

# Abstract

## **Surface links which are coverings over the standard Projective plane**

Seonmi Choi (Kyungpook National University, M2)

It is known that any oriented surface link can be presented by a simple branched covering over  $S^2$ . In 2012, I.Nakamura introduced a new construction of a surface link in the 4-space which is presented by a simple branched covering over the standard torus. In this talk, we will study about a surface link which is presented by a simple branched covering over the standard real projective plane.

## **The flat plumbing basket number of knots with 6 crossings or less**

Yun Ki Chung (Gyeonggi Science High School)

A new direction of the classification of links is developing by presenting links as boundaries of the flat plumbing basket surfaces. The minimal flat plumbing number among all flat plumbing basket surfaces of a given link  $L$  is defined to be the flat plumbing basket number of the link  $L$ . In present article, we find a classification theorem about the knots of the flat plumbing basket number up to 4. Using this classification theorem, we find the flat plumbing basket number knots with 6 crossings or less.

## **Ford domains of quasi-fuchsian once-punctured Klein bottle groups**

Mikio Furokawa (Hiroshima University, D1)

Jorgensen gave a complete description of the combinatorial structure of the Ford domains of quasi-fuchsian once-punctured torus groups. By using Jorgensen's method, we determine the combinatorial structure of the Ford domains of fuchsian once-punctured Klein bottle groups. We also show that there are quasi-fuchsian once-punctured Klein bottle groups whose Ford domains have quite different nature compared with those of quasi-fuchsian once-punctured torus groups.

## Bergman-Sobolev spaces with exponential weight on the unit disc

Su Kyung Han (Pusan National University, D2)

Our result shows that a *Bergman-Sobolev space* can be realized as a *weighted Bergman space*:  
For  $1 \leq p < \infty$  and  $\alpha \in \mathbb{R}$ ,  $m = 0, 1, 2, \dots$ ,

$$A_{\alpha,exp}^{p,m} = A_{\alpha-2m,exp}^p$$

with equivalent norms.

## Differentiation of Radon measures on $\mathbf{R}^n$

Masato Hashizume (Osaka City University, M1)

We introduce a notion of “differentiation” of a Radon measure with respect to another Radon measure on  $\mathbf{R}^n$ . The differentiation theorem for Radon measures states that, under certain condition, a Radon measure  $\nu$  has a derivative with respect to a Radon measure  $\mu$ , and  $\nu$  is represented by the integral with respect to  $\mu$  of its derivative. Thus, this theorem can be seen as a generalization of the fundamental theorem of calculus in the context of measure theory. I show a proof and an example of this theorem.

## Coset decomposition by images of homomorphisms induced by region crossing change on 3-component link diagrams

Megumi Hashizume (Nara Women’s University, M2)

Let  $D$  be a link diagram. In 2010, A.Shimizu [Shi] et al. introduced a local move on  $D$  called region crossing change. Let  $\mathcal{R}$  ( $\mathcal{C}$  resp.) be the set of the regions (crossings resp.) of  $D$ . In [Ha], I introduced  $\mathbf{Z}_2$ -linear structures on  $2^{\mathcal{R}}$  and  $2^{\mathcal{C}}$ , and showed that region crossing change on  $D$  induces a linear map  $\varphi : 2^{\mathcal{R}} \rightarrow 2^{\mathcal{C}}$ . In this talk, I will describe the coset decomposition of  $2^{\mathcal{C}}$  by  $\text{Im}\varphi$  for the case that  $D$  is a 3-component link diagram.

[Shi] A.Shimizu. *Region crossing change is an unknotting operation*, to appear in Journal of the Mathematical Society of Japan.

[Ha] M.Hashizume. *On the homomorphism induced by region crossing change*, to appear in JP Journal of Geometry and Topology.

## **Uniqueness of the direct decomposition of toric manifolds**

Miho Hatanaka (Osaka City University, D1)

In this talk, I will talk about the uniqueness of the direct decomposition of a toric manifold. I first talk that the direct decomposition of a toric manifold as algebraic varieties is unique up to order of the factors. An algebraically indecomposable toric manifold happens to decompose as smooth manifold and no criterion is known for two toric manifolds to be diffeomorphic, so the unique decomposition problem for toric manifolds as smooth manifolds is highly nontrivial. But this problem is affirmative if the complex dimension of each factor in the decomposition is less than or equal to two.

## **Bruhat ordering of Coxeter system**

Atsuhiko Hayashi (Osaka City University, M2)

I will explain the construction of Coxeter system  $(W, S)$  and give the definition of the length function  $W \rightarrow \mathbb{R}$ . Then I will define a partial ordering on  $W$ , called the Bruhat ordering on  $W$ , and give a necessary and sufficient condition for two elements in  $W$  to be ordered.

## **Invariants for long virtual knots via the parity**

Jieon Hong (Pusan National University, D3)

In this talk, we introduce an invariant of long virtual knots by using the parity and Kauffman's affine index polynomial for virtual knots. Also, we obtain invariants for long virtual knots through even crossings for parity.

## **Introduction of Springer variety**

Tatsuya Horiguchi (Osaka City University, D1)

Springer variety is a subvariety of a flag variety. It has an  $S^1$  action. In this talk, I present the equivariant cohomology of Springer variety of type  $(n - k, k)$ .

