwell's equation.

- 11 牧田 慎平 (北大 理) Stability of metric viscosity solutions under Hausdorff convergence ... 15  
 中安 淳 (京大 理)  
 Shimpei Makida (Hokkaido Univ.) Stability of metric viscosity solutions under Hausdorff convergence  
 Atsushi Nakayasu (Kyoto Univ.)

概要 Recently, the domain perturbation problem for the Hamilton–Jacobi equation has been studied. In this talk we investigate the stability of viscosity solutions of the Hamilton–Jacobi equations for a sequence of domains that are not necessarily monotone. The proof is based on the relaxed half semilimit and a characterization of the metric viscosity solutions in terms of squared distance functions.

- 12 上野 竜也 (神奈川大理) 連立非線形キルヒホッフ・シュレディンガー方程式の劣臨界・臨界指数  
 の場合の正值解の存在 ..... 10  
 Tatsuya Ueno (Kanagawa Univ.) Existence of positive ground state solution of coupled nonlinear Kirchhoff–  
 Schrödinger system for a subcritical and critical case

概要 In this talk, we prove the existence of positive ground state solution of a nonlinear Kirchhoff–Schrödinger system with constant potentials for a subcritical case and critical case. We use a variational technique, in particular, we consider a minimization problem on the Nehari–Pohozaev manifold corresponding to the problem.

- 13 宮本 安人 (東大 数理) Exact Morse index of radial solutions for semilinear elliptic equations  
 with critical exponent on annuli ..... 10  
 Yasuhito Miyamoto (Univ. of Tokyo) Exact Morse index of radial solutions for semilinear elliptic equations  
 with critical exponent on annuli

概要 We consider a Dirichlet problem of the Henon equation with a critical exponent on annuli. This problem has exactly two radial solutions with  $n$  nodal domains. When the domain is a ball, the problem has no positive solution due to Pohozaev identity. Therefore, it is interesting to study the case where the inner radius goes to zero. In this talk we study the Morse index of radial solutions. In particular, an exact Morse index can be determined when the inner radius is small. Several estimates of the Morse index are also obtained.



- 14 竹村 春希 (東大数理) スカラーフィールド方程式の線形化問題における固有値の明示的表示 … 15  
宮本 安人 (東大数理)  
若狭 徹 (九工大工)  
Haruki Takemura (Univ. of Tokyo) Asymptotic formulas of the eigenvalues for the linearization of the scalar  
Yasuhito Miyamoto (Univ. of Tokyo) field equation  
Tohru Wakasa (Kyushu Inst. of Tech.)

**概要** We give asymptotic formulas for all the eigenvalues of the linearization problem of the Neumann problem for the scalar field equation  $\varepsilon^2 u_{xx} - u + u^3 = 0$ . The eigenvalues are classified into three categories. The eigenvalues in the three categories respectively converge to  $-3$ ,  $0$  and  $1$  as  $\varepsilon \rightarrow 1$ . The number of the eigenvalues which converge to  $-3$  is equal to the number of the interior and boundary peaks of the solution of Neumann problem  $u$ . The number of the eigenvalues which converge to  $0$  is equal to the number of the interior peaks of  $u$ . In this study, complete elliptic integrals and Jacobi's elliptic functions play an important role.

- 15 中村 謙太 分数階放物型 De Giorgi クラスの局所的性質 …………… 10  
(熊本大数理科学総合教育センター)  
Kenta Nakamura (Kumamoto Univ.) Local properties of fractional parabolic De Giorgi classes

**概要** This talk studies fractional parabolic De Giorgi classes of order  $s, p$  and renders the local boundedness and the nonlocal weak Harnack estimate. I will present a brief sketch of the proof of my results as long as time permits.

- 16 佐藤 光汰朗 (東北大理) 準静的発展方程式の解の長時間挙動について …………… 15  
Kotaro Sato (Tohoku Univ.) Long-time behavior of solutions to some quasistatic evolution equation

**概要** We investigate long-time dynamics of strong solutions of the initial-boundary value problem for differential equations of doubly-nonlinear type in this talk. More precisely, we characterize the stationary limits of the global-in-time  $L^2$ -solutions as a solution to the corresponding stationary problem. Here, the layer structure (or so-called comparison principle) of the equations plays an important role in the proof of the characterization of the limit.

### 16:30~17:30 特別講演

- 後藤 良彰 (小樽商大) 超幾何積分とホモロジー・コホモロジー  
Yoshiaki Goto Hypergeometric integrals —homology and cohomology  
(Otaru Univ. of Commerce)

**概要** Hypergeometric integrals are defined as integrals of the product of complex powers of polynomials. We study hypergeometric integrals by using homology and cohomology groups with local coefficients, so-called twisted homology and cohomology groups. Many types of relations between hypergeometric functions can be regarded as relations in (co)homology groups. Further, the intersection forms on (co)homology groups are also useful tools. In this talk, I would like to show some examples that hypergeometric integrals are studied by using twisted (co)homology groups and intersection forms.



3月18日(月) 第II会場

9:30~12:00

- 17 草場 竜之介 (早大理工) Higher order asymptotic expansions for the complex Ginzburg–Landau  
小澤 徹 (早大理工) type equation in the supercritical case ..... 15  
Ryunosuke Kusaba (Waseda Univ.) Higher order asymptotic expansions for the complex Ginzburg–Landau  
Tohru Ozawa (Waseda Univ.) type equation in the supercritical case

概要 We present explicit asymptotic profiles with parabolic self-similarity of global solutions to the Cauchy problem for the complex Ginzburg–Landau type equation in the super Fujita-critical case. Our approach is based on the integral representation of the CGL semigroup and Taylor expansions with respect to the both space and time variables. We also discuss the optimal decay rate in time of the remainder for the asymptotic expansion.

- 18 小波津 晶平 (東京理大理) Immediate smoothing of measure-valued population densities in a Keller–  
Segel system with flux limitation ..... 15  
Shohei Kohatsu (Tokyo Univ. of Sci.) Immediate smoothing of measure-valued population densities in a Keller–  
Segel system with flux limitation

概要 We deal with a Keller–Segel system with flux limitation. For the one-dimensional Keller–Segel system, it is known that given any nonnegative measure-valued initial data, the system admits a global classical solution which is continuous at  $t = 0$ . The purpose is to show this immediate smoothing in the system for any dimension with the aid of effect of flux limitation.

- 19 石田 祥子 (千葉大理)  $N$ 次元癌浸潤モデルに対する最大正則性原理を用いた大域可解性 ..... 10  
横田 智巳 (東京理大理)  
Sachiko Ishida (Chiba Univ.) Global solvability for  $N$ -dimensional tumor invasion models via the  
Tomomi Yokota (Tokyo Univ. of Sci.) maximum Sobolev regularity

概要 We consider the initial-boundary value problem for a degenerate chemotaxis model arising from tumor invasion, in which the first equation is  $u_t = \nabla \cdot (f(u, w)\nabla u - g(u)\nabla v)$ . The diffusivity and the sensitivity are assumed to fulfill  $f(u, w) \geq u^{m-1}$  ( $m > 1$ ),  $0 \leq g(u) \leq u(u+1)^{\alpha-1}$  ( $\alpha \in \mathbb{R}$ ). It is shown that if  $\alpha + 1 = m + \frac{4}{N}$  ( $N \geq 3$ ), then for any initial data with small mass, the system possesses a global bounded weak solution.

- 20 細野 竜也 (東北大理)b Global existence and boundedness of solutions to the 4D fully parabolic  
P. Laurençot chemotaxis system with indirect signal production ..... 15  
(CNRS·Univ. Savoie Mont Blanc)  
Tatsuya Hosono (Tohoku Univ.) Global existence and boundedness of solutions to the 4D fully parabolic  
Philippe Laurençot chemotaxis system with indirect signal production  
(CNRS/Univ. Savoie Mont Blanc)

概要 We consider the Cauchy problem for the 4 dimensional fully parabolic chemotaxis system with indirect signal production. In this talk, we show that the solution exists globally in time provided that the initial mass is less than the value  $(8\pi)^2$ , known as the 4 dimensional threshold value whether the blow-up of solutions occurs or not. Furthermore some condition on the initial mass ensuring the boundedness of solutions is also obtained. This talk is based on a joint work with Philippe Laurençot (CNRS & Université Savoie Mont Blanc).

- 21 下條昌彦 (都立大理) Convergence to traveling waves of predator-prey type reaction-diffusion systems with equal diffusivity by utilizing a relative entropy ..... 15  
郭忠勝 (Tamkang Univ.)  
Masahiko Shimojo (Tokyo Metro. Univ.) Convergence to traveling waves of predator-prey type reaction-diffusion systems with equal diffusivity by utilizing a relative entropy  
Jong-Shenq Guo (Tamkang Univ.)

概要 Our aim is to construct a general framework to derive the asymptotic stability of traveling waves. This method is universal in the sense that it works well for waves in many reaction-diffusion systems with equal diffusivities.

- 22 下條昌彦 (都立大理) Stability of monostable traveling waves in diffusive three-species competition systems ..... 15  
郭忠勝 (Tamkang Univ.)  
郭珈好 (Providence Univ.)  
Masahiko Shimojo (Tokyo Metro. Univ.) Stability of monostable traveling waves in diffusive three-species competition systems  
Jong-Shenq Guo (Tamkang Univ.)  
Karen Guo (Providence Univ.)

概要 We discuss the asymptotic stability of traveling waves of diffusive three-species competition systems under certain perturbations of initial data.

- 23 谷口雅治 (岡山大異分野基礎研) Traveling front solutions of dimension  $n$  generate entire solutions of dimension  $(n - 1)$  in reaction-diffusion equations ..... 15  
二宮広和 (明大総合数理)  
Masaharu Taniguchi (Okayama Univ.) Traveling front solutions of dimension  $n$  generate entire solutions of dimension  $(n - 1)$  in reaction-diffusion equations  
Hirokazu Ninomiya (Meiji Univ.)

概要 Multidimensional traveling front solutions and entire solutions of reaction-diffusion equations have been studied intensively. To study the relationship between multidimensional traveling front solutions and entire solutions, we study the reaction-diffusion equation with a bistable nonlinear term. It is well known that there exist multidimensional traveling front solutions with every speed that is greater than the speed of a one-dimensional traveling front solution connecting two stable equilibria. In this paper, we show that the limit of the  $n$ -dimensional multidimensional traveling front solutions as the speeds go to infinity generates an entire solution of the same reaction-diffusion equation in the  $(n - 1)$ -dimensional space.

- 24 谷口雅治 (岡山大異分野基礎研) Entire solutions with and without radial symmetry in balanced bistable reaction-diffusion equations ..... 15  
Masaharu Taniguchi (Okayama Univ.) Entire solutions with and without radial symmetry in balanced bistable reaction-diffusion equations

概要 Let  $n \geq 2$  be a given integer. In this paper, we assert that an  $n$ -dimensional traveling front converges to an  $(n - 1)$ -dimensional entire solution as the speed goes to infinity in a balanced bistable reaction-diffusion equation. As the speed of an  $n$ -dimensional axially symmetric or asymmetric traveling front goes to infinity, it converges to an  $(n - 1)$ -dimensional radially symmetric or asymmetric entire solution in a balanced bistable reaction-diffusion equation, respectively. We conjecture that the radially asymmetric entire solutions obtained in this paper are associated with the ancient solutions called the Angenent ovals in the mean curvature flows.

**13:00~14:00 特別講演**

- 柳 青 (沖縄科学技術大) Monge solutions of eikonal equations in metric spaces  
 Qing Liu Monge solutions of eikonal equations in metric spaces  
 (Okinawa Inst. of Sci. and Tech. Grad. Univ.)

**概要** In recent years, there has been rapid progress in the study of nonlinear partial differential equations in general metric spaces, driven by applications in optimal transport, traffic flows, control theory, data sciences and many others. This talk provides a summary of recent results on the first order Hamilton–Jacobi equations in metric spaces, with emphasis on a special case of the eikonal equation.

We begin with a brief review of the theory of viscosity solutions, a well-established powerful tool for fully nonlinear partial differential equations in the Euclidean space. We next discuss several recently developed approaches to tackle the well-posedness of Hamilton–Jacobi equations in metric spaces. Our focus will be placed on the notion of so-called Monge solutions to the eikonal equation, which was originally introduced by Newcomb–Su (1995) as an equivalent alternative of viscosity solutions in the Euclidean case. We extend their idea to metric spaces. Compared to other known notions of metric viscosity solutions, its advantage lies in the convenience that it does not require any smooth test functions, whose existence is a significant obstacle in general metric spaces.

It is possible to adapt this method to further study eikonal equation with a discontinuous or even only integrable inhomogeneous term. In the last part of the talk, we present our recent results concerning this problem in metric measure spaces.

3月19日(火) 第II会場

**9:45~12:00**

- 25 國分海斗 (東京理大理) On solitary wave solutions to dispersive equations with double power nonlinearities ..... 10  
 Kaito Kokubu (Tokyo Univ. of Sci.) On solitary wave solutions to dispersive equations with double power nonlinearities

**概要** We study semilinear elliptic equations with the fractional Laplacian in dimension 1. The equations with single power nonlinearities have been observed by Weinstein (1987), Frank–Lenzmann (2013), and so on. We focus on the equations with double power nonlinearities and consider the existence of ground states.

- 26 中橋 涉 (東京理大理) Non-smoothness of the fundamental solutions for Schrödinger equations  
 加藤 圭一 (東京理大理) with super-quadratic and spherically symmetric potentials ..... 15  
 只野之英 (東京理大理)  
 Wataru Nakahashi (Tokyo Univ. of Sci.) Non-smoothness of the fundamental solutions for Schrödinger equations  
 Keiichi Kato (Tokyo Univ. of Sci.) with super-quadratic and spherically symmetric potentials  
 Yukihide Tadano (Tokyo Univ. of Sci.)

**概要** We consider non-smoothness of the fundamental solution for the Schrödinger equation with a spherically symmetric and super-quadratic potential in the sense that  $V(x) \geq C|x|^{2+\varepsilon}$  at infinity with constants  $C > 0$  and  $\varepsilon > 0$ . Yajima(1996) has shown that if  $V$  is super-quadratic and the spatial dimension is one, then the fundamental solution  $E(t, x, y)$  is not smooth anywhere with respect to  $(t, x, y)$ . In this talk, we show that the fundamental solution  $E(t, x, y)$  does not belong to  $C^1$  as a function of  $(t, x, y)$  if  $V$  is a spherically symmetric and super-quadratic potential, the spatial dimension is larger than or equals to 4.

- 27 瀧澤 駿 (東京理大理) Short-time asymptotics of the fundamental solutions for Schrödinger equations with non-smooth potentials ..... 15  
 Shun Takizawa (Tokyo Univ. of Sci.) Short-time asymptotics of the fundamental solutions for Schrödinger equations with non-smooth potentials

概要 We consider short-time asymptotic behaviors of the fundamental solutions for Schrödinger equations with potentials which are time-dependent and at most quadratic growth. Fujiwara (1980) has studied asymptotic behaviors of the fundamental solutions in the case where potentials are smooth. The purpose of this talk is to show in the case where potentials are non-smooth.

- 28 波多間 備 (京大数理研) 無限量子系に対する Hartree 方程式の殆ど確実な局所解の存在 ..... 15  
 山本 拓人 (京大数理研)  
 Sonae Hadama (Kyoto Univ.) Almost sure existence of local solutions to the Hartree equation for  
 Takuto Yamamoto (Kyoto Univ.) infinite quantum systems

概要 This talk focuses on the Cauchy problem of the Hartree equation for infinite quantum systems. The Strichartz estimates for orthonormal systems play an essential role in this problem. The initial data is given in the Schatten classes, and the orthonormal Strichartz estimates determine the optimal Schatten exponents  $\alpha$ . Consequently, when relying solely on deterministic estimates to manage the initial data terms, we cannot construct any solutions for initial data in Schatten classes with exponents greater than  $\alpha$ . However, we can go beyond this limitation by introducing a randomization of initial data. In this talk, we will first establish probabilistic Strichartz estimates and then apply them to the Hartree equation. Finally, we obtain local solutions for initial data in bigger Schatten classes than the deterministic Strichartz estimates allow.

- 29 生駒 真 (名大多元数理) 3次元 Dirac 方程式の平滑化評価式の最良定数 ..... 15  
 鈴木 聡一郎 (中大理工)  
 Makoto Ikoma (Nagoya Univ.) Optimal constants of smoothing estimates for the 3D Dirac equation  
 Soichiro Suzuki (Chuo Univ.)

概要 Kato–Yajima smoothing estimates are one of the fundamental results in study of dispersive equations such as Schrödinger equations and Dirac equations. For  $d(\geq 2)$ -dimensional free Schrödinger equations, optimal constants of smoothing estimates were given by Bez–Saito–Sugimoto (2015). In contrast, optimal constants for free Dirac equations are known only in the 2-dimensional case (Ikoma, 2022). In this talk, we give optimal constants for the 3-dimensional free Dirac equation.

- 30 田中 智之 (同志社大理工) Improved bilinear Strichartz estimates with application to the well-  
 L. Molinet (Univ. Tours) posedness of periodic generalized KdV type equations ..... 15  
 Tomoyuki Tanaka (Doshisha Univ.) Improved bilinear Strichartz estimates with application to the well-  
 Luc Molinet (Univ. Tours) posedness of periodic generalized KdV type equations

概要 We consider the Cauchy problem for one-dimensional dispersive equations of KdV type on the torus. Our main new ingredient is the replacement of improved Strichartz estimates with improved bilinear estimates so as to treat the worst resonant interactions. As a result, we obtain the unconditional well-posedness for the generalized KdV equation in  $H^s(\mathbb{T})$  for  $s > 1/2$ . Our result also holds for more general equations whose dispersive operator behaves for high frequencies as a Fourier multiplier with the symbol  $i|\xi|^\alpha \xi$  for  $1 \leq \alpha \leq 2$ . We remark that our methods work for the real line case as well.

- 31 佐藤拓也 (熊本大先端)  $\flat$  Optimal  $L^2$ -decay rate of solutions to dissipative nonlinear Schrödinger equations in the analytic class ..... 15

Takuya Sato (Kumamoto Univ.) Optimal  $L^2$ -decay rate of solutions to dissipative nonlinear Schrödinger equations in the analytic class

概要 We consider the Cauchy problem of one dimensional dissipative nonlinear Schrödinger equations with a critical power nonlinearity. In this talk, we show that  $L^2$ -decay rate obtained in the previous work is optimal in the analytic class.

#### 14:15~16:00

- 32 川上隼平 (京大理) Scattering and blow up for nonlinear Schrödinger equation with the averaged nonlinearity ..... 15

Jumpei Kawakami (Kyoto Univ.) Scattering and blow up for nonlinear Schrödinger equation with the averaged nonlinearity

概要 We consider a 3-dimensional nonlinear Schrödinger equation with average nonlinearity. This is a generalized model of the resonant system of an NLS with a partial harmonic oscillator in terms of nonlinear power. We provide a new proof for the conservation law of kinetic energy and remove the restriction on nonlinearity. Moreover, in the focusing, super-quintic, and sub-nonic cases, we construct a ground-state solution and classify the behavior of the solutions below the ground state. We demonstrate a sharp threshold for scattering and blow-up.

- 33 宮崎隼人 (香川大教育) 時間減衰する調和振動子を持つ非線形シュレディンガー方程式の修正散乱作用素について ..... 15  
川本昌紀 (愛媛大理工)

Hayato Miyazaki (Kagawa Univ.) Modified scattering operator for nonlinear Schrödinger equations with a time-decaying harmonic potential  
Masaki Kawamoto (Ehime Univ.)

概要 We consider nonlinear Schrödinger equations with a time-decaying harmonic potential. The nonlinearity is gauge-invariant of the long-range critical order. Kawamoto and Muramatsu show that the equation admits a nontrivial solution that behaves like a free solution with a logarithmic phase correction in the frameworks of both the final state problem and the initial value problem. Also, in the equation without the potential, Hayashi and Naumkin establish the existence of a modified scattering operator. In this talk, we construct a modified scattering operator for our equation by utilizing a generator of the Galilean transformation.

- 34 北村駿介 (東北大理工)  $\flat$  非コンパクト台の初期値を持つ空間変数重み付き半線形波動方程式の古典解の lifespan 評価 ..... 15

Shunsuke Kitamura (Tohoku Univ.) Lifespan of solutions of one dimensional semilinear wave equations with spatial weights and not-compactly supported data

概要 In this talk, I will report on the lifespan estimates of time-local classical solutions of semilinear wave equations with spatial weights and non-compactly supported data in one space dimension. Lifespan means the maximum existence time of solutions. There are cases where no time-local solution exists due to the spatial weight of the nonlinear term and the decay of the initial data.

- 35 肥田野久二男 (三重大教育) Global existence for a 2-speed and 3-component semilinear system of  
横山和義 (北海道科学大工) wave equations in 3D ..... 15  
Kunio Hidano (Mie Univ.) Global existence for a 2-speed and 3-component semilinear system of  
Kazuyoshi Yokoyama (Hokkaido Univ. of Sci.) wave equations in 3D

概要 This talk is concerned with global existence of small solutions to a two-speed and three-component system with quadratic nonlinear terms in 3D that so far has fallen beyond the capability of existing techniques. At the price of assuming radial symmetry, we resort to a point-wise estimation approach. The proof of global existence is based on the iteration argument using only weighted sup norms. Our weight functions are useful in observing that gain of time decay occurs in the product of derivatives of two components with different propagation speeds. This gain compensates for a small loss of decay of a certain component. Gain of time decay is observed also for “the tangential derivatives”, and we thereby allow for some null forms in the nonlinear terms.

- 36 岡本 葵 (阪大理) 粘性効果を含む非線形波動方程式の初期値問題の非適切性 ..... 15  
P. de Roubin (Univ. of Edinburgh)  
Mamoru Okamoto (Osaka Univ.) Ill-posedness of the Cauchy problem for the viscous nonlinear wave equation  
Pierre de Roubin (Univ. of Edinburgh) tion

概要 We consider the Cauchy problem for the viscous nonlinear wave equation. We show the ill-posedness in negative Sobolev spaces of the Cauchy problem for polynomial nonlinearity. In particular, we prove a norm inflation result above the scaling critical regularity in some cases.

- 37 M. A. Hamza (Imam Abdulrahman Bin Faisal Univ.) Asymptotic profiles for the Cauchy problem of damped beam equation  
with two variable coefficients and derivative nonlinearity ..... 10  
若杉 勇太 (広島大先進理工)  
吉川 周二 (大分大理工)  
Mohamed Ali Hamza (Imam Abdulrahman Bin Faisal Univ.) Asymptotic profiles for the Cauchy problem of damped beam equation  
with two variable coefficients and derivative nonlinearity  
Yuta Wakasugi (Hiroshima Univ.)  
Shuji Yoshikawa (Oita Univ.)

概要 We study the asymptotic behavior of solutions to the Cauchy problem of nonlinear damped beam equation with time-dependent coefficients. We give a conjecture of the classification of the asymptotic behavior of solutions depending on the coefficients, and show a partial answer for the case of parabolic-type behavior.

