The 9th Graduate Student Workshop on Mathematics

Osaka City University
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Abstracts

Sunday 26 July

Estimates for the number of negative eigenvalues of Schrödinger operators

Naoki Hamamoto (Osaka City University, D2)

In order to investigate the shape of graph of solutions to semi-linear elliptic differential equations, one of useful way is to analyze the linearized operator which is understood to be a Shrödinger operator, the number of whose negative eigenvalue is called a Morse index. I'd like to introduce how to bound the Morse index.

On the Hardy-Sobolev inequalities

Masato Hashizume (Osaka City University, D1)

We consider a minimization problem for the Hardy-Sobolev inequality. This problem is affected by the position of the singularity on domain. In this talk, we consider about the best constant for the embedding of Hardy-Sobolev type in case of the singularity is in the interior of domain.

The Hardy inequality in a limiting case with the quasi-scale invariance

Megumi Sano (Osaka City University, D1)

In my talk, I deal with the Hardy inequality in a limiting case. After introducing a new scaling for my inequality, I show that my inequality has the quasi-scale invariance under the scaling, and there is no minimizer for an associated minimizing problem by using a scaling argument.

Random walk and discrete heat equation

Kei Takioka (Osaka City University, M1)

Let A be a finite subset of $\mathbb{Z}^d$ with boundary ∂A, the temperature $p_n(y)$ at time n and at y in A satisfies the discrete heat equation. In this talk, I will state that $p_n(y)$ corresponds to the probability distribution of the random walkers on A until they reach A.

On S-Noetherian rings

Dong Kyu Kim (Kyungpook National University, M2)

Let R be a commutative ring with identity, S a multiplicative subset of R, I an ideal of R and M an R-module. In [1], Anderson and Dumitrescu defined the concept of S-Noetherian rings, a general concept of Noetherian rings. To define the concept of S-Noetherian ring, we define the concept of S-finite. Similarly, we define the concept of S-Noetherian module and S-finite module. Anderson and Dumitrescu proved some properties of S-Noetherian, Hilbert basis theorem, Eakin Nagata Theorem, Cohen type theorem, etc. In [2], Lim defined composite ring extension and proved the equivalent condition of the composite ring extension is S-Noetherian. In this talk, I will talk about local property of S-Noetherian and define Nagata ring and t-Nagata ring. I will introduce equivalent conditions of Nagata rings and t-Nagata rings are (t-) locally S-Noetherian domain.

References

[1] D. D. Anderson and Dumitrescu, *S-Noetherian rings*, Comm. Algebra **30** (2002), no. 9, 4407–4416.

[2] J. W. Lim and D. Y. Oh, *S-Noetherian properties of composite ring extensions* Comm. Algebra **43** (2015), no. 7, 2820–2829.

On S-Nonnil-Noetherian rings

Minjae Kwon (Kyungpook National University, M1)

A commutative ring R with identity is called S-Nonnil-Noetherian, where $S \subseteq R$ is a given multiplicative set, if for each nonnil ideal I of R, $sI \subseteq J \subseteq I$ for some $s \epsilon S$ and some finitely generated ideal J.
In this talk, we introduce the notion of S-Nonnil-Noetherian rings, and we study some properties.

On a generalization of Hurwitz series rings

Seung Min Lee (Kyungpook National University, M2)

As a new kind of a power series ring, Keigher defined the notion of Hurwitz series rings by using binomial coefficients and called it the Hurwitz series ring. The Gaussian coefficient means the number of subspaces of a finite dimensional vector space over a finite field, and it can be regarded as a generalization of binomial coefficients. In this talk, we construct a new ring by using Gaussian coefficients, and we study some properties.

On the crossing changes for surface-knots

Amal Al Kharusi (Sultan Qaboos University, PhD)

The cross-change operation is called an unknotting operation for a surface-knot F if an unknotted surface-knot is obtained from F by a finite sequence of crossing changes. It is still unknown whether the crossing change is an unknotting operation for any surface-knot. In this talk, we define a set of surface-knots called DU-exchangeable surface-knots such that the crossing change is an unknotting operation for DU-exchangeable surface-knot.

Gordian distances of the unknotting operation $H(T)$ of the rotation type

Byeorhi Kim (Kyungpook National University, M2)

$H(T)$-move is a local move on a knot diagram obtained by rotating a tangle diagram T. Recently, Y. Bae and the author studied the tangles T whose corresponding $H(T)$-move are unknotting operations. In particular, $H(T)$-move is an unknotting operation for every n-chord-tangle diagram $T(n = 2, 3)$. In this talk, we will study such unknotting operations by comparing Gordian distances.

On Fox-Hosokawa conjecture

Seonmi Choi (Kyungpook National University, D2)

Fox-Hosokawa conjecture says that if L is a trivial link and $\mathfrak{B}$ is a complete fusion band set such that $L_{\mathfrak{B}}$ is a trivial knot, then the closed realizing surface of the hyperbolic transformation $L \xrightarrow{\mathfrak{B}} L_{\mathfrak{B}}$ is unknotted. In this talk, we will try to show that Fox-Hosokawa conjecture is affirmative.

Monday 27 July

On representation decompositions of cohomology rings of toric manifolds associated to cycle graphs

Miho Hatanaka (Osaka City University, D3)

We can construct a graph associahedron from a simple graph, and a graph associahedron is a Delzant polytope. So, one can construct a toric manifold from a simple graph. Moreover, the automorphism group of a graph induces a representation on the cohomology ring of the toric manifold associated to the graph. In particular, we take a cycle graph. The automorphism group of a cycle graph is a dihedral group. In this talk, we describe representation decompositions of cohomology rings of toric manifolds associated to cycle graphs with 3,4, and 5 nodes.

On Betti numbers of toric origami manifolds

Zeng Haozhi (Osaka City University, D3)

Toric origami manifolds, introduced by A. Cannas da Silva, V. Guillemin and A. R. Pires, are generalizations of symplectic toric manifolds. In this talk, we discuss the Betti numbers of orientable toric origami manifolds with acyclic proper faces. This talk is based on the joint work with A. Ayzenberg, M. Masuda and S. Park.

Some properties of integral topological toric manifolds

Hideya Kuwata (Osaka City University, D3)

Topological toric manifolds are the generalization of toric manifolds(=compact smooth toric varieties). In particular, integral topological toric manifolds are very similar to toric manifolds in some sense. We will talk about it in the workshop.

Simplicial 2-spheres obtained from non-singular complete fans

Yusuke Suyama (Osaka City University, D1)

We show that a simplicial 2-sphere satisfying a certain condition is the underlying simplicial complex of a non-singular complete fan in $\mathbb{R}^3$.

Existence of solutions for vector p-Laplacian systems with singular weights

Xianghui Xu (Pusan National University, D4)

In this talk, we introduce a new solution operator for the Dirichlet boundary value problem of a vector p-Laplacian system with a singular weight function which may not be in L^1. As an application, we use the solution operator to study the existence of solutions for the p-Laplacian problem.

References

[1] R.P. Agarwal, H.S. Lü and D. O'Regan, *Eigenvalues and the one-dimensional p-Laplacian*, J. Math. Anal. Appl. **266** (2002), 383–400.

[2] R. Manásevich and J. Mawhin, *Periodic solutions of nonlinear systems with p-Laplacian-like operators*, J. Diff. Eqns. **145** (1998), 367–393.

[3] I. Sim and Y. H. Lee, *A new solution operator of one-dimensional p-Laplacian with a sign-changing weight and its application*, Abstr. Appl. Anal. 2012 (2002) Article ID 243740, 1–15.