**16:15～17:15 2023年度(第22回)日本数学会解析学賞受賞特別講演**

太田 雅人 (東京理大理) 非線形シュレディンガー方程式に対する定在波の強不安定性解析

Masahito Ohta (Tokyo Univ. of Sci.) Strong instability analysis of standing waves for nonlinear Schrödinger equations

概要 A typical equation considered in this talk is the following nonlinear Schrödinger equation (NLS):

$$i\partial_t u = -\Delta u + |x|^2 u - |u|^2 u, \quad (t, x) \in \mathbb{R} \times \mathbb{R}^3.$$

It is known that for any  $\omega \in (-3, \infty)$  there exists a unique positive solution (ground state)  $\phi_\omega(x)$  of the stationary problem  $-\Delta\phi + |x|^2\phi + \omega\phi - |\phi|^2\phi = 0$  in the energy space  $X := \{v \in H^1(\mathbb{R}^3) : |x|v \in L^2(\mathbb{R}^3)\}$ . A standing wave solution  $e^{i\omega t}\phi_\omega(x)$  of (NLS) is said to be stable if for any  $\varepsilon > 0$  there exists  $\delta > 0$  such that if  $\|u_0 - \phi_\omega\|_X < \delta$  then the solution  $u(t)$  of (NLS) with  $u(0) = u_0$  exists globally and satisfies  $\inf\{\|u(t) - e^{i\theta}\phi_\omega\|_X : \theta \in \mathbb{R}\} < \varepsilon$  for all  $t \in [0, \infty)$ . Otherwise,  $e^{i\omega t}\phi_\omega(x)$  is said to be unstable. On the other hand,  $e^{i\omega t}\phi_\omega(x)$  is said to be strongly unstable if for any  $\varepsilon > 0$  there exists  $u_0 \in X$  such that  $\|u_0 - \phi_\omega\|_X < \varepsilon$  and the solution  $u(t)$  of (NLS) with  $u(0) = u_0$  blows up in finite time. In this talk, we will review the strong instability of standing wave solutions for some nonlinear Schrödinger equations.

3月20日(水) 第II会場

**10:00～12:00**

- 38 高山正宏 (慶大理工) 吊り下げられた紐の運動に対する解のアプリオリ評価 ..... 15  
井口達雄 (慶大理工)

Masahiro Takayama (Keio Univ.) A priori estimates for solutions to the motion of an inextensible hanging string  
Tatsuo Iguchi (Keio Univ.) string

概要 We consider the initial boundary value problem to the motion of an inextensible hanging string of finite length under the action of the gravity. In this problem, the tension of the string is also an unknown quantity. It is determined as a unique solution to a two-point boundary value problem, which is derived from the inextensibility of the string together with the equation of motion, and degenerates linearly at the free end. We derive a priori estimates for solutions to the initial boundary value problem in weighted Sobolev spaces under a natural stability condition. The necessity for the weights results from the degeneracy of the tension. Uniqueness of solution is also proved.

- 39 江口太一 (早大理工) The energy equality of the magnetohydrodynamic system in the framework of Lorentz–Besov spaces ..... 15

Taichi Eguchi (Waseda Univ.) The energy equality of the magnetohydrodynamic system in the framework of Lorentz–Besov spaces

概要 We find a new criterion of the Lorentz–Besov spaces to establish the energy equality of the incompressible magnetohydrodynamic (MHD) system in  $\mathbb{R}^3$ . In the Navier–Stokes equations, Cheskidov–Luo (2020) obtained the energy equality if the weak solution belongs to the class of the Lorentz–Besov spaces that are not contained in the classical Onsager space  $L^3(0, T; B_{3,\infty}^{1/3})$ . Motivated by Cheskidov–Luo (2020), we obtain a new criterion of the Lorentz–Besov spaces to establish the energy equality of the MHD system. We may regard our criterion on the MHD system as a generalization of the criterion of Cheskidov–Luo (2020).



- 40 T. Binz (TU Darmstadt) Uniqueness of weak solutions to the primitive equations in some anisotropic spaces ..... 15  
 飯田 祥樹 (早大理工) Uniqueness of weak solutions to the primitive equations in some anisotropic spaces ..... 15  
 Tim Binz (TU Darmstadt) Uniqueness of weak solutions to the primitive equations in some anisotropic spaces ..... 15  
 Yoshiki Iida (Waseda Univ.) Uniqueness of weak solutions to the primitive equations in some anisotropic spaces ..... 15

概要 We consider the three dimensional primitive equations for large scale oceanic and atmospheric dynamics. The uniqueness of weak solutions to the system is still open. In this talk, based on regularity in terms of Besov spaces, we give a new class in which the uniqueness holds, and compare with the known result by Tachim Medjo (2010). The proof of our result is basically relied on Littlewood–Paley theory argument.

- 41 顧 仲陽 (東大数理) Anomalous smoothing effect on the incompressible Navier–Stokes–Fourier  
 コキン (東大数理) limit from Boltzmann with periodic velocity ..... 10  
 米田 剛 (一橋大経済) Anomalous smoothing effect on the incompressible Navier–Stokes–Fourier  
 Zhongyang Gu (Univ. of Tokyo) limit from Boltzmann with periodic velocity ..... 10  
 Xin Hu (Univ. of Tokyo) limit from Boltzmann with periodic velocity ..... 10  
 Tsuyoshi Yoneda (Hitotsubashi Univ.) Anomalous smoothing effect on the incompressible Navier–Stokes–Fourier  
 limit from Boltzmann with periodic velocity ..... 10

概要 Adding a nontrivial term composed from a microstructure, we prove the existence of a global-in-time weak solution, whose enstrophy is bounded for all the time, to an incompressible 3D Navier–Stokes–Fourier system for arbitrary initial data. It cannot be expected to directly derive the energy inequality for this new system of equations. The main idea is to employ the hydrodynamic limit from the Boltzmann equation with periodic velocity and a specially designed collision operator.

- 42 小泉 祐太 (早大理工) Convergence of approximating solutions of the Navier–Stokes equations  
 in higher ordered Sobolev norms ..... 15  
 Yuta Koizumi (Waseda Univ.) Convergence of approximating solutions of the Navier–Stokes equations  
 in higher ordered Sobolev norms ..... 15

概要 We show that the approximating solutions  $\{u_j\}_{j=0}^{\infty}$  of the Navier–Stokes equations constructed by Kato (1984) with the initial data  $u(0) \in L^q_{\sigma}(\mathbb{R}^n)$  converge to the local strong solution  $u$  in the topology of  $W^{k,q}(\mathbb{R}^n)$  for all  $k \in \mathbb{N}$  provided the convergence in the scaling invariant norm in  $L^q(\mathbb{R}^n)$  with the time weight holds. As an application of our convergence, it is clarified that the approximation of the pressure is established in  $W^{k+1,q}(\mathbb{R}^n)$ .

- 43 中塚 智之 (松山大経済) Existence of time-periodic strong solutions to the Navier–Stokes equation  
 in the whole space ..... 15  
 Tomoyuki Nakatsuka Existence of time-periodic strong solutions to the Navier–Stokes equation  
 in the whole space ..... 15  
 (Matsuyama Univ.) Existence of time-periodic strong solutions to the Navier–Stokes equation  
 in the whole space ..... 15

概要 In this talk, the existence of time-periodic strong solutions to the Navier–Stokes equation in  $\mathbb{R}^n$  is established under a suitable smallness condition on the external force. Our analysis is based on splitting periodic solutions into steady and purely periodic parts. One advantage of this decomposition is the availability of slightly more regularity in time of the purely periodic part. We apply this property to construct time-periodic solutions of the Navier–Stokes equation with information on the classes of their steady and purely periodic parts.



## 14:15~15:15

- 44 牛越 惠理佳 (横浜国大環境情報・阪大基礎工) 時間依存領域における Helmholtz–Weyl 分解と Navier–Stokes 方程式の  
時間周期解の存在について ..... 12  
岡部 考宏 (阪大基礎工)  
菅野 晴瑠 (横浜国大環境情報)  
Erika Ushikoshi (Yokohama Nat. Univ./Osaka Univ.) Helmholtz–Weyl decomposition on a time dependent domain for time  
periodic Navier–Stokes flow  
Takahiro Okabe (Osaka Univ.)  
Haru Kanno (Yokohama Nat. Univ.)

概要 We consider the Helmholtz–Weyl decomposition on a time dependent bounded domain  $\Omega(t)$  in  $\mathbb{R}^3$ . Especially, we investigate the domain dependence of each component in the decomposition, namely, the harmonic vector fields (i.e., div and rot free vectors), vector potentials, and scalar potentials equipped with suitable boundary conditions, when  $\Omega(t)$  moves along to  $t \in \mathbb{R}$ . As an application, we construct a time periodic solution of the incompressible Navier–Stokes equations for some large boundary data with non-zero fluxes.

- 45 寺本 惠昭 (京大情報) Decay of solutions to the initial boundary value problem of the Stokes  
system in the halfspace ..... 15  
西田 孝明 (京大情報)  
Yoshiaki Teramoto (Kyoto Univ.) Decay of solutions to the initial boundary value problem of the Stokes  
system in the halfspace  
Takaaki Nishida (Kyoto Univ.)

概要 The initial boundary value problem of the Stokes system in the 3D halfspace is considered. The boundary condition subject on  $x_3 = 0$  is the balance of stress. Under certain conditions on the initial value we derive the rate of decay in time of  $L^2$  norm of solutions to this problem. The solutions to an auxiliary boundary value are estimated by residue analysis.

- 46 郭 柔均 (早大理工)  $L_1$  approach to the compressible viscous fluid flows in the half-space  
柴田 良弘 (早大\*) ..... 15  
Jou-chun Kuo (Waseda Univ.)  $L_1$  approach to the compressible viscous fluid flows in the half-space  
Yoshihiro Shibata (Waseda Univ.\*)

概要 This talk is devoted to proving the local well-posedness for the Navier–Stokes equations describing the isotropic motion of the compressible viscous fluid flows in the half-space with non-slip boundary conditions. We construct a unique strong solution in the  $L_1$  in time and  $B_{q,1}^{s+1} \times B_{q,1}^s$  in space maximal regularity class. Here,  $1 < q < \infty$  and  $-1 + N/q \leq s < 1/q$ , where  $N \geq 2$  is the space dimension. The approach is by means of the analytic semigroup theory and we use Lagrange transformation in order to eliminate the convection term  $\mathbf{v} \cdot \nabla \rho$ .

**15:30~16:30 特別講演**

橋本伊都子

(金沢大理工・阪公大数学研)

流体方程式の球対称問題に関する流入及び流出問題について

Itsuko Hashimoto

(Kanazawa Univ./Osaka Metro. Univ.)

Inflow and outflow problem on radially symmetric solution for fluid equation

**概要** We consider the boundary value problem of radially symmetric solutions for the multi-dimensional Burgers equation and compressible Navier–Stokes equation on the exterior domain, where the boundary and far field conditions are prescribed. In this talk, we first consider the existence of radially symmetric stationary solutions for both inflow and outflow problems. We also comment for the asymptotic stability of the obtained stationary solutions for both Burgers equation and compressible Navier–Stokes equation. Next we consider the inviscid limit problem of the radially symmetric stationary solutions to compressible Navier–Stokes equation. In this consideration, we investigate the corresponding Euler equation and boundary layer equation and their relations. Finally we clear the difference of the inviscid limit state between Inflow and outflow problem.

# 実函数論

3月19日(火) 第VI会場

9:30~12:00

- 1 伊東由文 公理的集合論 I の定義と存在定理 ..... 15  
Yoshifumi Ito Definition and existence theorem of the axiomatic set theory I

概要 In this lecture, we give the complete system of axioms of the set theory I.

This is the combined system of axioms ZFC and the axiom of the ordinal numbers and the axiom of the transcendental construction. Here the system of axioms of the set theory I is given in the new formulation.

We prove the existence theorem of the set theory I by constructing its model.

This is the final and complete solution of the problem of the axiomatic set theory.

- 2 伊東由文 ユークリッド幾何学の定義と存在定理 ..... 10  
Yoshifumi Ito Definition and existence theorem of Euclidean geometry

概要 In this lecture, we define Euclidean geometry and prove its existence theorem by using the axiomatic method.

In the present time, we know the complete set theory.

Thereby we can define the plane in the exact sense. Thus we use the notion of the point, the straight line in the plane.

Thereby we give the complete solution of the problem of the foundation of Euclidean geometry.

- 3 川崎敏治 拡張積分可能関数全体の空間構造について (II) ..... 15  
(玉川大工・千葉大法経・千葉大理)  
Toshiharu Kawasaki On the structure of space of all extended integrable functions, II  
(Tamagawa Univ./Chiba Univ./Chiba Univ.)

概要 In this talk, we expand the concept of integration and further discuss the structure of space of extended integrable functions.

- 4 福田亮治 (大分大理工) 非加法的測度が導く  $\mathcal{L}_0$  上の一様構造 ..... 15  
本田あおい (九工大情報工)  
岡崎悦明 (フuzzyシステム研)  
Ryoji Fukuda (Oita Univ.) Uniform topologies on  $\mathcal{L}_0$  with respect to a non-additive measure  
Aoi Honda (Kyushu Inst. of Tech.)  
Yoshiaki Okazaki  
(Fuzzy Logic Systems Inst.)

概要 Let  $\mathcal{L}_0$  be a space of all measurable functions defined on a non-additive measure space  $(\Omega, \mu)$ . We discuss the uniform topology on  $\mathcal{L}_0$ , which is given by entourages  $V_\varepsilon = \{(f, g) \mid \mu(|f - g| > \varepsilon) \leq \varepsilon\}$  ( $\varepsilon > 0$ ). We give some equivalent conditions for this uniformness and these also equivalent conditions for the uniformness of the measure algebra, which is naturally included in  $\mathcal{L}_0$ .

- 5 山口 哲志 (茨城大理工) Bi-preduals of generalized Morrey spaces with variable growth condition ..... 15  
 Satoshi Yamaguchi (Ibaraki Univ.) Bi-preduals of generalized Morrey spaces with variable growth condition

概要 Let  $L_{p,\lambda}(\mathbb{R}^d)$  be the Morrey space. In 2015 Rosenthal and Triebel gave the proof that

$$\left(\overline{C_{\text{comp}}^{\infty}(\mathbb{R}^d)}^{L_{p,\lambda}(\mathbb{R}^d)}\right)'' = L_{p,\lambda}(\mathbb{R}^d).$$

We consider generalized Morrey spaces  $L_{p,\phi}(\mathbb{R}^d)$  with variable growth function  $\phi : \mathbb{R}^d \times (0, \infty) \rightarrow (0, \infty)$ . In this talk we extend the duality to  $L_{p,\phi}(\mathbb{R}^d)$ . Moreover, we characterize  $\overline{C_{\text{comp}}^{\infty}(\mathbb{R}^d)}^{L_{p,\phi}(\mathbb{R}^d)}$  by the mean value of functions in  $L_{p,\phi}(\mathbb{R}^d)$ .

- 6 川 澄 亮 太 A characterization of boundedness of composition operators on Orlicz–  
 池 田 正 弘 (理化学研 AIP) Morrey spaces ..... 15  
 石 川 勲  
 (愛媛大データサイエンスセンター)  
 Ryota Kawasumi A characterization of boundedness of composition operators on Orlicz–  
 Masahiro Ikeda (RIKEN) Morrey spaces  
 Isao Ishikawa (Ehime Univ.)

概要 In this talk, we introduce our recent result about the necessary condition on boundedness of composition operators to the Orlicz–Morrey space, which extends the result about the Morrey space by Hatano, Ikeda, Ishikawa and Sawano in 2021. The composition operator is also called the Koopman operator and has been applied to data science and dynamical system extensively. To show the necessary condition we prove the boundedness of the composition operator from a Orlicz–Morrey space to itself, which was introduced in MSJ Autumn Meeting 2023 at Tohoku University. Next, we show that the product of the singular values of a Jacobi matrix is a positive constant. Finally, we find a function in Orlicz–Morrey space satisfying the previous step.

- 7 水 口 洋 康 (関西大システム理工) 2次元ノルムにより Pythagorean orthogonality を一般化する関係式 ... 15  
 Hiroyasu Mizuguchi (Kansai Univ.) generalized relation of Pythagorean orthogonality by two-dimensional norms

概要 The orthogonality relation in inner product spaces is simple, fruitful and interesting. When moving to normed spaces, we have many possibilities to extend this notion. Pythagorean orthogonality is one of them. The condition of Pythagorean orthogonality can be expressed by usual  $\ell_2$ -norm  $\|\cdot\|_2$  on  $\mathbb{R}^2$ . So we consider the generalized relation of Pythagorean orthogonality by two-dimensional norms. Similar to Pythagorean orthogonality or other orthogonalities, we obtain three existence theorems on this generalized relation.

- 8 厚 芝 幸 子 (東京女大現代教養) Approximation of fixed points of monotone nonexpansive-type mappings ..... 15  
 Sachiko Atsushiba Approximation of fixed points of monotone nonexpansive-type mappings  
 (Tokyo Woman's Christian Univ.) mappings

概要 In this talk, we prove weak and strong convergence theorems for monotone nonexpansive-type mappings. We also study the asymptotic behavior of orbits of some nonlinear mappings.

## 14:15~16:15

- 9 米田 剛 (一橋大経済) フーリエ変換の不確定性原理と機械学習の数理構造 ..... 15  
 Tsuyoshi Yoneda (Hitotsubashi Univ.) Fourier uncertainty principle and mathematical analysis on machine learning

概要 Reservoir Computing (RC) is a type of recursive neural network (RNN), and there can be no doubt that the RC will be more and more widely used for building future prediction models for time-series data, with low training cost, high speed and high computational power. In this talk, we clarify hidden structures of input and recurrent weight matrices in RC neural networks, and show that such structures are closely related to the Fourier uncertainty principle.

- 10 近藤 恵夢 (奈良女大人間文化) 非増加関数に対する重み付き Hardy の不等式と doubling condition につ  
 森藤 紳哉 (奈良女大自然) いて ..... 15  
 Emu Kondo (Nara Women's Univ.) Weighted Hardy's inequality for nonincreasing functions and the dou-  
 Shinya Moritoh (Nara Women's Univ.) bling condition for weights

概要 The aims of my talk are to state a limiting case of weighted Hardy's inequality and to give a simple proof of it by using the doubling condition for weights.

- 11 原田 真衣 (神奈川大工) 再感染を考慮した SIRS モデルの時間周期解の存在について ..... 15  
 山崎 教昭 (神奈川大情報)  
 Mai Harada (Kanagawa Univ.) On the existence of time periodic solutions for the SIRS model with the  
 Noriaki Yamazaki (Kanagawa Univ.) seasonally-dependent transmission rate

概要 We consider periodic problems for SIRS models with the seasonally-dependent transmission rate. Then, we prove the existence of time-periodic solutions to our problems.

- 12 鵜飼 直孝 (千葉大教育) 画像処理問題における方位調整を考慮する エネルギー勾配流 ..... 15  
 水野 大樹 (千葉大融合理工)  
 白川 健 (千葉大教育)  
 H. Antil (George Mason Univ.)  
 Naotaka Ukai (Chiba Univ.) Anisotropic energy gradient system associated with image denoising  
 Daiki Mizuno (Chiba Univ.) process with orientation adjustment  
 Ken Shirakawa (Chiba Univ.)  
 Harbir Antil (George Mason Univ.)

概要 In this talk, we consider a gradient system of a non-convex functional, based on a governing energy for anisotropic image denoising, as developed in [Berkels et al., SFB 611, 2006]. A characteristic of our gradient system lies in the nonstandard part  $\partial\gamma \circ R$ , which consists of the (set-valued) subdifferential  $\partial\gamma$  of an anisotropic metric  $\gamma \in W^{1,\infty}(\mathbb{R}^2)$ , and a rotation matrix  $R \in C^\infty(\mathbb{R}; \mathbb{R}^{2 \times 2})$ . This part plays a key role in the orientation adjustment within the image denoising process. Under appropriate settings, we will provide some mathematical observations for the gradient system using the time-discretization approach.

- 13 水野大樹 (千葉大融合理工) 凝固現象を考慮した結晶粒界運動の擬放物型フェーズ・フィールドモデル  
白川健 (千葉大教育) ..... 15  
Daiki Mizuno (Chiba Univ.) Pseudo-parabolic phase-field model of grain boundary motion with so-  
Ken Shirakawa (Chiba Univ.) lidification effect

**概要** In this talk, we deal with a coupling system consisting of Allen–Cahn equation with singular type diffusion and Kobayashi–Warren–Carter type system with pseudo-parabolicity. This system is based on the  $\phi$ - $\eta$ - $\theta$  model, which is proposed by [Kobayashi, RIMS Kokyuroku, 1210, 68–77 (2001)] as a mathematical model of grain boundary motion with solidification. In this system, the main characteristics are the strong singularity in the diffusions and variable-dependent mobilities, and these characteristics make it difficult to guarantee important mathematical properties, including the uniqueness of solutions. To address these problems, we consider a system modified by introducing pseudo-parabolic structure, which delivers better smoothness to the solution. Based on the above, we set our goal to discuss solvability, uniqueness, and regularity results of the system.

- 14 山崎教昭 (神奈川大情報) Approximate methods for optimal control problems of the Frémond  
P. Colli (Univ. of Pavia) model for shape memory alloys ..... 15  
M. H. Farshbaf-Shaker  
 ( WIAS )  
白川健 (千葉大教育)  
Noriaki Yamazaki (Kanagawa Univ.) Approximate methods for optimal control problems of the Frémond  
Pierluigi Colli (Univ. of Pavia) model for shape memory alloys  
M. Hassan Farshbaf-Shaker (WIAS)  
Ken Shirakawa (Chiba Univ.)

**概要** In this talk, we consider optimal control problems for the one-dimensional Frémond model for shape memory alloys. This model is constructed in terms of basic functionals like free energy and pseudo-potential of dissipation. The state problem is expressed by a system of partial differential equations involving the balance equations for energy and momentum. We prove the existence of an optimal control that minimizes the cost functional for a nonlinear and nonsmooth state problem. Moreover, we show the necessary condition of the optimal pair by using optimal control problems for approximating systems.

### 16:30~17:30 特別講演

- 松下慎也 不動点アルゴリズムとその応用  
 (秋田県立大システム科学技術)  
Shin-ya Matsushita (Akita Pref. Univ.) Fixed point algorithms and their applications

**概要** The main purpose of this talk is to present some current progress about the fixed point algorithms. This talk consists of two parts. The first part deals with the theory of nonexpansive mapping in Hilbert spaces and some fixed point algorithms. The second part focuses on the many different interpretations of nonexpansive mappings and algorithms, and describes their connections to many other topics in optimization and applied mathematics.

## 3月20日(水) 第VI会場

## 9:30~12:00

- 15 赤川佳穂(岐阜工高専) ある弾塑性モデルを記述する仮似変分不等式の閾値関数の非負値性について  
 松井一徳(成蹊大理工) いて…………… 10  
 Yoshiho Akagawa Nonnegativity of the threshold function in an elastoplasticity model  
 (Gifu Nat. Coll. of Tech.) based on quasi-variational inequality  
 Kazunori Matsui (Seikei Univ.)

概要 This paper discusses the nonnegativity of the threshold function in the elastoplasticity model based on quasi-variational inequality. In the previous work, the existence of a solution is proved under the assumption that the threshold function is strictly positive. In physical terms, it is natural that the threshold function is nonnegative. Therefore, it is meaningful to discuss the well-posedness under the weaker assumption. To prove the existence of a solution to the elastoplasticity model, we construct the concrete projection of the constraint set.

- 16 垣内花(日本女大理) 放物型方程式の連立系に対する自由境界問題の可解性について…………… 15  
 愛木豊彦(日本女大理)  
 Hana Kakiuchi (Japan Women's Univ.) Solvability of free boundary problems for the parabolic equation system  
 Toyohiko Aiki (Japan Women's Univ.)

概要 We consider a free boundary problem for a system of two parabolic equations on the one-dimensional space interval. The problem has been proposed as a mathematical model for a baking bread process in a hot oven. In the modeling we assume that the region consists of crumb, crust, and the evaporation front. The unknown functions of the problems are the position of the evaporation front which is regarded as the free boundary, the temperature field, and the mass distribution. Here, the temperature field and the mass distribution satisfy the standard parabolic equations in the crumb and crust regions, which are separated by the free boundary. We discuss about solvability of the approximation problem in the present talk.