Estimates for the Bergman kernel of Fock-type space

Soo Hyun Park (Pusan National University, D1)

In 2009, J. Marzo and J. Ortega-Cerdà proved Bergman kernel estimates for Fock-type spaces on $\mathbb{C}$ under the hypothesis that the weight function is a subharmonic function whose Laplacian is a doubling measure. We obtained similar size estimates without the doubling condition. In this talk, we would sketch a proof of the theorem and introduce other kernel estimates for the several variables case due to K. Seip and E. H. Youssfi.

References

[1] J. Marzo and J. Ortega-Cerdà, *Pointwise estimates for the Bergman kernel of the weighted Fock space*, Journal of Geometric Analysis **19** (2009), 890–910.

[2] K. Seip and E. H. Youssfi, *Hankel Operators on Fock Spaces and Related Bergman Kernel Estimates*, Journal of Geometric Analysis **23** (2013), 170–201.

A mixed norm equivalence on generalized Fock spaces

Jeong Min Ha (Pusan National University, D1)

In this talk we consider a norm equivalence for the Fock type mixed norm of a holomorphic function and its radial derivative in the n-dimensional complex space. We prove that the mixed norm for an exponential type weighted integral of a holomorphic function is equivalent to the mixed norm of its radial derivative and the distortion function from the weight function in the n-dimensional complex space.

The characterization theorems of the generalized scherk surface and catenoid

Daehwan Kim (Pusan National University, D3)

The catenoids and generalized Scherk's surfaces(doubly periodic minimal surfaces) are very classical minimal surfaces. Since Scherk's surface is represented by $z(x, y) = \log(\cos x) - \log(\cos y)$, it is one of translation surfaces which are expressed as the sum of two planar curves $\alpha(v)$ and $\beta(u)$ that means the curve $\alpha(v)$ foliates along $\beta(u)$. The catenoid is a surface of revolution which means it is foliated by homothetical circles which have different radii. In this talk, we consider the minimal surface foliated by the planar curves along the space curve instead of planar curve which are congruent and foliated by the homothetical curves instead of circles. When each surface is minimal, it is either the generalized Scherk's surface or catenoid.

References

[1] F. Dillen, I. V. de Woestijne, L. Verstraelen, and J. Walrave, *The surface of Scherk in E^3 : a special case in the class of minimal surfaces defined as the sum of two curves*, Bull. Inst. Math. Acad. Sinica **26** (1998), no. 4, 257–267.

[2] R. López and M. Moruz, *Translation and homothetical surfaces in euclidean space with constant curvature*, J. Korean Math. Soc. **52** (2015), no. 3, 523–535.

[3] R. López, *Special Weingarten surfaces foliated by circles*, Monatsh. Math. **154** (2008), no. 4, 289–302.

Real hypersurfaces in Complex two-plane Grassmannians with certain structure Jacobi operator

Gyu Jong Kim (Kyungpook National University, D2)

In this talk, several kinds of structure Jacobi operator tensors are defined on a Real hypersurface M in complex two-plane Grassmannians $G_2(C^{m+2})$. Using the Berndt and Suh's classification theory, we give some complete classifications of M in $G_2(C^{m+2})$ with these conditions about GTW Lie derivative structure Jacobi operator.

CMC surfaces and the sinh-Gordon equation

Minoru Yoshida (Osaka City University, M1)

In the 3-dimensional Euclidian space, constant mean curvature surfaces (CMC surfaces) are smooth surfaces with constant mean curvature H which is not equal to zero. In this talk, I will talk about the relation between CMC surfaces and the sinh-Gordon equation, $\Delta\omega + \sinh\omega\cosh\omega = 0$. Moreover, I will explain the associated one parameter family of CMC surfaces, which is one of the most fundamental properties for CMC surfaces.