- 17 森村晃子(日本女大理) 水分移動モデルに対する有限体積法を用いた数値解の収束…………… 15  
 愛木豊彦(日本女大理)  
 Akiko Morimura Convergence of approximation solutions obtained by the finite volume  
 (Japan Women's Univ.) method in moisture transport model  
 Toyohiko Aiki (Japan Women's Univ.)

概要 We consider the initial boundary value problem for nonlinear parabolic equations with non-monotone boundary conditions. The problem was already investigated as a mathematical model for moisture transport phenomena in porous materials. In our recent work, we have established existence and uniqueness of weak solutions by the Schauder fixed point theorem and the dual equation method, respectively. Since the proof for the existence is not constructive, it is important to show convergence of numerical solutions. In the present result, by applying the finite volume method, we approximate the partial differential equations and prove that the sequence of approximation solutions converges to the weak solution. The key to the proof is a compact theorem for discretized functions.

- 18 小杉千春 (山口大理) 圧縮性弾性体の伸縮運動を表す初期値境界値問題のエネルギー保存系に  
愛木豊彦 (日本女大理) 対する強解の存在について ..... 15  
Chiharu Kosugi (Yamaguchi Univ.) Existence of strong solutions for the energy conservation system repre-  
Toyohiko Aiki (Japan Women's Univ.) senting motions of incompressible elastic curve on the plane

**概要** In this talk, we consider the energy conservation system for the beam equation with the nonlinear stress function having singularity. In the previous meeting, we established existence and uniqueness of the weak solution to this problem. Also, existence and uniqueness of the solution for the energy dissipative system were already obtained. We note that the dissipative property is characterized by the viscosity coefficient. In this talk by showing that the sequence of the strong solution of the conservation system as the viscosity coefficient tends to 0, we prove the existence of the solution to the conservation system. In our proof the well-known compact theorem plays an important role.

- 19 菅原佑也 (東京理大理) Regularizing property of a Keller–Segel system with density-dependent  
田中悠也 (東京理大理) sensitivity ..... 15  
横田智巳 (東京理大理)  
Yuya Sugawara (Tokyo Univ. of Sci.) Regularizing property of a Keller–Segel system with density-dependent  
Yuya Tanaka (Tokyo Univ. of Sci.) sensitivity  
Tomomi Yokota (Tokyo Univ. of Sci.)

**概要** This talk deals with a parabolic–parabolic Keller–Segel system with density-dependent sensitivity. In a Keller–Segel system with logistic source, Lankeit (2021) constructed global classical solutions for initial data in  $L^1 \times W^{1,2}$ . The purpose of this talk is to show existence of global classical solutions for initial data in  $L^2 \times (W^{2,q} \cap W^{1,2})$  with some  $q > 1$  in a parabolic–parabolic Keller–Segel system with density-dependent sensitivity.

- 20 小波津晶平 (東京理大理) Boundedness and blow-up of weak solutions to a chemotaxis system  
with flux limitation ..... 15  
Shohei Kohatsu (Tokyo Univ. of Sci.) Boundedness and blow-up of weak solutions to a chemotaxis system  
with flux limitation

**概要** We consider boundedness and finite-time blow-up in a chemotaxis system with flux limitation. When there is no logistic term, Tello (Comm. Partial Differential Equations; 2022; 47; 307–345) obtained a condition such that finite-time blow-up occurs, however, the condition could still be improved. We improved the condition for finite-time blow-up in the system within the framework of weak solutions. Also, we established boundedness and finite-time blow-up of weak solutions to a chemotaxis system with flux limitation and logistic source.

- 21 千代祐太郎 (東京理大理) Global existence and boundedness in a fully parabolic chemotaxis sys-  
F. G. Düzgün (Hecettepe Univ.) tem with nonlocal source ..... 15  
S. Frassu (Cagliari Univ.)  
G. Viglialoro (Cagliari Univ.)  
Yutaro Chiyo (Tokyo Univ. of Sci.) Global existence and boundedness in a fully parabolic chemotaxis sys-  
Fatma Gamze Düzgün tem with nonlocal source  
(Hecettepe Univ.)  
Silvia Frassu (Cagliari Univ.)  
Giuseppe Viglialoro (Cagliari Univ.)

**概要** This talk deals with a fully parabolic chemotaxis system with nonlocal source. In the case that the second equation is simplified by the elliptic one, global existence and boundedness have already been obtained by Bian, Chen and Latos (Nonlinear Anal.; 2018; 176; 178–191). The purpose of this talk is to derive global existence and boundedness in the case that the second equation is parabolic.



- 22 P. Colli (Univ. of Pavia) Convergence of a nonlocal phase field system with inertial term ····· 15  
 来間俊介 (東京理大理)  
 L. Scarpa (Politecnico di Milano)

Pierluigi Colli (Univ. of Pavia) Convergence of a nonlocal phase field system with inertial term  
 Shunsuke Kurima (Tokyo Univ. of Sci.)  
 Luca Scarpa (Politecnico di Milano)

概要 There are some studies on nonlocal-to-local convergence of evolution equations. For example, Davoli–Scarpa–Trussardi (2021) and Abels–Terasawa (2022) have studied nonlocal-to-local convergence of Cahn–Hilliard equations. On the other hand, regarding phase field systems, in the case of a conserved phase field system related to entropy balance, nonlocal-to-local convergence has already been confirmed (K. (2022)). In this talk, we focus on convergence of a nonlocal phase field system with inertial term to a parabolic-hyperbolic phase field system.

- 23 伊藤昭夫 Quasi-variational structural evolution inclusion with perturbation on a real Hilbert space ····· 15  
 Akio Ito Quasi-variational structural evolution inclusion with perturbation on a real Hilbert space

概要 We consider a Cauchy problem of a quasi-variational structural evolution inclusion on an abstract real Hilbert space. The main purpose of this talk is to establish the abstract perturbation theory for evolution inclusions on real Hilbert spaces with quasi-variational structures by showing the existence of strong solutions on any finite interval, not strong global-in-time solutions. Moreover, it is applicable to the tumor invasion system with quasi-variational degenerate diffusion for the movement of tumor cells, which is treated in the paper, Quasi-variational Structure Approach to Systems with Degenerate Diffusions, Rendiconti del Seminario Matematico della Università di Padova, 147 (2022), 169–235.

#### 14:15~15:40

- 24 白川 健 (千葉大教育) Optimal control problems governed by pseudo-parabolic gradient systems for KWC type energies ····· 15  
 水野大樹 (千葉大融合理工)  
 H. Antil (George Mason Univ.)  
 Ken Shirakawa (Chiba Univ.) Optimal control problems governed by pseudo-parabolic gradient systems for KWC type energies  
 Daiki Mizuno (Chiba Univ.)  
 Harbir Antil (George Mason Univ.)

概要 In this talk, we consider a class of optimal control problems governed by KWC type systems with pseudo-parabolicity. Here, KWC type system means a gradient system associated with KWC energy, which was a free-energy of grain boundary motion proposed by [Kobayashi–Warren–Carter, Physica D, 140 (2000)]. In this study, we should be note that our state system admits a unique solution, even under unknown-dependent mobilities. Indeed, in previous works, unknown-dependent mobilities brought significant difficulties in the observations of uniqueness and linearization for the KWC type system. In view of this, we set the objective of this talk to establish a mathematical theory for optimization problems governed by the KWC type system. The main focuses of this talk will be on the existence of the optimal control, and the necessary conditions for the optimal control.

- 25 池田正弘 (理化学研AIP・慶大理工) An approximation of evolution equation with clique expansion of hypergraph Laplacian ..... 15  
 内田俊 (大分大理工)  
 深尾武史 (龍谷大先端理工)  
 Masahiro Ikeda (RIKEN/Keio Univ.) An approximation of evolution equation with clique expansion of hypergraph Laplacian  
 Shun Uchida (Oita Univ.)  
 Takeshi Fukao (Ryukoku Univ.)

概要 Hypergraph  $G$  is the triplet consisting of a finite set  $V$ , a family  $E \subset 2^V$ , and  $w : E \rightarrow (0, \infty)$ . We are concerned with an ODE governed by some nonlinear set-valued operator defined on  $\mathbb{R}^V$ , which is called “hypergraph Laplacian”. This ODE can be interpreted as a model of “heat” diffusion in the network represented by hypergraph. In this talk, we consider the case where the heat at some vertices of the hypergraph is given, and discuss the existence of solution and the continuous dependence of solution on given data.

- 26 江幡隆典 (新潟大自然) 一般の平衡則方程式のエントロピー解の初期値と流束に関する連続依存性  
 應和宏樹 (新潟大理) ..... 15  
 Takanori Ebata (Niigata Univ.) Continuous dependence on the initial and flux functions for entropy solutions of general balance laws  
 Hiroki Ohwa (Niigata Univ.)

概要 We consider the continuous dependence on the initial and flux functions for the entropy solutions to the Cauchy problem of general balance laws. In general, for the proof, it is necessary to assume that the flux and source functions are continuously differentiable. However, without the assumption that the functions are continuously differentiable, under only the assumption that the functions are locally Lipschitz continuous, we prove the continuous dependence on the initial and flux functions for the entropy solutions.

- 27 熊崎耕太 (京都教育大) あるマルチスケールモデルの解の時間大域的挙動について ..... 15  
 A. Muntean (Karlstad Univ.)  
 Kota Kumazaki (Kyoto Univ. of Edu.) Large-time behavior of a solution to a multiscale model  
 Adrian Muntean (Karlstad Univ.)

概要 In this talk, we consider a multiscale model describing nonlinear phenomena in porous materials. This model consists of a diffusion equation for the relative humidity distributed in materials and a free boundary problem describing the water-filling process in microscopic pockets. We consider each microscopic pocket as a one-dimensional interval and correspond the interval to each point of materials. In the previous result, we have proved the existence and uniqueness of a globally-in-time solution to the model. In this talk, we discuss the large-time behavior of a solution and investigate the steady state in each pocket.

- 28 深尾武史 (龍谷大先端理工) 空間4階の動的境界条件を課した Allen–Cahn 方程式への発展方程式論  
 P. Colli (Univ. of Pavia) 的接近 ..... 15  
 Takeshi Fukao (Ryukoku Univ.) Allen–Cahn equations with dynamic boundary conditions of fourth-order  
 Pierluigi Colli (Univ. of Pavia)

概要 In this study, we consider the initial and boundary value problem of the second-order parabolic Allen–Cahn equation with the dynamic boundary condition of fourth-order Cahn–Hilliard type. As an approximation problem, we consider an evolution equation governed by a subdifferential and discuss the limiting procedure approaching the target problem.

**15:45～16:45 2023年度(第22回)日本数学会解析学賞受賞特別講演**

田中直樹(静岡大理) 発展方程式に対する抽象理論—加藤による準線形理論に関連する話題を中心に—

Naoki Tanaka (Shizuoka Univ.) Abstract theory for evolution equations

**概要** This presentation provides an overview of recent advances in abstract theory for evolution equations, with a focus on topics related to the abstract quasi-linear theory pioneered by Kato. The significant theme is to explore strategies for weakening or eliminating stability, continuity with respect to the time variable, and denseness of domains of operators imposed in Kato's theory.

The discussion will begin by relaxing the strong continuity condition on the time variable, and our result obtained under Carathéodory's condition will be explained. Subsequently, a new concept of stability will be proposed, and Kōmura's conjecture regarding the well-posedness of an abstract degenerate wave equation will be discussed.

Future topics, such as the well-posedness of an abstract quasi-linear evolution equation governed by a family of non-densely defined operators in a reflexive Banach space and the approximate solvability of differential equations in a complete metric space, will be outlined. The former necessitates investigating a family of operators that do not satisfy the known stability conditions. The latter is related not only to mutational analysis but also to QDE theory, which is associated with product formulas for semigroups of operators.

**17:00～18:00 特別講演**

黒田紘敏(北大理) 4階の全変動流方程式の解の挙動について

Hirotohi Kuroda (Hokkaido Univ.) On the behaviour of solutions to the fourth order total variation flow equation

**概要** We consider the fourth order total variation flow equation. In the case of the second order, many results are known. Typical results are presented for comparison with the case of the fourth order. We characterize the solution in terms of what is called the Cahn–Hoffman vector field for the fourth order case. Next, we introduce a notion of calibrability of a set in our fourth order setting to explain the behaviour of solutions. This notion is related to whether a characteristic function preserves its form throughout the evolution. These concepts are used to discuss the relationship between the behaviour of solutions and spatial dimensions and boundary conditions.

# 函数解析学

3月17日(日) 第VII会場

9:30~11:00

- 1 渡辺 秀司 (群馬大理工) 外部磁場のあるときの超伝導のBCS理論におけるBogoliubov変換とギャップ方程式 ..... 15

Shuji Watanabe (Gunma Univ.) The Bogoliubov transformation and the gap equation in the BCS model of superconductivity with external magnetic field

概要 Under a simple condition, we derive the Bogoliubov transformation and the gap equation in the BCS model of superconductivity with external magnetic field.

- 2 佐々木 格 (信州大理) 対相互作用模型の基底状態の収束半径について ..... 15

松澤 泰道 (信州大教育)

泉 真之介 (信州大理)

井村 航太 (長野県富士見高)

Itaru Sasaki (Shinshu Univ.) On the radius of convergence of the ground state in a pair interaction model

Yasumichi Matsuzawa (Shinshu Univ.)

Shinnosuke Izumi (Shinshu Univ.)

Kouta Imura

(Nagano Pref. Fujimi High School)

概要 A year ago at the Mathematical Society of Japan we reported that the ground state and ground state energy of a pair interaction model are analytic with respect to the coupling constant. However, it was not enough to estimate the coupling constants such that the Maclaurin series converges. We have improved the proof and extended it to what we consider to be the best possible value.

- 3 只野之英 (東京理大理) Continuum limit for Laplace operators on lattices ..... 15

中村 周 (学習院大理)

三上 溪太 (理化学研THEMS)

Yukihide Tadano (Tokyo Univ. of Sci.) Continuum limit for Laplace operators on lattices

Shu Nakamura (Gakushuin Univ.)

Keita Mikami (RIKEN)

概要 We consider Laplace operators defined on lattices with mesh size  $h$  and those operators with perturbations of potentials. We prove that the above operators converge to certain elliptic operators in the continuum limit from the view point of spectral theory. We obtain as an application the asymptotic behavior of the spectra and eigenfunctions of the above operators.

- 4 廣島 文生 (九大数理) Positivity improving for the Nelson model with nonzero total momenta ..... 15

Fumio Hiroshima (Kyushu Univ.) Positivity improving for the Nelson model with nonzero total momenta

概要 It is shown that the strongly continuous semigroup generated by the Nelson Hamiltonian with zero total momentum zero is positivity improving. It is also shown that the strongly continuous semigroup generated by the Nelson Hamiltonian with nonzero total momentum zero is also positivity improving. Moreover the similar results are obtained for the relativistic Nelson Hamiltonian.

- 5 和田 和 幸 (北 教 大 旭 川) 量子ウォークの離散固有値に付随する固有関数の指数減衰性 ..... 15  
 Kazuyuki Wada Exponential decay for eigenfunctions associated with discrete spectra of  
 (Hokkaido Univ. of Edu.) quantum walks

概要 In this talks, we show that eigenfunctions associated with discrete spectra of quantum walks possesses exponential decay property. First, we establish the abstract theorem for unitary operators whose eigenvector associated with discrete spectra has exponential decay property. We consider the  $d$ -dimensional 2d-state quantum walks as an application.

#### 14:15~15:15 特別講演

- A. Galtbayar The  $L^p$ -boundedness of the wave operators for bi-Schrödinger operators  
 (National Univ. of Mongolia) on  $\mathbb{R}^4$   
 Artbazar Galtbayar The  $L^p$ -boundedness of the wave operators for bi-Schrödinger operators  
 (National Univ. of Mongolia) on  $\mathbb{R}^4$

概要 We prove that the wave operators for the fourth order Schrödinger operator  $\Delta^2 + V(x)$  in  $\mathbb{R}^4$  are bounded in  $L^p(\mathbb{R}^4)$  for the set of  $p$ 's of  $(1, \infty)$  depending on the kind of spectral singularities of  $H$  at zero which can be described by the space of bounded solutions of  $(\Delta^2 + V(x))u(x) = 0$ .

3月18日(月) 第VII会場

#### 9:30~11:00

- 6 青山 天馬 (東 大 数 理) BenSaïd–Kobayashi–Ørsted 理論にもとづく熱核と Wiener 測度の変形  
 ..... 15  
 Temma Aoyama (Univ. of Tokyo) Deformation of heat kernels and Wiener measures from the viewpoint  
 of BenSaïd–Kobayashi–Ørsted's Laguerre semigroup theory

概要 The BenSaïd–Kobayashi–Ørsted theory gives a generalization of the theory of metaplectic representations, and metaplectic representations relate to a classical harmonic analysis including heat flow. From this perspective, we may consider a deformation of classical heat theory. In this talk, we examine which basic properties of the classical heat theory can be generalized and, by using these properties, we discuss a construction of a deformed Wiener measure.

- 7 久保 利 久 (龍 谷 大 経 済) The classification and construction of projectively covariant differential  
 B. Ørsted ( Aarhus Univ. ) operators on  $\mathbb{RP}^2$  ..... 15  
 Toshihisa Kubo (Ryukoku Univ.) The classification and construction of projectively covariant differential  
 Bent Ørsted ( Aarhus Univ. ) operators on  $\mathbb{RP}^2$

概要 In contrast to conformal geometry, in which there are a large number of works on conformally covariant differential operators, only a few results are known for projectively covariant differential operators. For instance, the classification of such differential operators for  $\mathbb{RP}^2$  seems not in the literature, although the case for  $\mathbb{RP}^1$  was done by G. Bol in 1949. In this talk, we shall discuss the classification and explicit construction of projectively covariant differential operators on  $\mathbb{RP}^2$ .

- 8 甘中一輝(理化学研) 半単純 Lie 群の固有作用と Hurwitz–Radon 数 I ..... 15  
 Kazuki Kannaka (RIKEN) Proper actions of semisimple Lie groups and the Hurwitz–Radon number I

概要 Let  $G/H$  be a homogeneous space of reductive type and  $L$  a reductive Lie subgroup of  $G$ . We consider the natural left action of  $L$  on  $G/H$ . When  $H$  is non-compact, the properness of this action often imposes serious constraints on  $L$ .

In this talk, we introduce a certain condition for classical  $G/H$  (of possibly higher corank). Then I would like to discuss a type of theorem stating that there are almost no semisimple Lie subgroups  $L$  that act properly on  $G/H$  satisfying this condition. This talk is based on a joint work with Koichi Tojo (RIKEN).

- 9 東條広一(理化学研) 半単純 Lie 群の固有作用と Hurwitz–Radon 数 II ..... 15  
 Koichi Tojo (RIKEN) Proper actions of semisimple Lie groups and the Hurwitz–Radon number II

概要 Let  $G \subset GL(N, \mathbb{C})$  be a classical Lie group and  $G/H$  a homogeneous space satisfying "very even condition". We show that for fixed  $n \in \mathbb{N}$ , the condition that  $G/H$  admits a  $Spin(n, 1)$  proper action can be described by the Hurwitz–Radon number (or its analogues) of the size  $N$ . This talk is based on a joint work with Kazuki Kannaka (RIKEN).

- 10 笹木集夢(東海大理) Weyl group of pseudo-Riemannian symmetric space ..... 15  
 Atsumu Sasaki (Tokai Univ.) Weyl group of pseudo-Riemannian symmetric space

概要 It is well-known that the Weyl group of a non-compact real semisimple Lie group coincides with the Weyl group of the restricted root system of its Lie algebra. This talk considers the Weyl group  $W(G/H)$  of pseudo-Riemannian symmetric space  $G/H$ . We show that  $W(G/H)$  is the same as the Weyl group of the Lie group associated to  $G/H$ .

### 13:00~14:00 特別講演

田内大渡(青学大理工) Relationship between multiplicities of induced representations and orbit decomposition on real and complex flag varieties

Taito Tauchi (Aoyama Gakuin Univ.) Relationship between multiplicities of induced representations and orbit decomposition on real and complex flag varieties

概要 Let  $G$  be a real reductive algebraic group and  $H$  its real reductive algebraic subgroup. It was proved by T. Kobayashi and T. Oshima that the finiteness of the multiplicities of irreducible  $G$ -representations in  $C^\infty(G/H)$  is equivalent to the real sphericity of  $G/H$ . Moreover, they also proved that the uniform boundedness of the multiplicities in  $C^\infty(G/H)$  is equivalent to the sphericity of  $G_{\mathbb{C}}/H_{\mathbb{C}}$ , where  $G_{\mathbb{C}}$  and  $H_{\mathbb{C}}$  are complexifications of  $G$  and  $H$ , respectively. These theorems indicate a relationship between the multiplicities in  $C^\infty(G/H)$  and the orbit decomposition of the real and complex full flag varieties with respect to the action of  $H$  and  $H_{\mathbb{C}}$ , respectively. In this talk, a variant of this relationship will be discussed by replacing the full flag varieties with partial flag varieties.

3月19日(火) 第VII会場

### 9:30~11:30

- 11 渡邊恵一(新潟大理) 複素内積空間の開球におけるジャイロ演算について ..... 15  
 Keiichi Watanabe (Niigata Univ.) On gyro operations in open balls of complex inner product spaces

概要 We present some results on structures which should be called as Moebius or Einstein gyrovector spaces. They are introduced into an open balls centered at the origin of complex inner product spaces.

- 12 羽鳥 理 (新潟大\*) A Mazur–Ulam theorem on a GGV and its application ..... 15  
 阿部 敏一 (茨城大工)  
 Osamu Hatori (Niigata Univ.\*) A Mazur–Ulam theorem on a GGV and its application  
 Toshikazu Abe (Ibaraki Univ.)

概要 We show a Mazur–Ulam theorem on a GGV and a revised proof. As an application, we show a rather short proof of a known result about a characterization of the Thompson isometry on the positive cone of the positive invertible elements in a unital  $C^*$ -algebra.

- 13 森 迪也 (東大数理) On the Scottish Book Problem 155 by Mazur and Sternbach ..... 15  
 Michiya Mori (Univ. of Tokyo) On the Scottish Book Problem 155 by Mazur and Sternbach

概要 Problem 155 of the Scottish Book asks whether every bijection  $U: X \rightarrow Y$  between two Banach spaces  $X, Y$  with the property that, each point of  $X$  has a neighborhood on which  $U$  is isometric, is globally isometric on  $X$ . We prove that this is true under the additional assumption that  $X$  is separable and the weaker assumption of surjectivity instead of bijectivity.

- 14 瀬尾 祐貴 (大阪教育大教育) 幾何平均に関する数域半径不等式について ..... 15  
 Yuki Seo (Osaka Kyoiku Univ.) On numerical radius inequalities related to geometric means

概要 In this talk, we show numerical radius inequalities related to geometric means of real power for positive invertible operators, which estimates the upper and lower bounds of the  $\alpha$ -geometric means in terms of the generalized Kantorovich constant.

- 15 伊藤 公智 (前橋工科大) Inequalities among the weighted Heinz mean and related ones ..... 15  
 Masatoshi Ito (Maebashi Inst. of Tech.) Inequalities among the weighted Heinz mean and related ones

概要 Recently Furuichi, Minculete and Moradi got an improvement of the weighted arithmetic-logarithmic-geometric mean inequality. In this talk, as an extension of their result, we obtain inequalities among the weighted Heinz mean and related ones. Our approach is to consider the notion of a transpose symmetric path of weighted means.