Tuesday 28 July

Some inequalities of weighted shifts associated by directed trees

Bo Geon Kim (Kyungpook National University, M2)

Let $\mathcal{H}$ be an infinite dimensional complex Hilbert space, and let $B(\mathcal{H})$ be the algebra of all bounded linear operators on $\mathcal{H}$. Recall that an operator $T \in B(\mathcal{H})$ has property $B(n)$ if $|T^n| \geq |T|^n$, which generalizes the class A-operator. We characterize the property $B(n)$ of weighted shifts S_λ over (η, κ)-type directed trees which appeared in the study of subnormality of weighted shifts over directed trees recently. In addition, we discuss the classes of weighted shifts S_λ over $(2,1)$-type directed trees with property $B(n)$ are being distinct with respect to $n \geq 2$. And we give some properties of weighted shifts S_λ over $(2,1)$-type directed trees with property $B(2)$. (This is a joint work with M. Seo.)

Backward extensions of recursively generated Hamburger-type weighted shifts and Aluthge transforms

Joo-young Jin (Kyungpook National University, D4)

In this talk, we characterize property $H(n)$ of backward extensions of recursively generated Hamburger-type weighted shifts $W_{(\sqrt{a},\sqrt{b},\sqrt{c})^H)}$. We study the Aluthge transform of the property $H(n)$ and the Hamburger-type weighted shifts. We prove that Aluthge transform of weighted shifts need not preserve the property $H(n)$. Moreover, we show that if is Hamburger-type weighted shift with 2-atomic Hamburger measure then its Aluthge transform $\widetilde{W_\alpha}$ is subnormal if and only if 2 atom are symmetric. (This is a joint work with G. Exner and I. Jung.)

On the Hermitian Positive Definite Solution to a Nonlinear Matrix Equation

Jie Meng (Pusan National University, M2)

In this talk, we consider the nonlinear matrix equation $X^p = A + M(B + X^{-1})^{-1}M^*$, where $p \geq 2$ is a positive integer, M is an arbitrary $n \times n$ matrix, A and B are $n \times n$ Hermitian positive semidefinite matrices. Based on the fixed-point theory, a sufficient condition for the existence and uniqueness of the Hermitian positive definite (HPD) solution to this nonlinear matrix equation is derived. A fixed-point iterative method and an inversion-free variant iterative method for obtaining the HPD solution are proposed. Some numerical examples are presented to show the efficiency of the proposed two iterative methods.

A continuous function whose Fourier series diverges at a point

Akimasa Tamagaki (Osaka City University, M1)

We consider the Banach space of continuous functions on the real line with period 2π. We prove the existence of a function whose Fourier series diverges at a point in the space. The main tool of the proof is the uniform boundedness principle.

On quantum invariants of 3-manifolds with genus one open book decompositions

Atsushi Mochizuki (Kyoto University (RIMS), D2)

I'll calculate some types of quantum invariants of 3-manifolds with genus one open book decompositions.

Heegaard Floer correction terms of $(+1)$-surgeries of $(2, q)$-cablings

Kouki Sato (Tokyo Institute of Technology, D1)

Heegaard Floer correction term (d-invariant) is an invariant of rational homology 3-spheres associated with Spin^c structure. In particular, the correction term of 1-surgeries along knots in S^3 has been investigated as a ($2\mathbb{Z}$-valued) knot concordance invariant d_1. In this talk, we give an evaluation of $d_1(K_{2,q})$ for any $q > 1$ and the $(2, q)$-cabling $K_{2,q}$ of any knot K. This evaluation does not depend on the knot type of K, and if K belongs to a certain class which contains any negative knot, the evaluation becomes equality. As a corollary, we show that the relationship between d_1 and Heegaard Floer τ-invariant is very weak in general.

The fundamental group and its application to knot theory

Hironaga Ogawa (Osaka City University, M1)

We introduce the notion of the fundamental group of a topological space, and apply it to knot theory.

Parities and odd polynomial invariants for virtual links

Su Hyeon Jeong (Pusan National University, M1)

We introduce the odd Jones-Kauffman polynomial of virtual link diagrams by using the parity of virtual link diagrams given in [Y. H. Im and K. I. Park, *A parity and a multi-variable polynomial invariant for virtual links*, J. Knot Theory Ramifications **22** (2013), no. 13 Article ID: 1350073, 18pp.].