- 16 大坂 博幸 (立命館大理工) On characterization of matrix monotone decreasing functions ..... 15  
 M. Kian (Univ. of Bojnord)  
 M. S. Moslehian (Ferdowsi Univ. of Mashhad)  
 Hiroyuki Osaka (Ritsumeikan Univ.) On characterization of matrix monotone decreasing functions  
 Mohsen Kian (Univ. of Bojnord)  
 Mohammad Sal Moslehian (Ferdowsi Univ. of Mashhad)

概要 Relating to finding possible upper bounds for the probability of error for discriminating between two quantum states, it is well-known that

$$\operatorname{tr}(A + B) - \operatorname{tr}|A - B| \leq 2\operatorname{tr}(f(A)g(B))$$

holds for every positive-valued matrix monotone function  $f$ , where  $g(x) = x/f(x)$ , and all positive definite matrices  $A$  and  $B$ . In this talk, we present a characterization of matrix monotone decreasing functions based on a matrix version of the above inequality.



- 17 山崎 丈明 (東洋大理工) The induced Aluthge sequence of compact operators ..... 15  
 大坂 博幸 (立命館大理工)  
 Takeaki Yamazaki (Toyo Univ.) The induced Aluthge sequence of compact operators  
 Hiroyuki Osaka (Ritsumeikan Univ.)

概要 We shall introduce convergence properties of iteration of the induced Aluthge transforms. In this talk, we shall consider compact, AN and AM operators.

#### 14:15~15:45

- 18 磯野 優介 (京大数理研) Haagerup and Størmer's conjecture for pointwise inner automorphisms ..... 15  
 Yusuke Isono (Kyoto Univ.) Haagerup and Størmer's conjecture for pointwise inner automorphisms

概要 In 1988, Haagerup and Størmer conjectured that any pointwise inner automorphism of a type III<sub>1</sub> factor is a composition of an inner and a modular automorphism. We study this conjecture and prove that any type III<sub>1</sub> factor with trivial bicentralizer indeed satisfies this condition. In particular, this shows that Haagerup and Størmer's conjecture holds in full generality if Connes' bicentralizer problem has an affirmative answer. Our proof is based on Popa's intertwining theory and Marrakchi's recent work on relative bicentralizers.

- 19 後藤 聡史 (上智大理工) Ocneanu の ADE Dynkin 図形間 connection system の一般化 ..... 15  
 Satoshi Goto (Sophia Univ.) A generalization of Ocneanu's ADE inter-Dynkin connection systems

概要 We generalize Ocneanu's ADE inter-Dynkin connection systems to the case of an arbitrary finite depth subfactor with its maximal atlas. We also discuss how to determine the intermediate subfactor lattice of an irreducible subfactor arising from an irreducible bimodule in the maximal atlas. Kawahigashi's "Quantum Galois correspondence" and "a characterization of a finite-dimensional commuting square producing a subfactor of finite depth" play a key role in this generalization.

- 20 曾我部 太郎 (京大理工) A duality of KK-theory and its application to the extensions of C\*-algebras ..... 15  
 Taro Sogabe (Kyoto Univ.) A duality of KK-theory and its application to the extensions of C\*-algebras

概要 KK-theory gives a tool to understand the morphisms of operator algebras and if the K-groups of the operator algebras are finitely generated one has a duality for the KK-groups which is called the Spanier-Whitehead K-duality. Many variants of this duality are studied in the context of the Poincaré duality, Paschke's duality and the dual algebras due to N. Higson. In this talk, I would like to talk about some categorical description of this duality and its application to the theory of extensions of C\*-algebras. I will explain how to understand a duality of extensions of C\*-algebras introduced by K. Matsumoto from the viewpoint of the Spanier-Whitehead K-duality.

- 21 縄田 紀夫 (阪大情報)  $\mathcal{W}$ -absorbing actions of finite abelian groups ..... 15  
 Norio Nawata (Osaka Univ.)  $\mathcal{W}$ -absorbing actions of finite abelian groups

概要 The Razak-Jacelon algebra  $\mathcal{W}$  is the simple separable nuclear monotracial  $\mathcal{Z}$ -stable C\*-algebra which is KK-equivalent to  $\{0\}$ . We say that an action  $\gamma$  of a finite group on  $\mathcal{W}$  is  $\mathcal{W}$ -absorbing if there exist a simple separable nuclear monotracial C\*-algebra  $A$  and an action  $\alpha$  on  $A$  such that  $\gamma$  is conjugate to  $\alpha \otimes \text{id}_{\mathcal{W}}$ . In this talk, we shall show a classification theorem for certain outer  $\mathcal{W}$ -absorbing actions of finite abelian groups.



- 22 小沢登高 (京大数理研) Quasi-local operators and finite-propagation operators ..... 15  
 Narutaka Ozawa (Kyoto Univ.) Quasi-local operators and finite-propagation operators

概要 This talk is about an operator theoretic aspect of Coarse Geometry. Every operator on (the  $\ell_2$  space on) a uniformly locally finite metric space  $X$  that is approximable by finite-propagation operators is quasi-local. Since introduced by J. Roe in 90s, it has been questioned whether the converse also holds true. It is indeed the case, by Spakula and Zhang's theorem (2018), if the metric space  $X$  is sufficiently nice (namely, satisfying Yu's property A). In this talk, I will report that the converse does not hold if the metric space  $X$  contains a sequence of expanders.

**16:00~17:00 特別講演**

武石拓也 (京都工繊大基盤) 代数体から構成される  $C^*$ -環と関連する代数体の完全不変量について

Takuya Takeishi (Kyoto Inst. Tech.)  $C^*$ -algebras constructed from number fields and related complete invariants of number fields

概要 The study of  $C^*$ -algebras from number theory originates from the work of Bost and Connes, but today there are several other known constructions. The interesting point is that for certain classes of  $C^*$ -algebras from number theory, it is possible to show that those  $C^*$ -algebras are isomorphic if and only if original fields are isomorphic. In this talk, we summarize those kind of rigidity results. As a consequence of rigidity results, we can see that the topological full groups of several groupoids from number theory are complete invariants of number fields. We summarize recent developments on the homology of the topological full group for a certain class.

# 統計数学

3月17日(日) 第Ⅲ会場

9:30~11:40

- 1 星野 浄生 (阪公大数学研) Characterization of the stochastic integral by the Riemann sum ..... 15  
 Kiyoi Hoshino (Osaka Metro. Univ.) Characterization of the stochastic integral by the Riemann sum

概要 We consider the Riemann sum of the same type we introduced at the MSJ autumn meeting in 2020 and discuss approximation and characterization of the stochastic integral with respect to a local martingale by the Riemann sum. We extend the preceding result given at the meeting mentioned above mainly in the following respect: (1) on the weight measures defining the Riemann sum, (2) on the continuity of the integrator and (3) on the uniform Riemann approximation of the stochastic integral.

- 2 山戸 康祐 (筑波大数理物質) Existence of quasi-stationary distributions of standard processes with  
 野場 啓 (統計数理研) no negative jumps ..... 15  
 Kosuke Yamato (Univ. of Tsukuba) Existence of quasi-stationary distributions of standard processes with  
 Kei Noba (Inst. of Stat. Math.) no negative jumps

概要 I will talk about the existence of quasi-stationary distributions for standard processes with no negative jumps killed at the boundaries. Quasi-stationary distributions are a kind of equilibrium state for Markov processes with killing. For standard processes with no negative jumps, we can define a function called the scale function, which provides a simple representation of the exit times and the potential density. Using the scale function, we can generalize the methods that have been used for one-dimensional diffusions and Lévy processes and provide necessary and sufficient conditions for the existence of quasi-stationary distributions.

- 3 甲斐 大貴 (京大理) Long time behavior of Lévy processes on manifolds ..... 15  
 Hirotaka Kai (Kyoto Univ.) Long time behavior of Lévy processes on manifolds

概要 Applebaum constructs a Lévy process on Riemannian manifolds by projecting the solution to the Marcus type stochastic differential equation on the orthonormal frame bundle, so called Elles–Elworthy–Malliavin construction. In this talk, we will show that how the curvature of a Riemannian manifold affects the properties of a Lévy process. We reveal these effects by introducing some estimates for the radial part of a Lévy process.

- 4 西森 康人 (阿南工高専) Limiting distributions for particles near the frontier of spatially inhomogeneous branching symmetric stable processes ..... 15  
 Yasuhito Nishimori  
 (Nat. Inst. of Tech., Anan Coll.) Limiting distributions for particles near the frontier of spatially inhomogeneous branching symmetric stable processes

概要 We discuss on the maximal displacement of the branching symmetric  $\alpha$ -stable processes. Here, we assume the branching rate measure is in the Kato class and it has a compact support on  $d$ -dimensional Euclidean space. We show that the maximal displacement exponentially grows and its order is determined by the index  $\alpha$  and the spectral bottom of the corresponding Schrödinger-type operator. Then, we consider the evolution of particles near the frontier and determine the limiting distribution of these particles.

- 5 濱名 裕治 (筑波大数理物質) ブラウン運動の到達時刻と到達位置の末尾確率の漸近展開について ..... 10  
 Yuji Hamana (Univ. of Tsukuba) Asymptotic expansion for the tail probability of the hitting time and site of Brownian motion

概要 We consider the large time asymptotics for the tail probability of the first hitting time of Brownian motion with the fixed arrival site. We give the first three terms in the three dimensional cases. In the two dimensional case, we show that the tail probability admits an asymptotic expansion in powers of  $1/\log t$ .

- 6 築島 瞬 (都立大理) 2曲線間に留まるよう条件付けられたランダムウォーク橋に対する不変原理  
石谷 謙介 (都立大理) 理 ..... 15  
Shun Yanashima (Tokyo Metro. Univ.) An invariance principle for random walk bridges conditioned to stay  
Kensuke Ishitani (Tokyo Metro. Univ.) between two curves

概要 Brownian house-moving is a stochastic process that plays an important role in computing higher-order Greeks for barrier options. It was introduced by Ishitani, Hatakenaka, and Suzuki (2020). In this presentation, we construct Brownian house-moving in a different way from their previous work. Specifically, we construct Brownian house-moving as the weak limit of Gaussian random walk bridges conditioned to stay between two curves.

- 7 西野 颯馬 (都立大理) Higher order integration by parts formulae for Wiener measures on a  
石谷 謙介 (都立大理) path space between two curves ..... 15  
Soma Nishino (Tokyo Metro. Univ.) Higher order integration by parts formulae for Wiener measures on a  
Kensuke Ishitani (Tokyo Metro. Univ.) path space between two curves

概要 The first order integration by parts formulae for Wiener measures on a path space between two curves are already known. In this talk, we extend this result to the higher order integration by parts. In the case of higher order, non-trivial boundary terms, which are absent in the conventional first order case, appear additionally. Furthermore, in the proof of this result, a construction method using random walk approximation of stochastic processes called Brownian excursion and Brownian house-moving becomes necessary. In the proof, we introduce the notion of first-order and second-order infinitesimal probabilities. We will explain that this concept is useful in organizing the integration by parts formulae.

- 8 星野 壮登 (阪大基礎工) Random models on regularity-integrability structures ..... 15  
I. Bailleul  
(Univ. Bretagne Occidentale)  
Masato Hoshino (Osaka Univ.) Random models on regularity-integrability structures  
Ismaël Bailleul  
(Univ. Bretagne Occidentale)

概要 In the study of singular SPDEs, it has been a challenging problem to obtain a simple proof of a general probabilistic convergence result (BPHZ theorem). Differently from Chandra and Hairer's Feynman diagram approach, Linares, Otto, Tempelmayr, and Tsatsoulis recently proposed an inductive proof based on the spectral gap inequality by using their multiindex language. Inspired by their approach, Hairer and Steele also obtained an inductive proof by using the regularity structure language. In this talk, we introduce an extension of the regularity structure including integrability exponents and provide a simpler proof of BPHZ theorem. This talk is based on a joint work with Ismael Bailleul (Univ Brest).

#### 14:15~15:15 特別講演

- 演 口 雄史 (阪大基礎工) 確率 Volterra 方程式の無限次元 Markov リフト  
Yushi Hamaguchi (Osaka Univ.) Infinite dimensional Markovian lifts of stochastic Volterra equations

概要 Stochastic Volterra equations (SVEs for short) are useful to model dynamics with hereditary properties, memory effects and roughness of the path, which cannot be described by standard SDEs. However, the analysis of SVEs is much more difficult than the SDEs case since the solutions are no longer Markovian or semimartingales in general. In this talk, we introduce an infinite dimensional framework which captures Markov and semimartingale structures behind SVEs. We show that an SVE can be "lifted" to an infinite dimensional stochastic evolution equation (SEE for short) and that the solution of the SEE becomes a Markov process on a Hilbert space. Furthermore, we establish asymptotic properties and well-posedness results for lifted SEEs, and then apply them to the original SVEs.

**15:30~16:30 特別講演**

永 沼 伸 顕 (熊本大先端) 非整数 Brown 運動により駆動される確率微分方程式の近似理論

Nobuaki Naganuma (Kumamoto Univ.) Approximation theory of SDEs driven by fractional Brownian motion

**概要** In this talk, we will consider approximation of solutions to stochastic differential equations (SDEs) driven by fractional Brownian motions. In particular we focus on asymptotic error distributions. In preceding results, several schemes (e.g. Euler–Maruyama scheme, Milstein scheme, Crank–Nicolson scheme and so on) to approximate the solutions were proposed and studied in several situations, which are classified by continuity and dimensions of the driving processes. To obtain such results, we use rough path theory to formulate SDEs and use the fourth moment theorem to identify limit distributions of error distributions. We will give an overview of them and introduce preceding results and recent developments.

3月18日(月) 第Ⅲ会場

**9:30~11:40**

9 田 端 操 樹 (立命館大理工) An infinite-dimensional Hawkes process ..... 15

Misaki Tabata (Ritsumeikan Univ.) An infinite-dimensional Hawkes process

**概要** We construct an infinite-dimensional stochastic process using the Hawkes process, specifically by establishing a compound Hawkes process. In this construction, we introduce a Poisson random measure to the process, thereby creating an infinite-dimensional stochastic process from a measure-theoretic perspective. For the constructed process, we derive sufficient conditions for the existence of  $\mathcal{L}_1, \mathcal{L}_2$  moments and the Laplace transform. In particular, for  $\mathcal{L}_2$  moment and the Laplace transform, we use a compensated Poisson measure to derive these conditions for the infinite-dimensional stochastic process we have constructed.

10 中 島 誠 (名大多元数理) 1点相互作用をもつ3次元熱方程式に関する Feynman–Kac 表現 ..... 15

Makoto Nakashima (Nagoya Univ.) Feynman–Kac representation for three-dimensional heat equation with one-center point interaction

**概要** In this talk, we consider the heat equation associated with the Schrödinger operator with one-center point interaction  $H_\lambda := -\Delta + \lambda\delta_0$ , where  $\delta_0$  is a Dirac measure at 0. This expression of the operator is the formal one but  $H_\lambda$  is mathematically defined via the norm-resolvent convergence of the Schrödinger operators with short-range interaction. We give a kind of Feynman–Kac representation of the heat equation associated with  $H_\lambda$ .

11 中 島 誠 (名大多元数理) 3次元 Edwards 測度に対する確率過程量子化 ..... 15

楠岡 誠一郎 (京大 理)  
 梁 松 (早大 教育)  
 アルベベリオセルジオ  
 (Univ. of Bonn)

Makoto Nakashima (Nagoya Univ.) Stochastic quantization of the three-dimensional Edwards measure  
 Seiichiro Kusuoka (Kyoto Univ.)  
 Song Liang (Waseda Univ.)  
 Sergio Albeverio (Univ. of Bonn)

**概要** In this talk, we focus on the Edwards model formally given by

$$\nu_\lambda(d\omega) = \frac{1}{Z_\lambda} \exp\left(-\lambda \int_0^1 \int_0^t \delta_0(\omega_t - \omega_s) ds dt\right) \nu_0(d\omega)$$

for  $\lambda \geq 0$ , where  $Z_\lambda$  is a normalizing constant. The formal random variable  $J(\omega) = \int_0^1 \int_0^t \delta_0(\omega_t - \omega_s) ds dt$  is called a self-intersection local time, that measures a random set  $T(\omega) = \{(s, t) : \omega_s = \omega_t\}$ . We will talk about the stochastic quantization of  $\nu_\lambda$  via the Dirichlet form.

- 12 上木直昌 (京大人間環境) Positivity of small ball probabilities of a Gaussian random field, and its applications to random Schrödinger operators ..... 15

Naomasa Ueki (Kyoto Univ.) Positivity of small ball probabilities of a Gaussian random field, and its applications to random Schrödinger operators

概要 The spectrum of a Schrödinger operator with a Gaussian random potential is  $\mathbb{R}$ . This is a theorem appeared in a book by Pastur and Figotin, and is proven by the theory on small ball probabilities, which had been extensively developed for Gaussian random fields. In this talk, some remarks are given on the proof, and similar facts are proven for a Schrödinger operator with a Gaussian random magnetic field.

- 13 田中晴喜 (鳴門教育大) Higher-order asymptotic behaviours of pressure functionals and statistical representations of the coefficients ..... 15

Haruyoshi Tanaka (Naruto Univ. of Edu.) Higher-order asymptotic behaviours of pressure functionals and statistical representations of the coefficients

概要 We study the higher-order asymptotic behaviour of the pressure functional  $\epsilon \mapsto P(\varphi + \epsilon\psi)$  with potentials  $\varphi$  and  $\psi$  on a countable Markov shift  $X$ , where  $P(f)$  means the topological pressure of  $f$ . In this talk, we give a condition for obtaining the  $n$ -order asymptotic expansion of  $\epsilon \mapsto P(\varphi + \epsilon\psi)$ . Moreover, we have an explicit formula for the behaviour of  $\mu((\sum_{i=0}^{m-1} (\psi - \int_X \psi d\mu) \circ \sigma^i)^k)$  as  $m \rightarrow \infty$  with the Gibbs measure  $\mu$  of  $\varphi$  and the shift  $\sigma$ . As a corollary, it turns out that the 3-th coefficient of the expansion has a limit representation that looks like the asymptotic variance well.

- 14 大井拓夢 (京大数理研) Dynkin games for Markov processes ..... 15  
上村稔大 (関西大システム理工)

Takumu Ooi (Kyoto Univ.) Dynkin games for Markov processes  
Toshihiro Uemura (Kansai Univ.)

概要 We consider Dynkin games for Markov processes associated with semi-Dirichlet forms. Dynkin games are the optimal stopping games introduced as the models of zero-sum games by two players. We prove that the solution to the certain variational inequality with two obstacles is the equilibrium price of the Dynkin game. Moreover, we obtain the saddle point of the game.

- 15 篠崎裕司 (日本銀行・東工大理) 再結合測度法の誤差評価とその応用 ..... 15  
二宮祥一 (東工大理)

Yuji Shinozaki (Bank of Japan/Tokyo Tech) Error estimation of high-order recombination and its application  
Syoiti Ninomiya (Tokyo Tech)

概要 Those algorithms to perform the patch dividing which are necessary when weakly approximating SDEs using the recombination method developed in [C. Litterer T. Lyons, 2012] are proposed. Refining Litterer-Lyon's error estimation provides the patch radius criteria on which these algorithms are based. Numerical examples of the calculation of option prices under the Heston model are also presented.

- 16 植田 優基 (北教大旭川) Uniform convergence towards extreme value distributions in free probability ..... 15  
 Yuki Ueda (Hokkaido Univ. of Edu.) Uniform convergence towards extreme value distributions in free probability

**概要** In probability theory, there had been an interest in the uniform convergence to an extreme value distribution. Extreme value distributions are classified into three types: Fréchet, Weibull, and Gumbel types, and the uniform convergence rate for Fréchet type was obtained by Smith and Omey. Later, Bartholmé and Swan obtained a new convergence rate from Stein's method in the Fréchet case. In 2020, Kusumoto and Takeuchi similarly used the Stein method to obtain an estimate of the Gumbel case. In this talk, we will report the results obtained on the uniform convergence to the free extreme value distribution using the Stein method as in the classical case. In free case, we will point out that information on the left tail of the distribution, which does not appear in the classical case, becomes important.

### 11:40~12:10 統計数学分科会総会

3月19日(火) 第Ⅲ会場

#### 10:00~11:10

- 17 田中 輝雄 (広島市大情報) ある分数型評価基準の最適停止問題について—連続時間の場合— ..... 10  
 Teruo Tanaka (Hiroshima City Univ.) Certain fractional optimal stopping problems —continuous time case—

**概要** We give the formulation of optimal stopping problems which combined a continuous time stochastic process and the criterion of a fractional reward. Using standard arguments in the theory of mathematical programming, we prove the existence of optimal stopping times under certain assumptions on the regularity of the stochastic processes.

- 18 藤田 敏治 (九工大工) 確率環境下における分岐・合流型決定過程—最小型評価— ..... 15  
 Toshiharu Fujita Stochastic decision process with feedforward loop system —Minimum  
 (Kyushu Inst. of Tech.) reward system—

**概要** We consider minimum reward system on a stochastic decision process model with a feedforward loop system, which is one of the nonserial branch systems. We apply invariant imbedding approach to our model and introduce recursive equations by dynamic programming technique.

- 19 谷野 憲司 (神戸大システム情報)  $B$ 型鏡映群不変な球面デザインの単体的特徴付けと Hilbert 恒等式 ..... 15  
 平尾 将剛 (愛知県立大情報)  
 澤 正憲 (神戸大システム情報)  
 Kenji Tanino (Kobe Univ.) Research on the strength of  $B_d$ -invariant weighted spherical design using  
 Masatake Hirao (Aichi Pref. Univ.) simplicial characterization and Hilbert's identity  
 Masanori Sawa (Kobe Univ.)

**概要** In this talk we give an upper bound for the degree of a certain type of  $B_d$ -invariant weighted spherical designs, as a generalization of Bajnok (2007), Heo–Xu (2001) and Sawa–Xu (2014). To achieve this goal, we focus on the equivalence of designs on the simplex and on the sphere. In addition to this, we also pay attention to the equivalence between the design on sphere and a certain type of Hilbert's identity. In particular, the former allows us to evaluate the upper bound of the design, and this is precisely our main result. We also discuss the best possibility of our bound in low dimensions.

- 20 岡原久也 (東京理大創域理工) 多元分割表における対称性に関する分離可能モデル ..... 15  
藤澤健吾 (山口東京理大)  
田畑耕治 (東京理大創域理工)  
Hisaya Okahara (Tokyo Univ. of Sci.) Separable models related to symmetry for multi-way contingency tables  
Kengo Fujisawa  
 (Tokyo Univ. of Sci., Yamaguchi)  
Kouji Tahata (Tokyo Univ. of Sci.)

概要 We consider multi-way contingency tables with the same ordered classifications and propose an asymmetry model based on  $f$ -divergence, which extends a previous model. In this talk, we show the asymptotic properties of test statistics. Additionally, we also offer insights into the previous model from the perspective of the proposed model. Finally, we present numerical experiments as a validation of the obtained results.

### 3月20日(水) 第III会場

#### 10:00~11:40

- 21 栗田絵梨 (東京理大理) Mardiaによる多変量歪度に対する検定統計量 ..... 15  
瀬尾隆 (東京理大理)  
Eri Kurita (Tokyo Univ. of Sci.) A test statistic for Mardia's multivariate skewness  
Takashi Seo (Tokyo Univ. of Sci.)

概要 In this talk, we consider a test statistic for Mardia's multivariate skewness related to the test for multivariate normality. Mardia (1970) gave the definitions of the multivariate skewness and the sample measure of multivariate skewness, and the test statistic was given by using the expectation and variance of asymptotic approximate statistic for the multivariate sample skewness. In this talk, we consider an improvement on Mardia's result. In particular, we derive exact results, instead of asymptotic Mardia's results for the expectation and variance. From the exact results, we propose a new test statistic with a good chi-squared approximation. Finally, we compare our result with that of Mardia (1970) and investigate the accuracy of chi-squared approximation by a Monte Carlo simulation.

- 22 佃康司 (九大数理) 多変量 allometric 回帰モデルにおける第一主成分の推定について ..... 15  
松浦峻 (慶大理工)  
Koji Tsukuda (Kyushu Univ.) Estimation of the leading principal component in the multivariate allo-  
Shun Matsuura (Keio Univ.) metric regression model

概要 The multivariate allometric regression model is a multivariate multiple regression model which imposes that the difference of mean vectors of two observations is always parallel to the leading eigenvector of the covariance matrix of observations. For this model, we consider the estimation problem for the leading eigenvector. Considering a class of estimators which includes conventional estimators, we evaluate estimation accuracies of the estimators contained in this class. Moreover, some estimators based on a preliminary test are proposed.



- 23 藤森 洸 (信州大経法) Two step estimations via the Dantzig selector for ergodic time series  
 佃 康司 (九大数理) models ..... 15  
 Kou Fujimori (Shinshu Univ.) Two step estimations via the Dantzig selector for ergodic time series  
 Koji Tsukuda (Kyushu Univ.) models

概要 We consider the estimation problems for conditionally heteroskedastic ergodic time series models with high-dimensional and sparse parameters and possibly infinite-dimensional nuisance parameters. We first establish the asymptotic behavior of the Dantzig selector based on the least squares method to estimate the unknown parameter of interest. Then, using the Dantzig selector and a consistent estimator for the nuisance parameter, we propose the asymptotically normal estimator for the non-zero components of the parameter of interest. Applications to the integer-valued autoregressive models are also presented in this talk.

- 24 江頭 健斗 (東京理大理工) 高次元小標本におけるカーネル k-means 法について ..... 15  
 矢田 和善 (筑波大数理物質)  
 青嶋 誠 (筑波大数理物質)  
 Kento Egashira (Tokyo Univ. of Sci.) Asymptotic properties of kernel k-means for high-dimension, low-sample-size data  
 Kazuyoshi Yata (Univ. of Tsukuba)  
 Makoto Aoshima (Univ. of Tsukuba)

概要 Substantial works about clustering on high-dimension, low-sample-size (HDLSS) data have been performed. Particularly, asymptotic behaviors of hierarchical clustering are investigated without assuming normality. On the other hand, asymptotic properties of k-means on behalf of partitional clustering in the HDLSS settings seem to have not been studied sufficiently. Especially, while the kernel method with some methodologies is investigated, a theoretical result of kernel k-means is not obtained. In this talk, we show the asymptotic properties of k-means for HDLSS data. Then, we introduce kernel k-means and show its effectiveness. At last, we present numerical simulation studies that demonstrate the performance of k-means and kernel k-means for high dimensional data, discussing the achieved results.

- 25 矢田 和善 (筑波大数理物質) Reconstruction of a low-rank matrix by singular value decompositions  
 青嶋 誠 (筑波大数理物質) ..... 15  
 Kazuyoshi Yata (Univ. of Tsukuba) Reconstruction of a low-rank matrix by singular value decompositions  
 Makoto Aoshima (Univ. of Tsukuba)

概要 In this talk, we consider the problem of recovering a signal (low-rank) matrix in high-dimensional settings. We first consider the conventional PCA to recover the signal matrix and show that the estimation of the signal matrix holds consistency properties under severe conditions. The conventional PCA is heavily subjected to a noise. In order to remove the noise, we apply the cross-data-matrix (CDM) methodology and propose a new estimation of the signal matrix. We show that the proposed estimation by the CDM method holds the consistency properties under mild conditions and improves the error rate of the conventional PCA effectively.

- 26 柿沢 佳秀 (北大経済) シリンダーデータに対する密度推定 ..... 15  
 Yoshihide Kakizawa (Hokkaido Univ.) Density estimation for cylinder data

概要 For the data supported on  $[0, \infty)$  or  $[0, 1]$ , the so-called boundary bias problem is one of the interests. Instead of the location-scale kernel  $k((x - \cdot)/h)/h$ , we have recently developed asymmetric kernel method to solve the boundary bias problem. In this talk, we consider the problem of estimating the density for cylinder data, using the asymmetric kernel and von Mises kernel. This is a first step, so that some related works in this direction will be expected by combining the circular distribution theory with the nonparametric method.



**14:15～15:15 2023年度(第22回)日本数学会解析学賞受賞特別講演**

藤越 康祝 (広島大\*) 高次元統計解析における情報量規準に基づくモデル選択

Yasunori Fujikoshi (Hiroshima Univ.\*) Model selection based on information criteria in high-dimensional statistical analysis

**概要** In this talk we consider model selection methods based on information criteria such as AIC, BIC and  $C_p$  in high-dimensional statistical analysis. First we point in multivariate regression (Fujikoshi, Sakurai and Yanagihara (2014), Yanagihara, Wakaki and Fujikoshi (2015), Bai, Choi, Fujikoshi and Hu (2022)) that within the framework of large-sample and high-dimension data AIC and  $C_p$  are asymptotically consistent, but there exists a case that BIC is not asymptotically consistent. This is a remarkable result, since it was known that AIC and  $C_p$  are not asymptotically consistent under the large sample case. Existence of the case that BIC is not asymptotically consistent but AIC is asymptotically consistent can be seen for the other situation as in estimating the dimensionality in principal component analysis, multivariate regression analysis and discriminant analysis. There is a faulty in the use of AIC and the like in a variable selection problem, since the amount of computation becomes numerous as the number of variables to choose is large. In order to avoid this difficulty, we discuss KOO (kick-one-out) methods. As a result, it is shown that the methods have asymptotic high-dimensional consistency in multivariate regression and discriminant analysis models under certain conditions (Fujikoshi (2022)).

**15:30～16:30 特別講演**

中川 智之 (明星大データサイエンス) ダイバージェンスを用いたロバストな一般化ベイズ法とその応用

Tomoyuki Nakagawa (Meisei Univ.) Robust Bayesian inference using the divergences and its applications

**概要** In Bayesian statistics, the robustness against outliers is one of important issues. It is well known that an ordinary Bayesian inference is strongly influenced by outliers. As one of the solutions to this problem, Bayesian inference using heavy-tailed distributions has been used for a long time and has been studied extensively in recent years. However, the heavy-tailed distributions require a model to be constructed for each problem, and it is often difficult to deal with complex models. On the other hand, Bayesian inference using the divergence has the advantage of being flexible applied to a variety of models, and has been developed by numerous studies in recent years. In this presentation, we consider that the robustness of Bayesian inference using the density power and gamma divergences. In addition, we show the performance of these Bayesian inferences which applied to several models in simulation studies.

# 応用数学

3月17日(日) 第IX会場

9:00~12:00

- 1 赤堀次郎(立命館大理工) サイクル上の量子ウォークに対する絶対ゼータ関数と周期性 . . . . . 15  
 今野紀雄(立命館大\*)  
 岡本陸希(立命館大理工)  
 佐藤巖(小山工高専)  
 田村勇真(立命館大理工)

Jiro Akahori (Ritsumeikan Univ.) Absolute zeta functions and periodicity of quantum walks on cycles  
 Norio Konno (Ritsumeikan Univ.\*)  
 Rikuki Okamoto (Ritsumeikan Univ.)  
 Iwao Sato (Oyama Nat. Coll. of Tech.)  
 Yuma Tamura (Ritsumeikan Univ.)

概要 The absolute zeta function can be considered as a zeta function over  $\mathbb{F}_1$  and the quantum walk is a quantum counterpart of the classical random walk. We showed a connection between the quantum walk and the absolute zeta function. Then we focused Grover walks and Hadamard walks on cycle graphs, which are typical models of quantum walks, and using cyclotomic polynomials, we calculated the periods and absolute zeta functions of such quantum walks. Especially, our result includes other proofs of some known results which showed such periods in some cases.

- 2 岡本陸希(立命館大理工) 量子ウォークのゼータ関数に対する絶対ゼータ関数 . . . . . 15  
 今野紀雄(立命館大\*)  
 佐藤巖(小山工高専)  
 赤堀次郎(立命館大理工)

Rikuki Okamoto (Ritsumeikan Univ.) Absolute zeta functions of zeta functions of quantum walks  
 Konno Norio (Ritsumeikan Univ.\*)  
 Sato Iwao (Oyama Nat. Coll. of Tech.)  
 Akahori Jiro (Ritsumeikan Univ.)

概要 We consider the absolute zeta function of zeta functions of quantum walks. First, we define the matrix zeta function for square matrix. The zeta function of quantum walk is a matrix zeta function for the Grover matrix that determines quantum walk on a graph. The zeta function of quantum walk has an absolute automorphic form of weight depending on the number of edges of the graph. We can consider the absolute zeta function of zeta function of quantum walk by this absolute automorphy. Especially, we calculate the absolute zeta function of zeta functions of quantum walks on a complete graph.

- 3 穂坂大将(横浜国大環境情報) QW-search/Zeta 対応 . . . . . 10  
 瀬川悦生(横浜国大環境情報)  
 今野紀雄(立命館大\*)

Taisuke Hosaka (Yokohama Nat. Univ.) QW-search/Zeta correspondence  
 Etsuo Segawa (Yokohama Nat. Univ.)  
 Norio Konno (Ritsumeikan Univ.\*)

概要 In this talk, we introduce the zeta function for the search model based on quantum walk. For the cycle, we give an expression of the zeta function in the case where the position and number of the marked vertices are general. Moreover we deal with the  $d$ -dimensional torus in the two special case of the position of the marked vertices, fixing the number of marked vertices is half.

- 4 佐藤 巖 (小山工高専) Weighted alternating Walk/Zeta 対応 ..... 15  
 遠藤 隆子 (東北大工)  
 小松 堯 (山梨大工)  
 今野 紀雄 (立命館大\*)  
 Iwao Sato (Oyama Nat. Coll. of Tech.) Weighted alternating Walk/Zeta correspondence  
 Takako Endo (Tohoku Univ.)  
 Takashi Komatsu (Univ. of Yamanashi)  
 Norio Konno (Ritsumeikan Univ.\*)

概要 We define a generalized second weighted alternating zeta function of a graph, and express the generalized second weighted alternating zeta function of a vertex-transitive regular graph by spectra of the transition probability matrix of the symmetric simple random walk on it and its Laplacian. Furthermore, we present an integral expression for the limit of the generalized second weighted alternating zeta functions of a series of vertex-transitive regular graphs. As an example, we treat the generalized second weighted alternating zeta functions of a finite torus.

- 5 山岸 弘幸 (産業技術高専) 完全グラフに対応する 2 種類の 離散  $\ell^p$  ソボレフ不等式の最良定数 ..... 15  
 渡辺 宏太郎 (防衛大)  
 永井 敦 (津田塾大学芸)  
 Hiroyuki Yamagishi The best constants of two types of discrete  $\ell^p$  Sobolev inequalities on a  
 (Tokyo Metropolitan Coll. of Indus. Tech.) complete graph  
 Kohtaro Watanabe  
 (Nat. Defense Acad. of Japan)  
 Atsushi Nagai (Tsuda Coll.)

概要 Let  $p$  be a positive real number. We determine the best constants of two types of discrete  $\ell^p$  Sobolev inequalities on a complete graph  $K_N$ . The discrete  $\ell^p$  Sobolev inequality shows that the maximum of  $|u(i)|^p$  is estimated from above by constant multiples of the potential energy for vector  $\mathbf{u} = {}^t(u(0), \dots, u(N-1)) \in \mathbb{C}^N$ . The potential energy is the  $\ell^p$  norm of  $\mathbf{u}$  with dumping coefficient  $a$ . In addition, we also have the best constant of the discrete  $\ell^p$  Sobolev inequality in the case of  $a = 0$ .

- 6 藤村 丞 On the generation of all Euler trails in an Eulerian graph ..... 10  
 (福岡大情報基盤センター)  
 白石 修二 (福岡大理)  
 Sho Fujimura (Fukuoka Univ.) On the generation of all Euler trails in an Eulerian graph  
 Shuji SHIRAISHI (Fukuoka Univ.)

概要 Fujimura and Shiraishi showed that all Euler trails of  $G$  are obtained in parallel for any Eulerian graph with  $2^n$  edges. In this paper, we generalize this result for an arbitrary Eulerian graph  $G$  by an idea of adding a dummy padding path to  $G$ .

- 7 B. Jackson Spanning even trees of graphs ..... 15  
 (Queen Mary Univ. of London)  
 善本 潔 (日大理工)  
 Bill Jackson Spanning even trees of graphs  
 (Queen Mary Univ. of London)  
 Kiyoshi Yoshimoto (Nihon Univ.)

概要 A tree  $T$  is said to be *even* if all pairs of vertices of degree one in  $T$  are joined by a path of even length. We conjecture that every  $r$ -regular non-bipartite connected graph  $G$  has a spanning even tree and verify this conjecture when  $G$  has a 2-factor. Well-known results of Petersen and Hanson et al. imply that the only remaining unsolved case is when  $r$  is odd and  $G$  has at least  $r$  bridges. We investigate this case further and propose some related conjectures.

- 8 前澤 俊一 (東京理大理) 虹色禁止部分グラフが誘導する前順序について ..... 15  
 斎藤 明 (日大文理)  
 Shun-ichi Maezawa (Tokyo Univ. of Sci.) On a preorder induced by rainbow forbidden subgraphs  
 Akira Saito (Nihon Univ.)

概要 A subgraph  $H$  of an edge-colored graph  $G$  is rainbow if all the edges of  $H$  receive different colors. If  $G$  does not contain a rainbow subgraph isomorphic to  $H$ , we say that  $G$  is rainbow  $H$ -free. For connected graphs  $H_1$  and  $H_2$ , if every rainbow  $H_1$ -free complete graph edge-colored in sufficiently many colors is rainbow  $H_2$ -free, we write  $H_1 \leq H_2$ . The binary relation  $\leq$  is a preorder. Cui et al. (2021) characterized the pairs  $(H_1, H_2)$  with  $H_1 \leq H_2$  when either  $H_1$  or  $H_2$  is a subgraph of the other. Motivated by their result, we are currently searching for such pairs under the condition that neither  $H_1$  nor  $H_2$  is a subgraph of the other. In this talk, We give a progress report of this study.

- 9 小沢 誠 (駒澤大総合) Characterization of critical complexes which have a form  $(G \times S^1) \cup H$  ..... 10  
 M. Eudave-Muñoz (Univ. Nacional Autónoma de México)  
 Makoto Ozawa (Komazawa Univ.) Characterization of critical complexes which have a form  $(G \times S^1) \cup H$   
 Mario Eudave-Muñoz (Univ. Nacional Autónoma de México)

概要 A simplicial complex is said to be *critical* for the 3-sphere  $S^3$  if it cannot be embedded in  $S^3$  but after removing any one point, it can be embedded. We show the following theorem:

Let  $X = (G \times S^1) \cup H$  be a critical complex, where  $G$  and  $H$  are graphs. Then  $(G \times \{0\}) \cup H$  has a minor  $G' \cup H'$  which is one of the following.

- (1)  $G' \cup H'$  is  $K_5$ , where  $H' = K_{1,4}$ .
- (2)  $G' \cup H'$  is  $K_5$ , where  $H' = K_3$ .
- (3)  $G' \cup H'$  is  $K_{3,3}$ , where  $H' = K_{1,3}$ .

- 10 小沢 誠 (駒澤大総合) Partially ordered set of complexes by embeddings and the existence of critical subcomplexes ..... 10  
 M. Eudave-Muñoz (Univ. Nacional Autónoma de México)  
 Makoto Ozawa (Komazawa Univ.) Partially ordered set of complexes by embeddings and the existence of critical subcomplexes  
 Mario Eudave-Muñoz (Univ. Nacional Autónoma de México)

概要 A simplicial complex is said to be *critical* for the 3-sphere  $S^3$  if it cannot be embedded in  $S^3$  but after removing any one point, it can be embedded. There exist complexes which cannot be embedded in  $S^3$ , but they do not contain any critical complexes. From the property of those examples, we define an equivalence relation on all simplicial complexes  $\mathcal{C}$  and a partially ordered set of complexes  $(\mathcal{C}/\sim; \subseteq)$ , and refine the definition of critical. According to the refined definition of critical, we show that if a complex  $X$  cannot be embedded in  $S^3$ , then there exists  $[X'] \subseteq [X]$  such that  $[X']$  is critical for  $[S^3]$ .

- 11 田中 康平 (信州大経法) Directed topological complexity for CW complexes ..... 15  
 Kohei Tanaka (Shinshu Univ.) Directed topological complexity for CW complexes

概要 The topological complexity of a space is a numerical homotopy invariant closely related to the robot motion planning problem. If robot motions are required to go along with certain direction, the directed topological complexity plays an important role to control directed algorithms. This talk will focus on the directed topological complexity of a space decomposed by a poset.

- 12 東谷章弘 (阪大情報) 正則マトロイドに付随する反射的多面体と  $\gamma$  非負性 ..... 15  
 Akihiro Higashitani (Osaka Univ.) Reflexive polytopes arising from regular matroids and  $\gamma$ -nonnegativity

概要 The symmetric edge polytope (SEP) of a graph is a centrally symmetric reflexive polytope whose vertices are defined by the edges of the graph. SEPs have been studied extensively in the past twenty years. Recently, a generalized version of SEPs has been introduced from graphs (i.e. graphic matroids) to regular matroids, which is characterized by totally unimodular matrices. Generalized SEPs are known to have palindromic Ehrhart  $h^*$ -polynomials. On the other hand, it is conjectured that (ordinary) SEPs have nonnegative  $\gamma$ -vectors. In this talk, we show that the conjecture on the nonnegativity of  $\gamma$ -vectors of SEPs does not hold for generalized SEPs.

#### 14:15~16:50

- 13 永並健吾 (成蹊大理工) Difference of facial achromatic numbers between two triangular embed-  
 大野由美子 dings of a graph ..... 15  
 (横浜国大研究推進機構)  
 Kengo Enami (Seikei Univ.) Difference of facial achromatic numbers between two triangular embed-  
 Yumiko Ohno (Yokohama Nat. Univ.) dings of a graph

概要 A facial 3-complete  $k$ -coloring of a triangulation  $G$  on a surface is a vertex  $k$ -coloring such that every triple of the colors appears on the boundary of some face of  $G$ . The facial 3-achromatic number  $\psi_3(G)$  of  $G$  is the maximum integer  $k$  such that  $G$  has a facial 3-complete  $k$ -coloring. We show an upper bound for difference of facial 3-achromatic numbers between two triangular embeddings of the same graph on a surface.

- 14 高橋大樹 (横浜国大環境情報) Outer Steiner point を用いた多角形の四角形分割 ..... 15  
 中本敦浩 (横浜国大環境情報)  
 Daiki Takahashi (Yokohama Nat. Univ.) Quadrangulations of a polygon with outer Steiner points  
 Atsuhiko Nakamoto  
 (Yokohama Nat. Univ.)

概要 Given an  $n$ -sided polygon  $P$  on the plane with  $n \geq 4$ , we consider a problem whether  $P$  is quadrangulatable or not by adding straight segments into the interior. We can easily find a non-quadrangulatable polygon  $P$  and hence we introduce Steiner points, which are auxiliary points which can be put in any position in the interior or exterior of  $P$ . In our talk, we estimate the number of Steiner points for quadrangulating  $P$  using the notion “spirality” of  $P$  which measures how far  $P$  is from being convex polygon in a sense.

- 15 野口健太 (東京理大理工) 双対グラフが 1-点カットをもつような完全グラフの埋め込み ..... 15  
 G. Brinkmann (Ghent Univ.)  
 H. Van den Camp (Ghent Univ.)  
 Kenta Noguchi (Tokyo Univ. of Sci.) Embedding of complete graphs so that the dual has a 1-cut  
 Gunnar Brinkmann (Ghent Univ.)  
 Heidi Van den Camp (Ghent Univ.)

概要 In 2022, Bokal, Brinkmann, and Zamfirescu considered the problem of the connectivity of the dual and they defined a function  $\delta_k(c)$  as the smallest genus  $s$  which allows a simple  $c$ -connected graph  $G$  embedded in an orientable surface  $\mathbb{S}_s$  with a simple dual  $G^*$  with a  $k$ -cut. This function is well-defined for  $c \geq k \geq 1$  and they determined the exact value when  $k \geq 3$  or  $c \leq 6$ . In this talk, we determine the exact value of  $\delta_2(c)$  for all  $c$  and give an upper bound for  $\delta_1(c)$ , which is one apart from the best, for infinitely many  $c$ .

- 16 松村 英樹 (慶大理工) 重み付きデザインの中心対称性の複素類似について ..... 15  
 澤 正憲 (神戸大システム情報)  
 Hideki Matsumura (Keio Univ.) On a complex analogue of central symmetry of weighted designs  
 Masanori Sawa (Kobe Univ.)

概要 A quadrature formula is a formula computing a definite integration by evaluation at a set of finitely many points (design). Examining the existence of certain rational quadrature formulas leads to applications to interesting problems such as Waring's problem and spherical designs. A central symmetric quadrature is a central research object in the real case. Sawa and Uchida proved the existence and the non-existence of central symmetric rational quadrature formulas for Hermite polynomials. In this talk, we consider an extension of the above results to Bessel polynomials and discuss complex analogues of central symmetry with examples. This is a joint work with Masanori Sawa.

- 17 三島 輝之 (神戸大工) 有理的 interval design の明示的構成法と Hilbert Kamke 問題 ..... 15  
 澤 正憲 (神戸大工)  
 内田 幸寛 (都立大理)  
 盧 曉南 (岐阜大工)  
 Teruyuki Mishima (Kobe Univ.) Explicit construction of rational interval design and Hilbert–Kamke  
 Masanori Sawa (Kobe Univ.) problem  
 Yukihiro Uchida (Tokyo Metro. Univ.)  
 Xiao-Nan Lu (Gifu Univ.)

概要 In this talk we consider the existence of rational quadrature for Hermite polynomials and Chebyshev polynomials of the first kind, which originally goes back to a work by Hausdorff (1909) concerning Waring problem in number theory. We show some nonexistence theorems for quadrature with small number of points and then provide existence results, together with explicit constructions and individual curious examples. Our proof is based on elementary number-theoretic techniques and elementary geometric considerations.

- 18 坂内 英一 (九大\*) あるアソシエーションスキームの2変数  $Q$ -多項式性について ..... 15  
 栗原 大武 (山口大創成)  
 Da Zhao (京大情報)  
 Yan Zhu (上海理工大)  
 Eiichi Bannai (Kyushu Univ.\*) On the bivariate  $Q$ -polynomiality of certain association schemes.  
 Hirotake Kurihara (Yamaguchi Univ.)  
 Da Zhao (Kyoto Univ.)  
 Yan Zhu  
 (Univ. of Shanghai for Sci. Tech.)

概要 The classification problem of  $P$ - and  $Q$ -polynomial association schemes has been one of the central problems in algebraic combinatorics. The definition of the multivariate version of  $P$ - and/or  $Q$ -polynomial association schemes was reported at the last meeting. In this talk, we show that the non-binary Johnson scheme and the association scheme obtained from attenuated spaces are bivariate  $Q$ -polynomial association schemes.

- 19 栗田 円佳 (早大理工) 平方剰余符号を用いた 3-design 構造について ..... 15  
 Madoka Awada (Waseda Univ.) 3-designs constructed by using quadratic residue codes

概要 The transitivity argument shows that shells of the extended quadratic residue codes of length  $p+1$  over  $\mathbb{F}_q$ ,  $(\tilde{Q}_{q,p+1})_\ell$ , support combinatorial 2-designs. In the present talk, by computing Jacobi polynomials and harmonic weight enumerators, we show that  $(\tilde{Q}_{q,p+1})_\ell \cup ((\tilde{Q}_{q,p+1})^\perp)_\ell (\neq \emptyset)$  is a 3-design. In addition, we introduce the way to construct infinite series of 3-designs in  $\tilde{Q}_{r^2,p+1}$ , which does not follow from the transitivity argument.