An index definition of parity mappings of a virtual link diagram

Geun Young Kim (Pusan National University, M1)

H. Dye defined the parity mapping for a virtual knot diagram, which is a map from the set of real crossings of the diagram to $\mathbb{Z}$. The notion generalizes the parity which is studied extensively by V. Manturov. The mapping induces the i-th writhe ($i \in \mathbb{Z} \setminus \{0\}$) which is an invariant of the representing virtual knot. She applied the parity mapping to introduce a grade to the Henrich S-invariant for a virtual knot, and showed that the invariants are Vassiliev invariants of degree one. Following it, we define the parity mappings for a virtual link diagram, and define the similar invariants as above for a virtual link by using the parity mappings.

Index polynomials for Gauss diagrams of virtual links

Ji Hee Kim (Pusan National University, M1)

We introduce the index polynomial for Gauss diagrams corresponding virtual links, which is easier to calculate than that of virtual links.

Wednesday 29 July

The group of a semi-virtual knot diagram

Kengo Kawamura (Osaka City University, D3)

Goussarov, Polyak and Viro introduced a semi-virtual crossing for finite type invariant theory of virtual knots. A semi-virtual knot diagram is a virtual knot diagram admitting semi-virtual crossings. In this talk, we introduce the group of a semi-virtual knot diagram, and show a relationship between semi-virtual knot diagrams and certain singular torus-knots. This is joint work with Seiichi Kamada.

On a homomorphism induced by a 4-valent graph on a surface

Megumi Hashizume (Nara Women's University, D2)

In 2010, Ayaka Shimizu et.al. defined a local transformation on link diagram called region crossing change. In [1], for each link diagram G on S^2, I introduced a homomorphism $f : 2^{F(G)} \to 2^{V(G)}$ induced by region crossing change, where $F(G)$ ($V(G)$ reap.) denotes the set of the faces (crossings reap.) of G. Recently Kenta Ozeki extended f to a homomorphism induced by a 4-valent graph on a surface, denoted by φ and gave a dimension of the image of φ. In this talk, I introduce his results and give some observations about φ.

References

[1] M. Hashizume, *On the homomorphism induced by region crossing change*, JP Journal of Geometry and Topology **14**, (2013), no. 1, 29–37.

Braid alternation number of a knot

María de los Angeles Guevara Hernández
(Instituto Potosino de Investigación Científica y Tecnológica (IPICYT), D2)

We introduce a new numerical invariant called the braid alternation number of a knot K, which is defined to be the minimum number of crossing changes on a braid b, such that the closure of b is K, that is necessary to obtain an alternating braid b^* from b. In this talk, we show that the braid alternation number differs from both the alternation number and the dealternating number. This is a joint work with Akio Kawauchi.

Qualgebra colorings and cocycle invariants of spatial trivalent graphs

Kaori Hasegawa (Osaka City University, M2)

A qualgebra is a quandle with a multiplication. Using a qualgebra, we can define colorings and cocyce invariants of spatial trivalent graphs. We show an example of a 3-cocycle of a qualgebra with 4 elements, and culculate cocyce invariants for some spatial trivalent graphs.

Early effect through resonances in time-dependent, nonlinear dynamical systems

Youngyong Park (Kyungpook National University, D4)

The Early effect in slow passage dynamics is the recently found dynamical phenomenon related to the onset of a resonance in a damped harmonically forced oscillator whose forcing frequency is slowly ramped linear in time. We consider the flow in an enclosed circular cylinder driven by the harmonic modulation of the rotating bottom lid whose frequency is slowly ramped with various powers in time. We numerically observe that for various ramping powers p, there are early onsets of multiple resonances. For the onset condition for each resonance, we find that the ratio of the distance between the natural frequency and the jumping frequency to the distance between jumping frequency and the initial frequency is $p : 1$. To theoretically support the onset condition for the early effect with nonlinear monotonic power ramp, we derive it using the concept of instantaneous frequency. Our study shows that by rescaling a parameter, the dynamical properties obtained in a static system can be recovered by an investigation of a non-stationary system or system with a slowly varying parameter in time, which is a powerful method of time-saving and avoiding inconveniences.