- 20 石川 麗 菜 (早 大 理 工) 拡大平方剰余符号から得られる例外的デザイン構造 ..... 15  
 Reina Ishikawa (Waseda Univ.) Exceptional designs in some extended quadratic residue codes

概要 In general, a non-empty set of all codewords with a weight of  $\ell$  in extended quadratic residue codes has a combinatorial 2-design. Bonnecaze–Sóle (2021) demonstrated that extended binary quadratic residue codes of length 42 has a 3-design. However, this result was obtained only through electronic calculations. The goal of this presentation is to provide additional examples in the extended ternary and quaternary quadratic residue codes with logical proofs. We compute Jacobi polynomials and harmonic weight enumerators for the extended ternary quadratic residue code of length 14 and the extended quaternary quadratic residue code of length 18. By using these results, we prove our examples through logical reasoning.

- 21 谷 口 浩 朗 2 次的な APN 関数  $F(x) + Tr(x)L(x)$  について ..... 15  
 (大和大教育・香川高専\*)  
 Hiroaki Taniguchi On quadratic APN functions  $F(x) + Tr(x)L(x)$   
 (Yamato Univ./Kagawa Nat. Coll. of Tech.\*)

概要 We first characterize how two  $(n-1, m)$  functions  $f$  and  $g$  can be combined into an APN  $(n, m)$ -function  $F$  of the form  $F(x) = f(x)$  and  $F(x + e_0) = g(x)$  for  $x \in \mathbf{F}_2^{n-1}$  with  $e_0 \in \mathbf{F}_2^n \setminus \mathbf{F}_2^{n-1}$ . Next we specialize this characterization to the case when  $f$  is quadratic and  $g(x) = f(x) + L(x)$  for some linearized polynomial  $L$ . Lastly for a quadratic APN  $(n, n)$ -function  $F$  and a linearized polynomial  $L$ , we give a characterization of APN-ness for  $(n, n)$ -function  $F(x) + Tr(x)L(x)$ . With some computational experiments, we see that CCZ-inequivalent APN functions  $F(x) + Tr(x)L(x)$  can be obtained from  $F$  using this construction.

#### 17:00~18:00 特別講演

- 盧 曉 南 (岐 阜 大 工) グループテスト・組合せテストにおける組合せ構造について  
 Xiao-Nan Lu (Gifu Univ.) Combinatorial structures for group testing and combinatorial testing

概要 *Group testing* (GT) is a method for identifying defective items within a large population by pooling samples together for joint testing. Combinatorial structures in GT, commonly represented by binary matrices like *separable matrices* and *disjunct matrices*, serve as crucial mathematical frameworks for formulating efficient testing strategies. *Combinatorial testing* (CT) focuses on the identification and location of faults arising from interactions among a small number of factors, not just independent items. Test case designs in CT employ combinatorial structures, such as *covering arrays*, *locating arrays*, and *detecting arrays*. Remarkably, GT can be viewed as specialized CT models under particular conditions.

In both GT and CT, constructions and characterizations of combinatorial structures are closely related to extremal combinatorics, combinatorial designs, and coding theory. The practical applications of GT and CT have also impacted the advancements in combinatorial design theory. This talk aims to introduce the fundamental mathematical frameworks through key combinatorial structures for GT and CT. Moreover, recent research focusing on variations and extensions of classical GT and CT using novel combinatorial structures will be discussed.



## 3月18日(月) 第IX会場

## 9:00~12:00

- 22 佐藤 純 (東京工芸大工) 非一様な非対称単純排他過程の厳密な定常状態 ..... 15  
 石黒 裕樹 (東大物性研)  
 西成活裕 (東大先端研)  
 Jun Sato (Tokyo Polytechnic Univ.) Exact stationary state of the inhomogeneous ASEP  
 Yuki Ishiguro (Univ. of Tokyo)  
 Katsuhiko Nishinari (Univ. of Tokyo)

概要 We find the exact stationary state of the asymmetric simple exclusion process, where the hopping rates are dependent on the position of the lattice site.

- 23 上岡 修平 可積分系に基づく平面分割の乱択アルゴリズム ..... 15  
 (大阪成蹊大データサイエンス)  
 Shuhei Kamioka (Osaka Seikei Univ.) An integrable algorithm for randomly sampling plane partitions

概要 An algorithm for random sampling of plane partitions is proposed. The algorithm is based on an integrable system, called the discrete two-dimensional Toda equation. The complexity of the algorithm is about the same as a conventional fast method. In addition, the probability distribution for sampling is determined by a solution to the integrable system. For this property, we can perform the sampling from a nontrivial distribution in the same manner as the uniform one.

- 24 青木 利隆 (神戸大人間発達環境) Computing bipath persistent homology ..... 15  
 E. G. Escobar (神戸大人間発達環境)  
 多田 駿介 (神戸大人間発達環境)  
 Toshitaka Aoki (Kobe Univ.) Computing bipath persistent homology  
 Emerson Gaw Escobar (Kobe Univ.)  
 Shunsuke Tada (Kobe Univ.)

概要 In topological data analysis, persistent homology provides a compact descriptor of the birth and death scales of the topological features of data. In particular, the descriptor, the persistence diagram, can be algebraically understood using interval decompositions of persistence modules. In a previous work, we characterized all posets whose persistence modules are guaranteed to be interval decomposable. In addition to the classical setting of zigzag persistence, this includes what we call the bipath poset and bipath persistence, as a generalization of the persistent homology of filtrations. In this work, we provide algorithms to compute the interval decompositions and thus construct persistence diagrams for bipath persistence.

- 25 森田 英章 (室蘭工大工) 有限有向グラフの正則被覆について ..... 15  
 Hideaki Morita (Muroran Inst. of Tech.) On the regular covering of a finite digraph

概要 We consider the regular covering of a finite digraph which allows multi-arcs and multi-loops. We define the notion “inverse arcs” for such a digraph. In addition, we will see that the regular covering of the digraph can be constructed as the induced digraph with respect to the ordinary voltage assignment corresponding to the group action, including the behaviors of those inverse arcs of them. This enables one to consider the problem which describes decomposition of the generalized weighted zeta function for the regular covering of a digraph.



- 26 石川 彩香 (山形大データサイエンス教育研究推進センター) 周期経路に対するグラフゼータ関数とその行列式表示 ..... 15  
 Ayaka Ishikawa (Yamagata Univ.) A graph zeta function of periodic paths and its determinant expression

概要 In general, a graph zeta function is defined for ordinary paths. On the other hand, there also exists a graph zeta function defined for alternating paths. These can be expressed in the Ihara representation, similar to the case of ordinary paths. In this talk, we will define more general paths and present the Ihara expression of the graph zeta function.

- 27 釣井 達也 (東京情報大総合情報) 発展行列から得られる群構造を用いた Grover walk の周期性に関する研究  
 伊藤 直治 (奈良教育大教育) ..... 15  
 松山 豊樹 (奈良教育大教育)  
 Tatsuya Tsurii (Tokyo Univ. of Information Sci.) A study on periodicity of Grover walk using group structures obtained  
 Naoharu Ito (Nara Univ. of Edu.) from its evolution matrix  
 Toyoki Matsuyama (Nara Univ. of Edu.)

概要 In our previous paper [1], we have shown that Grover walk on complete graphs with  $n$  vertices and a self-loop at each vertex has period  $2n$ . The method of the proof is focus on the eigenvalues of the evolution matrix  $U$ . In this talk, we show another proof of the above problem by focusing on group structures obtained from the evolution matrix  $U$ .

- 28 船川 大樹 (北海学園大工) 1次元2状態の開放系量子ウォークにおける固有値の存在 ..... 15  
 齋藤 溪 (神奈川大工)  
 Daiju Funakawa (Hokkai-Gakuen Univ.) The existence of eigenvalues in one-dimensional two-state open quantum  
 Kei Saito (Kanagawa Univ.) walks

概要 Quantum walks are mathematical models that are said to be quantum version of random walks and are applied to topological insulators. In recent years, open quantum walks, in which the flow of particles are controlled, have been studied actively. For closed systems, topological invariants are described using the dimension of the eigenspace of the time evolution operator. For this reason, the analysis of the eigenvalues of the time evolution operator is important in the study of quantum walks. In this talk, we will analyze the birth eigenvalues of the Mochizuki–Kim–Obuse model, which is an example of an open quantum system.

- 29 三家 雅弘 (慶大理工) グラフのハミルトン性とタフネスおよび禁止誘導部分パスの条件 ..... 15  
 太田 克弘 (慶大理工)  
 Masahiro Sanka (Keio Univ.) Toughness, forbidden induced paths and hamiltonicity of graphs  
 Katsuhiko Ota (Keio Univ.)

概要 For a real number  $t > 0$ , we say that a graph  $G$  is  $t$ -tough if for any set  $S$  with  $G - S$  disconnected, the number of components of  $G - S$  is at most  $|S|/t$ . In 1973, Chvátal conjectured that there exists a constant  $t_0$  such that every  $t_0$ -tough graph is hamiltonian. In this talk, the result on 2-tough  $2K_2$ -free graphs provided by Ota and the presenter is introduced. To show the result, the theorem saying that every 2-tough graph has a 2-factor is useful. On the other hand, it is also known that every  $3/2$ -tough  $2K_2$ -free graph has a 2-factor. In this talk, the result on forbidden induced paths for a  $3/2$ -tough graph to have a 2-factor is also introduced.

- 30 横村 国治 (東海大理系教育センター) Balanced 3部グラフの Hamiltonian-connected 性について ..... 15

Kuniharu Yokomura (Tokai Univ.) On degree conditions of balanced 3-partite Hamiltonian-connected graphs

概要 For a graph  $G$  and  $u, v \in V(G)$ , a path in  $G$  from  $u$  to  $v$  is called a  $(u, v)$ -path, and if  $(u, v)$ -path is a Hamiltonian path from  $u$  to  $v$ , then  $(u, v)$ -path is called a  $(u, v)$ -Hamiltonian path. A graph  $G$  is said to be *Hamiltonian-connected* if there exists a  $(u, v)$ -Hamiltonian path between any two vertices  $u, v$ . A  $k$ -partite graph is said to be a *balanced  $k$ -partite graph* if each partite set has the same number of vertices. We give some conditions for balanced 3-partite graphs to be Hamiltonian-connected.

- 31 藤田 慎也 (横浜市大データサイエンス) 辺着色グラフにおける単色連結構造について ..... 10

Shinya Fujita (Yokohama City Univ.) On monochromatic connectivity in edge-colored graphs

概要 We consider edge-colored graphs. Let  $G$  be an edge-colored graph. If, for any two vertices in  $G$ , there exists a monochromatic path connecting them, then we say that  $G$  is monochromatic connected. Some recent results on monochromatic connectivity in edge-colored graphs will be reviewed.

- 32 安藤 清 (国立情報学研) A constructive characterization of 5-edge-connected 5-regular multi-graphs ..... 15

Kiyoshi Ando (Nat. Inst. of Informatics) A constructive characterization of 5-edge-connected 5-regular multi-graphs

概要 We deal with multi-graphs with no self-loops. By introducing a new operation “quasi-edge-binding”, we give a generating theorem for 5-edge-connected 5-regular multi-graphs. This is a 5-edge-connected analogue of Korzig–Simmons result on  $2k$ -edge-connected  $2k$ -regular multi-graphs.

### 13:00~14:00

- 33 深澤 知 (山形大理) グラフのガロア点について ..... 15  
三枝崎 剛 (早大理工)

Satoru Fukasawa (Yamagata Univ.) Galois points for a graph  
Tsuyoshi Miezaki (Waseda Univ.)

概要 In this talk, we introduce the notion of a Galois point for a finite graph, using the theory of linear systems of divisors for graphs discovered by Baker and Norine. We present a new characterization of complete graphs in terms of Galois points.

- 34 三枝崎 剛 (早大理工) 彩色対称関数の一般化 ..... 15

西村 優作 (早大理工)  
宗政 昭弘 (東北大情報)  
佐久間 雅 (山形大理)  
辻 栄 周 平 (北教大旭川)  
Tsuyoshi Miezaki (Waseda Univ.) A generalization of the chromatic symmetric function  
Yuusaku Nishimura (Waseda Univ.)  
Akihiro Munemasa (Tohoku Univ.)  
Tadashi Sakuma (Yamagata Univ.)  
Shuheii Tsujie (Hokkaido Univ. of Edu.)

概要 The present talk aims to give a generalization of the chromatic symmetric function. We call this the Kneser chromatic function and show that the set of Kneser chromatic functions is a complete invariant for graphs. Further, we give three graph invariants and discuss some of their properties.

- 35 西村 優作 (早大理工) シンプルランダムウォークの期待到達時間と equitable partition ..... 15  
Yusaku Nishimura (Waseda Univ.) A simple random walk and equitable partition

概要 It is known that the average hitting times of simple random walks from any vertex to any other vertex in distance-regular graphs are determined by their intersection array. In this paper, we introduce a new graph classification called  $f$ -equitable, utilizing both the equitable partition and the function  $f$ , which represents one of the generalizations of distance-regular graphs. We determine the average hitting times from any vertex to any other vertex in  $f$ -equitable graphs by using their parameter, referred to as the quotient matrix. Furthermore, we establish the existence of a function  $(f_1, f_2)$  such that the Cartesian product of two strongly regular graphs is  $(f_1, f_2)$ -equitable. We then calculate the quotient matrix for these graphs and determine the average hitting times from any vertex to any other vertex in these graphs.

- 36 田中 優帆 (早大理工) 有向 Cayley グラフ上の乱歩における期待到達時間の解析 ..... 15  
Yuho Tanaka (Waseda Univ.) On the average hitting times of directed Cayley graphs

概要 The exact formula for the average hitting time of simple random walks from one vertex to any other vertex on  $\text{Cay}(\mathbb{Z}_N, \{\pm 1, \pm 2\})$  was given by Y. Doi et al. [*Discrete Applied Mathematics*, **313** (2022) 18-28]. Y. Doi et al. give a simple formula for the average hitting times of simple random walks on  $\text{Cay}(\mathbb{Z}_N, \{\pm 1, \pm 2\})$  by using an elementary method. In this talk, using an elementary method also used by Y. Doi et al. [*Discrete Applied Mathematics*, **313** (2022) 18-28], we give a simple formula for average hitting times of simple random walks on  $\text{Cay}(\mathbb{Z}_N, \{+1, +2\})$ . Furthermore, we also give the exact formula for the average hitting times of random walks on the weighted Cayley graph  $\text{Cay}(\mathbb{Z}_N, \{+1, +2\})$ .

### 3月19日(火) 第IX会場

#### 9:50~12:00

- 37 縫田 光司 (九大IMI) 半順序集合の初等的性質による Zorn の補題の証明 ..... 10  
Koji Nuida (Kyushu Univ.) A proof of Zorn's Lemma from elementary properties of partially ordered sets

概要 Zorn's Lemma is stated purely in terminology of posets (partially ordered sets), but its standard proof relies on transfinite recursion, which is a non-elementary set-theoretic machinery. In this talk, we show a new simple proof of Zorn's Lemma that only uses (besides Axiom of Choice) basic properties of posets. In contrast to the existing similar proofs, our proof is more elementary in the sense that it even does not use the notion of well-ordered sets.

- 38 永野 哲也 (長崎県立大情報システム) フィンスラー暗号 ..... 15  
Tetsuya Nagano (Univ. of Nagasaki) Finsler encryption

概要 Inspired by previous work with the first example proposed at SecITC 2020, we give a general description of Finsler encryption that is based on a Finsler space, which uses a kind of a differentiable geometry on a smooth manifold, with appropriate quantization as the security parameter. Key generation, encryption and decryption algorithms are introduced in outline, and a further example is presented. Then we analyse security properties of Finsler encryption. First, as the dimension (as another security parameter) increases, the length of the secret key also increases, and hence the computational hardness becomes stronger. Second, we prove indistinguishability against chosen-plaintext attacks.

- 39 富安亮子 (九大IMI) 葉序と線形式の積に由来するパッキング理論 ..... 15  
 Ryoko Tomiyasu (Kyushu Univ.) Packing theory derived from phyllotaxis and products of linear forms

概要 Parastichies are spiral patterns observed in plants and numerical patterns generated using golden angle method. We generalize this method by using Markoff theory and the theory of product of linear forms, to obtain packings on Riemannian manifolds with a locally diagonalizable metric. Using this method, we prove that it is possible to generate packings on any real analytic Riemannian surfaces with the packing density bounded below by approximately 0.7. For 3-manifolds, the lower bound for the packing density is approximately 0.38.

- 40 須田智晴 (理化学研) A categorical perspective on the relationship between discrete and continuous time dynamical systems ..... 15  
 Tomoharu Suda (RIKEN) A categorical perspective on the relationship between discrete and continuous time dynamical systems

概要 Dynamical systems are broadly categorized into two types: discrete and continuous time systems. While it is commonly acknowledged that analogies exist between these two types, formalizing and proving this correspondence in a mathematically rigorous manner poses a challenge. This study aims to explore the relationship between these categories in the light of category theory. The main result of this research establishes a connection between discrete and continuous dynamical systems via classical constructs, namely the Poincaré map and suspension flow. This result not only elucidates the relationship between the two types of systems but also validates the natural relevance of these constructs in the study of dynamical systems.

- 41 宮路智行 (京大理) 離散回転対称性をもつ Neimark–Sacker 分岐と進行波 ..... 15  
 岡本和也 (早大理工)  
 友枝明保 (関西大総合情報)  
 Tomoyuki Miyaji (Kyoto Univ.) Neimark–Sacker bifurcation with discrete rotational symmetry and traveling waves  
 Kazuya Okamoto (Waseda Univ.)  
 Akiyasu Tomoeda (Kansai Univ.)

概要 The Neimark–Sacker bifurcation, a codimension-one bifurcation for a fixed point of a map with a pair of complex eigenvalues on the unit circle, leads to the appearance of an invariant closed curve. We show that a branch of traveling waves, which form invariant closed curves, bifurcates by the Neimark–Sacker bifurcation of a homogeneous fixed point provided that the map commutes with the action of the cyclic group. In addition, we discuss a method of numerical continuation of the bifurcating traveling waves and application to a system of delay difference equations proposed by the present authors as a traffic flow model.

- 42 村田実貴生 (東京農工大工) グレイ–スコットセル・オートマトンに現れるチューリングパターン ... 15  
 Mikio Murata Turing patterns appearing in Gray–Scott cellular automaton  
 (Tokyo Univ. of Agri. and Tech.)

概要 A cellular automaton constructed by positive value differentiation and ultradiscretization of the Gray–Scott model generates various non-uniform spatiotemporal patterns through numerical simulation. This spatiotemporal pattern can be considered a Turing pattern in a broad sense. In this presentation, we will report the results of numerical simulations of a two-dimensional Gray–Scott cellular automaton by replacing diffusion parameters, initial concentration, and neighborhoods and grids.

- 43 渡辺 樹 (早大理工) High density limit for nonlocal cross-diffusion model with self-diffusion ..... 15  
 Itsuki Watanabe (Waseda Univ.) High density limit for nonlocal cross-diffusion model with self-diffusion

概要 The deterministic limit of a stochastic model of nonlocal cross-diffusion with self-diffusion is considered. The stochastic model is given by two types particle system where the diffusion rate depends on the density of both particle types. In this talk, we reveal its deterministic limit, and show the existence of solution of nonlocal cross-diffusion equation by Markov chain approximation method.

- 44 古川 賢 (理化学研) 動的境界条件下での移流拡散方程式と濾過現象について ..... 15  
 北畑 裕之 (千葉大理)  
 Ken Furukawa (RIKEN) Drift-diffusion equations under dynamic boundary conditions for filtration phenomena  
 Hiroyuki Kitahata (Chiba Univ.)

概要 We introduce a mathematical model describing the microbial ecosystem in an aquarium. We present a mathematical analysis of the model and numerical simulation results. The model is based on a one-dimensional advection-diffusion equation, a predator-prey model, and dynamic boundary conditions. Dynamic boundary conditions are a type of boundary conditions that include time derivatives in the boundary conditions, unlike the Dirichlet, the Neumann, and the Robin boundary conditions. In this model, the dynamic boundary condition with the fourth boundary condition is considered. This study is based on joint research with Professor Hiroyuki Kitahata of Chiba University.

#### 14:15~14:40 2023年度日本数学会応用数学賞・応用数学研究奨励賞授賞式

#### 14:50~16:30

- 45 森田 善久 (龍谷大\*) Front propagation and blocking for the bistable reaction-diffusion equation on tree-like metric graphs ..... 15  
 神保 秀一 (北大理)  
 Yoshihisa Morita (Ryukoku Univ.\*) Front propagation and blocking for the bistable reaction-diffusion equation on tree-like metric graphs  
 Shuichi Jimbo (Hokkaido Univ.)

概要 We deal with the bistable reaction-diffusion equation on an unbounded metric graph, comprising half-lines and triple junctions, referred to as a tree-like metric graph. Our analysis focuses on the behavior of the entire solution displaying front propagation from the infinity end of a primary branch (half-line). We establish conditions for the existence of standing front solutions that block the front propagation. This blocking depends on not only conditions at the junctions but also the length between neighboring junctions. Additionally, we prove the stability/instability of the standing fronts.

- 46 穴田 浩一 (早大高等学院) 面積保存型曲率流における曲率の爆発レートに関する一考察 ..... 15  
 石渡 哲哉  
 (芝浦工大システム理工)  
 牛島 健夫 (東京理大創域理工)  
 Koichi Anada A Remark on the blow-up rates of curvatures in the area-preserving curvature flow in the plane  
 (Waseda Univ. Senior High School)  
 Tetsuya Ishiwata  
 (Shibaura Inst. of Tech.)  
 Takeo Ushijima (Tokyo Univ. of Sci.)

概要 We deal with the area-preserving curvature flow in the plane, particularly the blow-up phenomena of curvatures on cusp singularities in contractions of convex immersed curves with self-crossing points. For Abresch-Langer type curves with highly symmetric properties, it has been known that the maximum of curvatures blows up at a finite time under some assumptions. In this talk, we consider the blow-up rates in this case.

- 47 木村正人 (金沢大理工) Zener 型粘弾性波動方程式の弱解の一意存在と漸近挙動 ..... 15  
李敬潼 (金沢大自然)  
劉逸侃 (京大理工)  
中村玄 (北大理・北大電子研)  
野津裕史 (金沢大理工)  
上田好寛 (神戸大海事)  
Masato Kimura (Kanazawa Univ.) Unique existence of weak solution and asymptotic behavior of Zener-  
Jingtong Li (Kanazawa Univ.) type viscoelastic wave equation  
Yikan Liu (Kyoto Univ.)  
Gen Nakamura  
(Hokkaido Univ./Hokkaido Univ.)  
Hirofumi Notsu (Kanazawa Univ.)  
Yoshihiro Ueda (Kobe Univ.)

**概要** We consider a Zener-type viscoelastic wave equation in a bounded domain, which consists of  $n$  Maxwell-type viscoelastic components connected in parallel and a dumping term. Based on a physically natural energy dissipation identity, we establish the unique existence of a weak solution and a stability estimate. The proof of the existence of the solution is performed by a compactness argument for the time-discretized solution as the time increment tends to zero. Furthermore, we prove an exponential decay property of the energy as time tends to infinity even for the case without the dumping term.

- 48 大野航太 (中大理工) Deffuant model における合意形成過程 ..... 15  
小川知之 (明大総合数理)  
Kota Ohno (Chuo Univ.) Process to reach consensus in Deffuant model  
Toshiyuki Ogawa (Meiji Univ.)

**概要** Opinion dynamics, one of the fields of social science, is a multidisciplinary field and has been studied using the mathematical model. Among them, the Deffuant model is widely known, which simply models changes in the opinions of multiple agents. Both consensus and split states are seen as locally stable equilibriums. In this study, we introduce the “non-consensus ratio” to describe the behavior near the critical point through variations of this ratio. Furthermore, we also discuss the process to reach consensus in the modified Deffuant model where distance is introduced for the agent placement.

- 49 香川 溪一郎 (北大電子研) 毛包の形態形成の再現を目指した数値シミュレーション ..... 15  
 奥村 真善美 (甲南大知能情報)  
 小林 康明 (北大電子研)  
 D. Wuergezhen (理化学研BDR)  
 森田 梨津子 (阪大生命機能)  
 藤原 裕展 (理化学研BDR)  
 長山 雅晴 (北大電子研)  
 Keiichiro Kagawa (Hokkaido Univ.) Numerical simulation to reproduce morphogenesis of hair follicles  
 Makoto Okumura (Konan Univ.)  
 Yasuaki Kobayashi (Hokkaido Univ.)  
 Duligengaowa Wuergezhen (RIKEN)  
 Ritsuko Morita (Osaka Univ.)  
 Hironobu Fujiwara (RIKEN)  
 Masaharu Nagayama (Hokkaido Univ.)

概要 In this study, we focus on the morphogenesis of hair follicles, one of the appendages of the skin, in which a two-dimensional placode is transformed into a cylindrical structure. We use a mathematical model incorporating signal diffusion from fibroblasts and plastic deformation of the basement membrane to investigate how the signal affects the mechanical properties of the basement cells and membrane to reproduce the phenomenon of invagination. We hypothesize that only in regions where the signal is strong, basal cells deform vertically and that the basement membrane and dermis are more easily deformed, successfully reproducing the sinking phenomenon. This model will be the basis for future studies on avian hair follicles with projecting geometry and other skin appendages such as the mammary gland.

- 50 李 聖林 (京大高等研・京大医) 皮疹の形と生体内をつなぐ数理皮膚医学 ..... 15  
 Sungrim Seirin Lee Mathematical dermatology linking eruption morphology and in vivo  
 (Kyoto Univ./Kyoto Univ.) pathology

概要 Chronic spontaneous urticaria (CSU) is one of the most intractable human-specific skin diseases. However, as no experimental animal model exists, the mechanism underlying disease pathogenesis in vivo remains unclear, making the establishment of a curative treatment challenging. Here, using a novel approach combining mathematical modeling, *in vitro* experiments and clinical data analysis, we demonstrate that the pathological state of CSU patients can be inferred by geometric features of the skin eruptions. Our study not only demonstrates that pathological states of diseases can be defined by geometric features but will also facilitate more accurate decision-making to manage CSU in the clinical setting.

#### 16:45~17:45 特別講演

- 田中 吉太郎 (公立はこだて未来大) 非局所発展方程式と偏微分方程式系近似について  
 Yoshitaro Tanaka Nonlocal evolution equations and approximations by system of partial  
 (Future Univ.-Hakodate) differential equations

概要 Many evolutionary equations with spatial convolution using suitable integral kernel have been proposed. This type of equation is called the nonlocal evolution equation. Nonlocal evolution equations are analyzed for dispersion of animals and plants, pigmentation patterns in the animal epidermis, and cell migration, and so on. To reveal the relationship between the nonlocal evolution equations and local systems, we approximate the nonlocal evolution equations by systems of partial differential equations. We show that the nonlocal evolution equations with two types of convolution can be approximated by a multi-component reaction-diffusion system and Keller–Segel system, respectively. From this theory, we explain that dealing with a nonlocal interaction is in a sense equivalent to dealing with local dynamical system.



## 3月20日(水) 第IX会場

## 9:50~12:00

- 51 古屋 貴 士 Globally injective and bijective neural operators ..... 10  
(島根大数理・データサイエンス教育研究センター)

Takashi Furuya (Shimane Univ.) Globally injective and bijective neural operators

概要 Recently, there has been great interest in neural operators, which learn operators between infinite-dimensional function spaces. Given their discretization-invariance property, neural operators have been remarkably successful, especially in learning solution operators for partial differential equations (PDEs). In this talk, we show that injective neural operators are universal approximators of continuous operators. This holds substantial relevance to inverse problems in PDEs, as injective neural operators can serve invertible surrogate models for solution operators, which, in general, is not injective due to ill-posedness of inverse problems. This is joint work with Michael Puthawala (South Dakota State University), Matti Lassas (University of Helsinki), and Maarten V. de Hoop (Rice University).

- 52 長 瀬 准 平 区分非線型関数による ReLU 関数設計可能性 ..... 15  
(電通大データ教育センター)

Jumpei Nagase ReLU function representability by piecewise nonlinear functions  
(Univ. of Electro-Comm.)

概要 As a discussion on the representability of deep neural network models, we discuss the condition that the ReLU function can be represented by a composition of non-linear functions and affine functions. If the activation function is representable of the ReLU function, then the deep neural network model is possible to transform any linear connection into a multilayer perceptron model. And since it is possible to express the design of that model architecture down as a parameter constraint, representability of the ReLU function is an important concept in the systematic discussion of deep neural network models. Specific conditions are the case by linear combination of functions and the case by composition of functions.

- 53 後 藤 田 剛 (東工大情報理工) Numerical study of enstrophy variation on filtered-Euler flows ..... 15  
Takeshi Gotoda (Tokyo Tech) Numerical study of enstrophy variation on filtered-Euler flows

概要 We investigate enstrophy variation in an incompressible and inviscid flow through point-vortex solutions of the 2D filtered Euler equations, which are a regularized 2D Euler equations. The preceding results have shown that there exist three point-vortex solutions converging to self-similar collapsing solutions of the point-vortex system and dissipate the enstrophy in the zero limit of a filter scale. In this study, we numerically show that the enstrophy dissipation could occur for certain four and five point-vortex solutions in that limit.

- 54 清 水 雄 貴 (東 大 数 理) 曲率変化の点渦への作用の定量化 ..... 15  
Yuuki Shimizu (Univ. of Tokyo) Impact of curvature on a point vortex

概要 Towards quantifying the impact of curvature variations on a point vortex, we discuss some dynamical properties of the point vortex on continuously differentiable surfaces obtained by gluing two different constant-curvature surfaces.



- 55 木下 武彦 (佐賀大理工) 実  $2 \times 2$  行列の 2 ノルムと近似逆作用素ノルムの収束オーダーの改善に  
渡部 善隆 について ..... 15  
(九大情報基盤研究開発センター)  
中尾 充宏 (早大理工)  
Takehiko Kinoshita (Saga Univ.) Regarding the matrix 2-norm of real  $2 \times 2$  matrices and improved con-  
Yoshitaka Watanabe (Kyushu Univ.) vergence order of norm for approximate inverse operators  
Mitsuhiro T. Nakao (Waseda Univ.)

概要 We report that we have improved the convergence order of norm for approximate inverse operators reported in [1].

- 56 寺尾 剛史 無限次元線形作用素の近似逆作用素ノルムに対する精度保証付き特異値  
(九大情報基盤研究開発センター) 計算 ..... 15  
渡部 善隆  
(九大情報基盤研究開発センター)  
尾崎 克久  
(芝浦工大システム理工)  
Takeshi Terao (Kyushu Univ.) Numerical verification method of the approximate inverse operator norm  
Yoshitaka Watanabe (Kyushu Univ.) for infinite-dimensional linear operators  
Katsuhisa Ozaki  
(Shibaura Inst. of Tech.)

概要 In this talk, we present a verified singular value estimation, especially an enclosure of the spectral norm for the approximate inverse operator norm for infinite-dimensional linear operators. Enclosures of the spectral norm give important information in the computation of rigorous error bounds for the solution of ordinary and partial differential equations.

- 57 奥村 真善美 (甲南大知能情報) 動的境界条件下のある構造保存スキームの可解性の証明に現れる行列の  
正則性について ..... 15  
Makoto Okumura (Konan Univ.) On the regularity of a matrix appearing in the proof of the solvability  
of a structure-preserving scheme under dynamic boundary conditions

概要 Recently, the Cahn–Hilliard equation with dynamic boundary conditions that consider the Cahn–Hilliard equation even on the boundary has been proposed by Goldstein–Miranville–Schimperna (GMS). This model has characteristic conservation and dissipation laws. In the previous study, we proposed a structure-preserving scheme for the two-dimensional GMS model that retained the above laws in a discrete sense and proved its solvability. In the proof, it is necessary to show the regularity of a certain matrix, which was derived conditionally. Concretely, we clarified at least how small the time mesh size should be according to the space mesh sizes to make the mapping well-defined. In this study, we have unconditionally proved the regularity of the matrix in a particular case. In this talk, we talk about the result.

- 58 石渡哲哉 (芝浦工大システム理工) 時間非整数階移流方程式に対する空間単調性保存スキーム ..... 15  
 伊藤大將 (芝浦工大理工)  
 志賀大知  
Tetsuya Ishiwata (Shibaura Inst. of Tech.) Monotonicity-preserving numerical scheme for fractional advection equation  
 Daisuke Ito (Shibaura Inst. of Tech.)  
 Taichi Shiga

概要 The fractional advection equation is a time nonlocal equation that refers to the solution history; that is, it is a delay partial differential equation. In this talk, we propose a finite difference scheme that reproduces the monotonicity of the solution to the fractional advection equation and show theoretical results and some numerical demonstrations.

#### 14:15~15:25

- 59 菊地文雄 (東大\*) Techniques for hypercircle-based error estimation of finite element solutions ..... 15  
劉雪峰 (東京女大数理)  
Fumio Kikuchi (Univ. of Tokyo\*) Techniques for hypercircle-based error estimation of finite element solutions  
 Xuefeng Liu (Tokyo Woman's Christian Univ.)

概要 Kikuchi and H.Saito once proposed an a priori error estimation method for finite element solutions using  $P_1$  and Raviart–Thomas  $H(\text{div})$  triangular elements. Recently, we have found that improved results can be obtained and simplified technique introduced there is justified. We explain outline of the theory with its analysis and give numerical results for a few sample problems. Reasonable coincidence between theory and numerical results is observed, so that the proposed method and techniques are really effective. Our methodology is applicable to higher degree triangular and rectangular elements and also a posteriori estimation.

- 60 A. N. F. Rudiawan (金沢大理工) 混相流モデルのための有限要素スキーム ..... 15  
 A. Žák (Czech Tech. Univ. in Prague)  
 M. Beneš (Czech Tech. Univ. in Prague)  
 木村正人 (金沢大理工)  
野津裕史 (金沢大理工)  
 Aufa Numan Fadhilah Rudiawan (Kanazawa Univ.) A finite element scheme for a multiphase flow model  
 Alexandr Žák (Czech Tech. Univ. in Prague)  
 Michal Beneš (Czech Tech. Univ. in Prague)  
 Masato Kimura (Kanazawa Univ.)  
Hirofumi Notsu (Kanazawa Univ.)

概要 A numerical scheme for a multi-phase flow model describing sedimentation phenomena is presented. The unknown functions of the model are the velocities and the volume fractions of the N-phases and the common pressure, where N is the number of fluid phases. After introducing an energy estimate of the model, a stability result of the scheme and two-dimensional numerical results are also presented.

- 61 江藤 徳宏 (東大数理) A structure-preserving parametric finite element method for the multi-phase Mullins–Sekerka problem with triple junctions . . . . . 15  
 H. Garcke (Univ. of Regensburg)  
 R. Nürnberg (Univ. of Trento)
- Tokuhiro Eto (Univ. of Tokyo) A structure-preserving parametric finite element method for the multi-phase Mullins–Sekerka problem with triple junctions  
 Harald Garcke (Univ. of Regensburg)  
 Robert Nürnberg (Univ. of Trento)

概要 We consider a sharp interface formulation for the multi-phase Mullins–Sekerka flow. Making use of a variational formulation, we introduce a fully discrete finite element method. Our discretization features a parametric approximation of the moving interfaces that is independent of the discretization used for the equations in the bulk. The scheme can be shown to be unconditionally stable and to satisfy an exact volume conservation property. Moreover, an inherent tangential velocity for the vertices on the discrete curves leads to asymptotically equidistributed vertices, meaning no remeshing is necessary in practice. Several numerical examples, including a convergence experiment for the three-phase Mullins–Sekerka flow, demonstrate the capabilities of the introduced method.

- 62 シュワドレンカカレル 障害物上の非等方的な界面運動に対する近似スキームについて . . . . . 15  
 (都立大理)
- Karel Svadlenka (Tokyo Metro. Univ.) On an approximation scheme for anisotropic interfacial motion on obstacle

概要 We consider  $L^2$  gradient flow of anisotropic surface energy in the presence of an obstacle and possibly a volume constraint. With the twofold purpose of existence proof and numerical implementation, we introduce a thresholding approximation scheme employing anisotropic kernels, and investigate its properties, such as stability, convergence and Gamma-convergence of the corresponding approximate energies. We also show numerical simulations of motions involving topology changes.

#### 15:40～16:40 特別講演

- 劉逸侃 (京大理) 非整数階拡散方程式の結合系と半線形問題の解のダイナミクスについて  
 Yikan Liu (Kyoto Univ.) On solution dynamics of coupled systems and semilinear problems of time-fractional diffusion equations

概要 The last decade has witnessed explosive developments and gradual saturation of nonlocal models from various practical backgrounds. As a popular representative, partial differential equations with fractional derivatives in time have gathered considerable attentions among applied mathematicians. Recently, linear theory for fractional diffusion equations with time derivatives in  $(0, 1)$  has been well established, followed by extensive researches on related numerical methods and inverse problems. This motivates the generalizations of studies from single equations to coupled systems and from linear to nonlinear problems.

Started with a brief survey on existing results on time-fractional partial differential equations, this talk is concerned with the solution dynamics of their coupled and semilinear counterparts. For coupled time-fractional diffusion systems, we obtain a sharp estimate for the long-time asymptotic behavior of solutions by the Laplace transform. Further, we discover a new decay pattern by the coupling of non-fractional and fractional diffusion equations. For time-fractional diffusion equation with superlinear convex semilinear terms including Fujita type nonlinearity  $u^p$ , we show the blow-up of solutions and provide upper estimates of the blow-up times by a comparison principle.

## トポロジー

3月17日(日) 第V会場

9:30~11:10

- 1 大場 貴裕 (阪大 理) 球面の単位余接バンドルのシンプレクティック充填について ..... 15  
 Myeonggi Kwon  
 (Jeonbuk National Univ.)  
Takahiro Oba (Osaka Univ.) Symplectic fillings of unit cotangent bundles of spheres  
 Myeonggi Kwon  
 (Jeonbuk National Univ.)

概要 This talk is concerned with symplectic fillings of contact manifolds. After briefly giving an overview of results on the topology of symplectic fillings, I will present joint work with Myeonggi Kwon, in which we give some topological restrictions on symplectic fillings of unit cotangent bundles of spheres  $S^n$  and show the uniqueness of diffeomorphism types of them, under some condition, for the case  $n = 3$ . Also, I will explain an application of our result to exact symplectic cobordisms.

- 2 門田 直之 (岡山 大理) Geography of symplectic 4-manifolds admitting Lefschetz fibrations · · 15  
 A. Akhmedov (Univ. of Minnesota)  
Naoyuki Monden (Okayama Univ.) Geography of symplectic 4-manifolds admitting Lefschetz fibrations  
 Anar Akhmedov (Univ. of Minnesota)

概要 Ruled surfaces play an important role in the theory of Lefschetz fibrations. In fact, Lefschetz fibrations on blow-ups of ruled surfaces have given many interesting examples. In this talk, using them, we give Lefschetz fibrations on minimal symplectic 4-manifolds with arbitrary finitely presented fundamental groups that violate the Noether inequality.

- 3 門田 直之 (岡山 大理) Ruled surfaces and indecomposable Lefschetz fibrations ..... 15  
 A. Akhmedov (Univ. of Minnesota)  
Naoyuki Monden (Okayama Univ.) Ruled surfaces and indecomposable Lefschetz fibrations  
 Anar Akhmedov (Univ. of Minnesota)

概要 In this talk, we give a relation among the genus of the base space of blow-ups of a ruled surface admitting a Lefschetz fibration, the number of blow-ups and the genus of the Lefschetz fibration. Using this relation, we obtain a condition for a Lefschetz fibration to be fiber sum indecomposable. Moreover, we give fiber sum indecomposable Lefschetz fibrations on minimal total spaces.

- 4 鈴木 龍正 (東工 大理) 4次元多様体上の  $P_{a,b}$ -surgery ..... 15  
 丹下 基生 (筑波大数理物質)  
Tatsumasa Suzuki (Tokyo Tech)  $P_{a,b}$ -surgery on 4-manifolds  
 Motoo Tange (Univ. of Tsukuba)

概要 In 2004, Iwase and Matsumoto introduced pochette surgery. In 2018, Nakamura introduced a generalization of pochette surgery called  $P_{a,b}$ -surgery. A  $P_{a,b}$ -surgery on a 4-manifold  $X$  is an operation of removing the interior of the boundary sum  $P_{a,b} = \natural^a S^2 \times D^2 \natural^b S^1 \times D^3$  of  $a S^2 \times D^2$  and  $b S^1 \times D^3$  embedded in  $X$  from  $X$  and gluing  $P_{a,b}$  to  $X - \text{int } P_{a,b}$  by a diffeomorphism of  $\partial P_{a,b}$ .  $P_{1,1}$ -surgery is nothing but pochette surgery. In this talk, we introduce identification factors of the diffeomorphism type of any  $P_{a,b}$ -surgery on any 4-manifold by Nakamura. Furthermore, we compute the homology groups of any  $P_{a,b}$ -surgery of the 4-sphere with a trivial embedding. We also show that any finitely generated group is isomorphic to the fundamental group of a  $P_{a,b}$ -surgery on a simply connected 4-manifold.

- 5 磯島 司 (東工大理) Trisections of the doubles of some Mazur type 4-manifolds ..... 15  
 Tsukasa Isoshima (Tokyo Tech) Trisections of the doubles of some Mazur type 4-manifolds

概要 A trisection is roughly a decomposition of a closed, oriented, smooth 4-manifold into three 4-dimensional 1-handlebodies. A trisected 4-manifold can be described by a trisection diagram that consists of a closed, oriented surface and certain three kinds of cut systems on the surface. A Mazur type 4-manifold is a compact, contractible, smooth 4-manifold admits a handle decomposition that consists of only single 0-, 1-, and 2-handle. It is known that the double of each Mazur type is diffeomorphic to  $S^4$ . In this talk, we show that certain trisection diagrams of the doubles of the Mazur types introduced by Akbulut and Kirby are standard.

- 6 小川 将輝 (東北大MathCCS) Weinstein trisections of trivial surface bundles ..... 10  
 Masaki Ogawa (Tohoku Univ.) Weinstein trisections of trivial surface bundles

概要 Trisection is a decomposition of a closed, oriented 4-manifold. Recently, a trisection which has a symplectic property is introduced by Lambert-Cole, Meier and Starkston. This trisection is called a Weinstein trisection. They showed that any closed 4-manifold with symplectic structure admits a Weinstein trisection. But there only a few example of Weinstein trisection. In this talk, I introduce Weinstein trisections of product of two closed surfaces.

#### 11:20~12:00 トポロジー分科会総会

#### 14:20~15:20 特別講演

- 上 正明 (京大\*) Constraints on intersection forms of 4-manifolds with given boundary  
 in terms of Gauge theoretical invariants  
 Masaaki Ue (Kyoto Univ.\*) Constraints on intersection forms of 4-manifolds with given boundary  
 in terms of Gauge theoretical invariants

概要 For any closed 3-manifold  $Y$ , there exists a compact 4-manifold  $X$  bounded by  $Y$ . We discuss constraints on the intersection form of  $X$  (in particular when  $X$  is spin) in terms of several invariants of  $Y$  derived from Gauge theory, including Seiberg–Witten and Heegaard Floer theories. We mainly focus on Manolescu's  $\kappa$ -invariant of  $Y$ .

#### 15:40~17:30

- 7 森 淳秀 (大阪歯大歯) 極小主義言語学のモデル ..... 15  
 Atsuhide Mori (Osaka Dent. Univ.) A model of linguistic minimalism

概要 In this presentation, I will propose an easy topological model of what the external and internal merges in the generative linguistics are doing in the real brain and examine the need for formal techniques in a recent development of linguistic minimalism.

- 8 北野 晃朗 (創価大理工) 種数 2 の曲面の基本群の Euler 類の引き戻しが非自明となる  $SL(2; \mathbb{Z}[1/2])$   
 柴田 茉莉奈 (創価大理工) への線型表現について ..... 10  
 Teruaki Kitano (Soka Univ.) On linear representations of a surface group of genus 2 into  $SL(2; \mathbb{Z}[1/2])$   
 Marina Shibata (Soka Univ.) with a nontrivial real Euler class

概要 Milnor proved that there exists a flat real  $\mathbb{R}^2$ -vector bundle over a closed orientable surface of genus  $g > 1$  with non-trivial Euler number in 1958. This was proved by giving a representation from the fundamental group of a surface in  $SL(2; \mathbb{R})$ . Here  $SL(2; \mathbb{R})$  acts on the plane linearly and then does on the unit circle. Hence the above result implies that the real Euler class is nontrivial on  $SL(2; \mathbb{R})$ , which is defined originally in the homeomorphism group of the circle. Further as Sullivan mentioned in 1975, Milnor's construction was done implicitly on  $SL(2; \mathbb{Z}[1/2])$ . In this talk, we give concrete examples of representations in  $SL(2; \mathbb{Z}[1/2])$  with nontrivial Euler number. This is a joint work with Marina Shibata(Soka univ.).

- 9 小林 竜馬 (石川工高専) コンパクトな向き付け不可能曲面のレベル  $d$  写像類群の生成系 ..... 15  
 Ryoma Kobayashi Generating sets for the level  $d$  mapping class group of a compact non-orientable surface  
 (Ishikawa Nat. Coll. of Tech.)

概要 The level  $d$  mapping class group  $\mathcal{M}_d(S)$  of a surface  $S$  is the subgroup of the mapping class group of  $S$  consisting of mapping classes acting trivially on  $H_1(S; \mathbb{Z}_d)$ . In this work, we gave a normal generating set of  $\mathcal{M}_d(N_{g,n})$  for a genus  $g \geq 4$  compact non-orientable surface  $N_{g,n}$  with  $n \geq 0$  boundaries. In addition, we can construct a finite generating set of  $\mathcal{M}_d(N_{g,n})$  for  $n \geq 1$ , from a finite generating set of  $\mathcal{M}_d(N_{g,0})$  by induction on  $n$ .

- 10 山形 颯 (福岡大理) 純組紐群の表示と組紐配置の切断について ..... 15  
 So Yamagata (Fukuoka Univ.) Presentation of the pure braid group and section of the braid arrangement

概要 In 1891, Hurwitz introduced the (pure) braid group as the fundamental group of the configuration space of points in the complex plane.

Later, in 1925, Artin studied the algebraic and geometric perspectives of braids. In particular, he gave a presentation of the braid group, which is now recognized as a standard one. He also studied the pure braid group and gave its presentation. However, it is much more complicated than the one of the braid group. Thus, there is nothing better than to have a simple to look and intuitive presentation of the pure braid group.

In my talk, even though there is no new presentation, we connect two different approaches to the pure group: from group theory and from hyperplane arrangement.

- 11 盛 小 冰 (沖縄科学技術大) Some experimental results on knots and links constructed from Thompson's group  $F$  a la Jones ..... 15  
 Xiaobing Sheng Some experimental results on knots and links constructed from Thompson's group  $F$  a la Jones  
 (Okinawa Inst. of Sci. and Tech. Grad. Univ.)