Statistical properties of spatiotemporal chaos

Beomseok Kim (Kyungpook National University, D4)

In nature, there are many unexpected phenomena such as earthquake, landslide, heavy rain, etc. Typically, these phenomena are called as extreme events.To investigate these phenomena in the mathematical point of view, we study complex Ginzburg-Landau(CGL) equation which shows spatiotemporal chaos in the certain parameter range. To examine the temporal and spatial properties of the occurrence of extreme events, we study the frequency of occurring, time difference, mobility, and distance difference of the occurred extreme events. We find that the probability of mobility satisfies power law scaling.

Second-order Poincaré inequality

Takafumi Sato (Osaka City University, M1)

I'll introduce the second-order Poincaré inequality about a standard Gaussian random variable N. The inequality states that whenever f'' is small compared to f', then $f(N)$ has approximately a standard Gaussian distribution in the meaning of the Wasserstein distance.

The number of ideals of $\mathbb{Z}[x]$ containing $x(x-\alpha)(x-\beta)$ with given index

Semin Oh (Pusan National University, D3)

Let G be a graph with v vertices and A a adjacency matrix of G in $M_v(\mathbb{Z})$. We denote $\langle A\rangle$ is a subring of $M_v(\mathbb{Z})$ generated by A. Remark that $\langle A\rangle \simeq \mathbb{Z}[x]/m_A(x)\mathbb{Z}[x]$ where $m_A(x)$ is the minimal polynomial of A. If A has the three distinct integral eigenvalues then $\langle A\rangle$ is isomoprhic to a ring of the form $\mathbb{Z}[x]/x(x-\alpha)(x-\beta)\mathbb{Z}[x]$ where α and β are nonzero distinct integers.

In this talk we want to find a Dirichlet series of $\langle A\rangle$ which is defined by

$$\zeta_A(s) = \sum_{n=1}^{\infty} a_n n^{-s}$$

where a_n is the number of ideals of $\langle A\rangle$ with index n. After introducing some graphs with three integral eigenvalues, we compute $\zeta_A(s)$.

One dimensional sums and Kostka polynomials

Shouhei Machida (Osaka City University, M1)

The crystal of quantum groups of type A can be identified with a set of semi-standard tableaux. In this talk, I will explain the energy function on tensor products of crystals and one dimensional sums, generating function of crystal elements with energy statistic. I will also talk about relations between one dimensional sums and symmetric functions.

On NI-rings and relations amonzrg π-regular rings and its related rings

Eun-Kyung Cho (Pusan National University, M1)

In this talk, I will give a summarization of a paper 'A Note on Π-regular Rings' by professor Yang Lee and Chan Huh, and introduce some possibilities of extending the idea of this paper to another kind of rings such as nil-Armendariz rings or directly finite rings which are generalizations of NI-rings. Also I will introduce another concept of ring which is a generalization of NI-ring. The talk will mainly cover about the definitions and some relations among π-regular rings, strongly π-regular rings, 2-primal rings, NI-rings, $(S, 2)$-rings and so on based on the paper 'A Note on Π-regular Rings'.

References

[1] Yang Lee, Chan Huh, *A Note on Π-regular Rings*, Kyungpook Math. J. **38** (1998), 157–161.
[2] Ramon Antoine, *Nilpotent elements and Armendariz rings*, Journal of Algebra **319** (2008), 3128–3140.
[3] Seo Un Hwang, Young Cheol Jeon, Yang Lee, *Structure and topological conditions of NI rings*, Journal of Algebra. **302** (2006), 186–199.