概要 Vaughan Jones motivated by an attempt to develop new conformal field theory, obtained a sequence of results related to Thompson's groups  $F$ . One of the results is the concrete construction of knots and links from Thompson's group  $F$  and the oriented Thompson's group as an analogue of the results on braid groups. Aiello and Baader investigated knots and links constructed from certain positive words in  $F$  and they proved that the so-called positive oriented Thompson links are arborescent.

We present a sequence of computational results on certain sequences of knots from certain sequences of words and we also provide a way of estimating the number of crossings from the group theoretic property.

- 12 根上 春 (千葉大融合理工) Generalization of the twisted Long-Moody construction ..... 15  
 Haru Negami (Chiba Univ.) Generalization of the twisted Long-Moody construction

概要 The Long-Moody construction is a method for obtaining a representation of the braid group from a given representation of the semidirect product of the free group and the braid group defined by Artin representation. Artin representation has a geometric realization such as the transformation of the loops on a closed disk with  $n$  points. Wada generalized the Artin representation, which is called Wada-type representation, and obtained the group invariants of links.

We extended the Long-Moody construction to obtain an infinite series of representations of the braid groups and named it as twisted Long-Moody construction. In this talk, we further extend the method to some of the Wada-type representations. We then discuss the connection between this construction and the unitarity of the representation.

## 3月18日(月) 第V会場

## 9:30~10:00

- 13 秋田 利之 (北大 理) Wirtinger 表示を持つ群と 2 次の群ホモロジー ..... 10  
 高瀬 壮太 (北大 理)  
 Toshiyuki Akita (Hokkaido Univ.) Groups having Wirtinger presentations and the second group homology  
 Sota Takase (Hokkaido Univ.)

概要 Kuz'min (1996) characterized groups having Wirtinger presentations in relation to their second group homology. We further refine the connections between these groups and their second group homology.

- 14 吉永 正彦 (阪大 理) 因果順序複体とマグニチュードホモトピー型 ..... 15  
 田嶋 優 (北大 理)  
 Masahiko Yoshinaga (Osaka Univ.) Causal order complex and magnitude homotopy type  
 Yu Tajima (Hokkaido Univ.)

概要 The magnitude homology group of a metric space was introduced by Hepworth, Willerton, Leinster and Shulman. In this talk, for a given metric space, we construct a pair of simplicial complexes whose homology group is isomorphic to the magnitude homology group. The construction is based on the causal order on the metric space-time and its order complex.

## 3月18日(月) 第IV会場

## 10:10~10:25 2023年度日本数学会幾何学賞授賞式

## 10:30~11:30 2023年度日本数学会幾何学賞受賞特別講演 (幾何学分科会と合同)

- 藤田 健人 (阪大 理) ファノ多様体の K 安定性の判定法について  
 Kento Fujita (Osaka Univ.) On criteria for the K-stability of Fano varieties

概要 We survey recent progress on K-stability of Fano varieties.

## 3月18日(月) 第V会場

## 13:00~14:00

- 15 知念 直紹 (防衛大) Equivariant asymptotic dimension, asymptotic dimension and covering  
 山内 貴光 (愛媛大理工) dimension ..... 15  
 Naotsugu Chinen Equivariant asymptotic dimension, asymptotic dimension and covering  
 (Nat. Defense Acad. of Japan) dimension  
 Takamitsu Yamauchi (Ehime Univ.)

概要 We consider the following question. For a free action  $\Gamma \curvearrowright X$  of a discrete group  $\Gamma$  on a normal space  $X$  with  $\text{ead}(\Gamma \curvearrowright X) < \infty$ , does the inequality  $\text{ead}(\Gamma \curvearrowright X) \leq \text{asdim} \Gamma + \dim X$  hold? We give the following positive partial answer. If  $\Gamma$  is locally finite, then  $\text{ead}(\Gamma \curvearrowright X) \leq \dim X$  (without the assumption  $\text{ead}(\Gamma \curvearrowright X) < \infty$ ). In particular, if  $X$  is the  $n$ -dimensional sphere, then  $\text{ead}(\Gamma \curvearrowright X) = n$ .

- 16 平田 康史 (神奈川大工) 距離空間との積における弱い D-空間性 ..... 15  
 矢島 幸信 (神奈川大\*)  
 Yasushi Hirata (Kanagawa Univ.) Weak D-space properties on products with metric spaces  
 Yukinobu Yajima (Kanagawa Univ.\*)

概要 In this talk, we discuss weak  $D$ -space properties on products with metric spaces. We obtain the result that for each normal product space  $X \times Y$  with a metric space  $Y$ , (1) if  $X$  is a collectionwise Hausdorff  $aD$ -space, then  $X \times Y$  is an  $aD$ -space, (2) if  $X$  is an irreducible space, then  $X \times Y$  is irreducible.



- 17 平田 康史 (神奈川大工) 無限積空間における弱い D-空間性 ..... 15  
矢島 幸信 (神奈川大\*)  
Yasushi Hirata (Kanagawa Univ.) Weak D-space properties on infinite products  
Yukinobu Yajima (Kanagawa Univ.\*)

概要 In this talk, we discuss weak  $D$ -space properties on infinite products. We obtain the result that (1) the  $\Sigma$ -product of arbitrary many copies of  $\mathbb{I}$  is dually discrete, where  $\mathbb{I} = [0, 1]$  is the closed interval in the real line, (2) if  $\kappa$  is an infinite cardinal such that there is no weakly inaccessible cardinal  $\leq \kappa$ , then  $\mathbb{N}^\kappa$  is irreducible, where  $\mathbb{N} = \{0, 1, 2, \dots\}$  is the countable discrete space.

3月19日(火) 第V会場

9:30~12:00

- 18 石川 勝巳 (京大数理研) Twisted Alexander vanishing order of knots ..... 10  
森 藤 孝之 (慶大経済)  
鈴木 正明 (明大総合数理)  
Katsumi Ishikawa (Kyoto Univ.) Twisted Alexander vanishing order of knots  
Takayuki Morifuji (Keio Univ.)  
Masaaki Suzuki (Meiji Univ.)

概要 We define the twisted Alexander vanishing order of a knot to be the order of the smallest finite group such that the corresponding twisted Alexander polynomial is zero. In this talk, we show its basic properties.

- 19 合田 洋 (東京農工大工) 双曲結び目の chirality とねじれ Alexander 多項式 ..... 10  
森 藤 孝之 (慶大経済)  
Hiroshi Goda Chirality of hyperbolic knots and twisted Alexander polynomials  
(Tokyo Univ. of Agri. and Tech.)  
Takayuki Morifuji (Keio Univ.)

概要 In this talk, we report a relationship between the chirality of knots and higher-dimensional twisted Alexander polynomials associated with holonomy representations of hyperbolic 3-cone-manifolds. In particular, we provide a new necessary condition for a knot, that appears in a hyperbolic 3-cone-manifold of finite volume as a singular set, to be amphicheiral. Moreover, we can detect the chirality of hyperbolic twist knots, according to our criterion, using low-dimensional irreducible representations.

- 20 沢 辺 俊 (早大理工) On the annihilating polynomial of the colored Jones polynomial for the  
Whitehead link ..... 10  
Shun Sawabe (Waseda Univ.) On the annihilating polynomial of the colored Jones polynomial for the  
Whitehead link

概要 An annihilating polynomial of the colored Jones polynomial for a knot is conjectured to produce the  $A$ -polynomial when made into a commutative polynomial by putting  $q = 1$  (AJ conjecture). In this talk, we give an annihilating polynomial of the colored Jones polynomial for the Whitehead link. We observe that a kind of  $A$ -polynomial appears when we make the annihilating polynomial into a commutative polynomial as in the AJ conjecture. We also give another annihilating polynomial for the Whitehead link that is alternating under the transposition of colors.



- 21 田中 心 (東京学大教育) 結び目  $n$ -カンドルのカンドル二次ホモロジー群 ..... 10  
 谷口 雄大 (阪大 理)  
 Kokoro Tanaka (Tokyo Gakugei Univ.) The second quandle homology group of the knot  $n$ -quandle  
 Yuta Taniguchi (Osaka Univ.)

概要 The knot quandle is known to be a complete invariant for oriented classical knots up to orientation. Eisermann computed the second quandle homology group of the knot quandle and showed that it characterizes the unknot. In this talk, we compute the second quandle homology group of the knot  $n$ -quandle for each integer  $n > 1$ , where the knot  $n$ -quandle is a certain quotient of the knot quandle. Although the knot  $n$ -quandle is weaker than the knot quandle, the second homology group of the former is found to have more information than that of the latter.

- 22 姫野 圭佑 (広島大先進理工) 結び目フレア複体が  $(3, q)$  型トーラス結び目と安定同値な双曲結び目 .. 10  
 Keisuke Himeno (Hiroshima Univ.) Hyperbolic knots whose knot Floer complex is stably equivalent to that of a  $(3, q)$ -torus knot

概要 Two (full) knot Floer complexes are called stably equivalent if they can be made to become filtered chain homotopy equivalent by adding an acyclic complex to each complex. Hom showed that if two knots are concordant, then their knot Floer complexes are stably equivalent. In this talk, we construct infinitely many mutually non-concordant hyperbolic knots whose knot Floer complex is stably equivalent to that of a  $(3, q)$ -torus knot. In particular, the epsilon invariant of such knots is convex. This gives a new answer to Borodzik and Hedden's question of for which knots is the epsilon invariant a convex function.

- 23 吉田 はん (群馬工高専) Commensurators of Löbell polyhedra ..... 15  
 Han Yoshida Commensurators of Löbell polyhedra  
 (Gunma Nat. Coll. of Tech.)

概要 For a non-arithmetic Kleinian group  $\Gamma < \text{Isom}(\mathbb{H}^3)$ , the commensurator  $C(\Gamma) < \text{Isom}(\mathbb{H}^3)$  is the (unique) maximal group commensurable with  $\Gamma$ . Few examples of computation of commensurators of cocompact Kleinian groups are known. Let  $L_n$  be the Löbell polyhedron, which is a compact polyhedron with  $2n + 2$  faces, and  $\Gamma(L_n)$  the subgroup of  $\text{Isom}(\mathbb{H}^3)$ , generated by the reflections in the faces of  $L_n$ . In this talk, I will show the calculation of the commensurators  $C(\Gamma(L_n))$  for  $n \geq 61$ .

- 24 河村 建吾 絡み目射影図に対する整数値領域選択問題の可解性 ..... 15  
 (大阪産大全学教育機構)

Kengo Kawamura (Osaka Sangyo Univ.) Solvability of an integral region choice problem for a link projection

概要 Ahara and Suzuki proved that an integral region choice problem for a knot projection is solvable. This result does not hold for replacing “knot projection” with “link projection”. In this talk, we introduce a diagrammatic characterization to solve an integral region choice problem for a link projection.

- 25 小林 真人 (秋田大理工) 閉折れ線の全周投影変換を用いた幾何公式の証明 ..... 15  
 佐野 貴志 (北海学園大工)  
 山本 稔 (弘前大教育)  
 Mahito Kobayashi (Akita Univ.) Panorama views of closed piecewise linear curves in  $\mathbf{R}^2$  for shape study  
 Takashi Sano (Hokkai-Gakuen Univ.)  
 Minoru Yamamoto (Hiroaki Univ.)

概要 For a closed piecewise linear (PL) curve in  $\mathbf{R}^2$ , a geometric transformation called a panorama view is applied to show two basic formulae on the shape of the curve by Crofton and by Banchoff. We note that for a simple PL curve, a sequence of polygons can be obtained by which one can describe the organizations of so called hollows of the curve.

- 26 齋藤幸子 (北教大旭川)  $J_{10}^-$  型の強義混合擬斉次多項式 ..... 10  
 Sachiko Saito (Hokkaido Univ. of Edu.) Strongly mixed weighted homogeneous polynomials of type  $J_{10}^-$

**概要** We consider a strongly mixed weighted homogeneous polynomial  $f := f_{2,2,1,2,1,4} (k = 3) = z_2^2 \bar{z}_2 - 6z_1^2 z_2 \bar{z}_2 + 11z_1^2 \bar{z}_1^2 z_2 - 6z_1^4 \bar{z}_1^2$  of type  $J_{10}^-$ . We first show that  $f := f_{2,2,1,2,1,4} (k = 3)$  is strongly Newton non-degenerate. We next consider the toric modification  $\hat{\pi} : X \rightarrow \mathbb{C}^2$  associated with the regular simplicial cone subdivision  $\Sigma^*$  which is admissible for the dual Newton diagram  $\Gamma^*(f)$  of  $f$ . Then it is concluded that the strict transform  $\tilde{V}$  via the toric modification  $\hat{\pi}$  of the mixed hypersurface singularity  $V := f^{-1}(0)$  is not only a real analytic manifold outside of  $\tilde{V} \cap \hat{\pi}^{-1}(\mathbf{0})$  but also a real analytic manifold as a germ at  $\tilde{V} \cap \hat{\pi}^{-1}(\mathbf{0})$ .

#### 14:20~15:20 特別講演

山下真由子 (京大理) Topological Modular Forms and supersymmetric quantum field theories  
 Mayuko Yamashita (Kyoto Univ.) Topological Modular Forms and supersymmetric quantum field theories

**概要** In this talk I will explain my works with Y. Tachikawa and T. Johnson-Freyd to give a bridge between physics and homotopy theory, especially the theory of Topological Modular Forms (TMF). TMF is an  $E_\infty$  ring spectrum which has deep and rich structure from homotopy-theoretical viewpoints. On the other hand, TMF is relevant in physics because it is conjectured by Stolz and Teichner to classify two-dimensional supersymmetric quantum field theories (SQFTs). We originally started from applying TMF to a problem in superstring theory, but investigating it further, we have found many interesting mathematical results on TMF out of physical motivations.

In the first work (<https://arxiv.org/abs/2108.13542>) with Tachikawa we used TMF to prove the vanishing of anomalies in heterotic string theory. After that, N. Kawazumi suggested considering a secondary transformation of spectra arising from the vanishing result. This idea turns out to be crucial; we found that the secondary transformation coincides the Anderson duality of TMF. This result allows us to detect subtle torsion phenomena in TMF by differential-geometric ways, and leads us to new conjectures on the relation between VOAs and TMF (<https://arxiv.org/abs/2305.06196>). Moreover, in the work-in-progress with T. Johnson-Freyd, we found a new explanation of the mysterious 576-periodicity in TMF and SQFTs. In the talk, I explain this exciting interplay between physics and mathematics.

## 無限可積分系

3月19日(火) 第VIII会場

## 9:30~11:30

- 1 森みずき (お茶の水女大人間文化) ホインの微分方程式に関連する三項間漸化式 ..... 15  
 竹村剛一 (お茶の水女大基幹)  
 Mizuki Mori (Ochanomizu Univ.) Three-term recurrence relations and Heun equations  
 Kouichi Takemura (Ochanomizu Univ.)

概要 Heun's differential equation is a standard form of the second order Fuchsian differential equation with four singularity, and it has an accessory parameter. We investigate the coefficients of the local holomorphic solution to Heun's differential equation around the origin. We use the facts that the coefficients are polynomials on the accessory parameter and they satisfy a three-term recurrence relation.

- 2 新井由美 (お茶の水女大人間文化) Solutions to  $q$ -hypergeometric equations associated with  $q$ -middle convolution ..... 15  
 Yumi Arai (Ochanomizu Univ.) Solutions to  $q$ -hypergeometric equations associated with  $q$ -middle convolution

概要 We investigate the integral representations of solutions to  $q$ -hypergeometric equation and its variant obtained through  $q$ -middle convolution by using transformation formulas for  $q$ -hypergeometric series. We show the correspondence between these integral solutions and solutions obtained through other methods. We also show the linear relationships among the integral solutions.

- 3 信川喬彦 (神戸大理)  $q$  超幾何方程式の3次の変異版の接続問題 ..... 15  
 藤井大計 (神戸大理)  
 Takahiko Nobukawa (Kobe Univ.) Connection problem for the variant of  $q$ -hypergeometric equation of degree three  
 Taikei Fujii (Kobe Univ.)

概要 The variant of  $q$ -hypergeometric equation of degree three is introduced by Hatano–Matsunawa–Sato–Takemura (Funkcial. Ekvac., 2022) from the viewpoint of quantum integrable systems. Euler-type integral solutions and hypergeometric series solutions are obtained by Fujii–Nobukawa (arXiv:2207.12777). The main purpose of this talk is to give linear relations for the integral solutions. As an application, we get a three term relation for the very-well-poised  $q$ -hypergeometric function  ${}_8W_7$ .

- 4 森山翔文 (阪公大理) ABJM 行列模型と  $q$  パンルヴェ方程式 ..... 15  
 Sanefumi Moriyama (Osaka Metro. Univ.) ABJM matrix models and  $q$ -Painlevé equations

概要 It was known that sometimes Painlevé equations have solutions of matrix models. We conjecture that a certain matrix model solves the sixth  $q$ -Painlevé equation. This matrix model originates from a three-dimensional superconformal Chern–Simons theory which describes multiple M2-branes in M-theory. The partition function of this theory reduces to a matrix model using the localization theorem. After moving to the grand canonical ensemble by introducing the fugacity dual to the overall rank, we find the grand canonical partition function serves as the tau function and solves the 40 bilinear relations of  $q$ PVI. This talk is based on works with Tomoki Nosaka, JHEP08(2023)191.

- 5 大山陽介 (徳島大理工) Mano's decomposition and  $q$ -Painlevé equations ..... 15  
 Yousuke Ohyama (Tokushima Univ.) Mano's decomposition and  $q$ -Painlevé equations

概要 We study connection formula of several types of  $q$ -Painlevé equations. Mano's decomposition, which is a  $q$ -analogue of Jimbo's decomposition theorem, is a powerful tool to study global theory on  $q$ -Painlevé equations. We show existence of solutions given by formal double power series for the  $q$ -Painlevé equations. In degenerated cases, some confluent basic hypergeometric functions appear after decomposing the Lax pairs.

- 6 増田 哲 (青学大理工) Painlevé V 方程式の梅村多項式の判別式 ..... 15  
 Tetsu Masuda (Aoyama Gakuin Univ.) An explicit formula for the discriminants of the Umemura polynomials of the Painlevé V equation

概要 We present a combinatorial formula for the discriminants of the Umemura polynomials associated with a family of rational solutions to the Painlevé V equation.

#### 14:15~15:15 特別講演

- 大川 領 Non-stationary difference equation and affine Laumon space  
 (阪公大数学研・京大数理研)  
 Ryo Okawa Non-stationary difference equation and affine Laumon space  
 (Osaka Metro. Univ./Kyoto Univ.)

概要 In the first half of the talk, we will introduce the joint work with Awata, Hasegawa, Kanno, Shakirov, Shiraishi, and Yamada. We explain the theorem that the affine Laumon partition function is a solution of the Shakirov equation. The Shakirov equation is gauge equivalent to the quantized  $q$ -difference Painlevé VI equation proposed by Hasegawa. It is also identified with the quantum Knizhnik–Zamolodchikov ( $q$ -KZ) equation for  $U_q(A_1^{(1)})$ . In the latter half of the talk, we would like to introduce the joint work with Shiraishi, and point out the similarity between the Shakirov equation and the wall-crossing formula.

3月20日(水) 第VIII会場

#### 9:30~11:30

- 7 吉永正彦 (阪大理工) 重複度付き超平面配置の対数的ベクトル場の積分表示 ..... 15  
 M. Feigin (グラスゴー大)  
 Zixuan Wang (北大理工)  
 Masahiko Yoshinaga (Osaka Univ.) Integral expressions of logarithmic vector fields for multiarrangements  
 Misha Feigin (Univ. of Glasgow)  
 Zixuan Wang (Hokkaido Univ.)

概要 The explicit construction of the logarithmic vector fields for hyperplane arrangements with multiplicity is a hard problem in general. In this talk, we will discuss integral expression of them.

- 8 筧 三郎 (立教大理工) 楕円関数を背景場とする KP 階層の解 ..... 15  
 Saburo Kakei (Rikkyo Univ.) Solutions to the KP hierarchy with an elliptic background

概要 A class of “elliptic soliton” solutions of the Kadomtsev–Petviashvili hierarchy, which includes a determinantal solution of Li and Zhang, is described in terms of pseudo-differential operator formulation. Real-valued solutions are discussed and various examples that display web-like patterns are presented.

- 9 渋川元樹 (神戸大理) Ruijsenaars 型恒等式とその応用 ..... 15  
 野海正俊 (立教大理)  
 Genki Shibukawa (Kobe Univ.) Ruijsenaars-type identities and their applications  
 Masatoshi Noumi (Rikkyo Univ.)

概要 We prove some identities, which we call *Ruijsenaars-type identities*, and show their applications such as 1) commutativity of some difference operators and 2) Weyl group symmetry of the Tableau representation of interpolation polynomials.

- 10 武中亮 (阪公大理) Y-system に付随する指数について ..... 15  
 Ryo Takenaka (Osaka Metro. Univ.) On exponents associated with Y-systems

概要 Let  $\mathfrak{g}$  be a finite dimensional simple Lie algebra and  $X$  be its Dynkin diagram. Associated with  $X$  and a positive integer  $\ell$  such that  $\ell \geq 2$ , Kuniba and Nakanishi introduced a system of algebraic relations called Y-system. It has been proved that solutions of the Y-system have periodicity. Based on this result, Mizuno introduced a notion of exponent and gave a conjectural formula expressing the exponents for any  $(X, \ell)$ . He also gave a proof for  $(A_1, \ell)$  and  $(A_r, 2)$ . In this talk, we show results for some other Dynkin types and level  $\ell = 2$ .

- 11 赤木亮太 (名大多元数理) ランク 2 団散乱図の整列積表示について ..... 15  
 Ryota Akagi (Nagoya Univ.) Ordered product expressions of rank 2 cluster scattering diagrams

概要 We focus on cluster scattering diagrams, which were introduced in recent years. They are closely related to cluster algebras. By Nakanishi's study, it was clarified that dilogarithm elements play an important role in cluster scattering diagrams. In particular, for rank 2 cases, every cluster scattering diagram is recovered by a (possibly infinite) product of dilogarithm elements, which is called ordered product of dilogarithm elements. In this talk, we show some result for these ordered products.

- 12 井上玲 (千葉大理) 量子クラスター代数と 3 次元可積分性 ..... 15  
 国場敦夫 (東大総合文化)  
 寺嶋侑二 (東北大理)  
 Rei Inoue (Chiba Univ.) Quantum cluster algebras and 3D integrability  
 Atsuo Kuniba (Univ. of Tokyo)  
 Yuji Terashima (Tohoku Univ.)

概要 We construct new solutions to the tetrahedron equation and the 3D reflection equation, by developing the recent study by Sun and Yagi on the tetrahedron equation applying quantum cluster algebras.

#### 14:15~15:15 特別講演

- 伊藤克司 (東工大) ODE/IM 対応と量子力学における完全 WKB 解析  
 Katsushi Ito (Tokyo Tech) ODE/IM correspondence and exact WKB analysis in quantum mechanics

概要 The ODE/IM correspondence, which was found by P. Dorey and R. Tateo in 1998, provides a non-trivial relation between the spectral problem of ordinary differential equations and the functional relation approach in the quantum integrable system. This relation clarifies also the relation between the exact WKB analysis of one-dimensional quantum mechanics and the Thermodynamic Bethe Ansatz (TBA) equation in two-dimensional quantum integrable theory. The Voros symbols in the exact WKB analysis correspond to the Y-functions. In this talk, we review the ODE/IM correspondence for the Schrödinger equation with polynomial potential. The associated TBA equations show the wall-crossing phenomena under the deformation of the potential, which describes a detailed structure of the correspondence. We also discuss a generalization to higher-order ODE.