## The colorability of theta-curve by $\mathbb{Z}_2$ -family of quandles $(\mathbb{Z}_3, \{*_0, *_1\})$

Woosik Jeong (Kyungpook National University, M2)

A handlebody-knot is a handlebody embedded in  $\mathbb{Z}^3$ . A diagram of handlebody-knot is a diagram of spatial trivalent graph which represents handlebody-knot. A theta-curve ( $\theta$ -curve) is a spatial trivalent graph  $\Theta$  consisting of two vertices joined by three edges. It is well known that a handlebody-knot is colorable by a  $G$ -family of quandles  $(Q, \{*_g\}_{g \in G})$ . In this talk, we will talk about the colorability of a theta-curve by the  $\mathbb{Z}_2$ -family of quandles  $(\mathbb{Z}_3, \{*_0, *_1\})$ .

## On Hamburger moment sequences of weighted shifts

Joo Young Jin (Kyungpook National University, D2)

In this paper, we indicate how our subject emerges from the confluence of several streams of analysis, including the classical moment problems, the theory of positive matrices, subnormal operator theory. A new notion of Hamburger  $H(n)$ -property is introduced via Hamburger moment matrix in this paper. We discuss distinction of  $H(n)$ -property, flatness, backstep extension and perturbations.

## On $p$ -semisimplicity of Cayley graphs

Hyung-rok Jo (Pusan National University, M2)

We say that a graph  $\Gamma$  is  $p$ -semisimple if there exists a positive integer  $k$  such that  $(A_\Gamma)^{p^k}_{i,j} \equiv (A_\Gamma)_{i,j} \pmod{p}$  for all  $i, j$ , where  $A_\Gamma$  is the adjacency matrix of  $\Gamma$ . We define  $\Phi(\Gamma) = \{ p \mid p \text{ is a prime and } \Gamma \text{ is not } p\text{-semisimple} \}$  and  $\Phi(G) = \bigcup \{ \Phi(\Gamma) \mid \Gamma \text{ is a connected Cayley graph over } G \}$ . In this talk, we aim to prove that  $\Phi(G) = \{ p \mid p \text{ is a prime and } p \mid |G| \}$  if  $G$  is an abelian group, and we show some computational results for Cayley graphs over non-abelian groups of small orders.

## **A construction of ideal coset invariants for surface-links in $\mathbb{R}^4$**

Yewon Joung (Pusan National University, D3)

Lee defined a polynomial  $[[D]]$  for marked graph diagrams  $D$  of surface-links in  $\mathbb{R}^4$  by using a state-sum model involving a given classical link invariant. In this talk, we introduce an ideal coset invariant for surface-links, which is defined to be the coset of the polynomial  $[[D]]$  in a quotient ring of a certain polynomial ring modulo some ideal and represented by a unique normal form, i.e., a unique representative for the coset of  $[[D]]$  that can be calculated from  $[[D]]$  with help of a Gröbner basis package on computer.

## **On seven types of Roseman moves**

Kengo Kawamura (Osaka City University, D1)

Two diagrams of a classical knot are related by a sequence of Reidemeister moves. Similarly, two diagrams of a surface-knot are related by a sequence of Roseman moves. There are seven types of Roseman moves. It is known that a particular one of the seven types can be realized by the other six. We show that there is another type that can be realized by the other six, and that any other type except these two cannot be realized by the other six.

## **Invariancy of the Ricci tensor in complex two-plane Grassmannians**

Gyu Jong Kim (Kyungpook National University, M2)

In this paper, we introduce some notions of invariancy for the Ricci tensor on real hypersurfaces in complex two-plane Grassmannians  $G_2(\mathbb{C}^{m+2})$ , namely, invariant and  $\mathcal{F}$ -invariant Ricci tensor. Using these notions, we give non-existence theorem and characterization for the special case among the real hypersurfaces of Type (A) in  $G_2(\mathbb{C}^{m+2})$ , respectively.

## **Twisted Alexander polynomials of periodic knots with rational quotients**

Jieon Kim (Pusan National University, D1)

In this talk, we first review the twisted Alexander polynomial associated with a metabelian representation, which is a generalization of classical Alexander polynomial. Then we compute twisted Alexander polynomials for periodic knots with rational quotients and discuss some applications.

### **A note on obesity as epidemic in Korea**

Munseok Kim (Kyungpook National University, D3)

To analyze the incidence of obesity in adults aged 19–59 years in Korea and predict its trend in the future. We considered a two-compartmental deterministic mathematical model Susceptible-Infected-Susceptible (SIS), a system of difference equations, to predict the evolution of obesity in the population and to propose strategies to reduce its incidence. The prevention strategy on normal-weight individuals produced a greater improvement than that produced by treatment strategies. Mathematical model sensitivity analysis suggests that obesity prevention strategies are more effective than obesity treatment strategies in controlling the increase of adult obesity in Korea.

### **A relationship between two different quotient structure on the Takasaki quandle**

Seongjeong Kim (Kyungpook National University, M2)

In 2010, D.N.Yetter studied about quotients of quandles in terms of a normal subgroup of the inner quandle automorphism group. And, I talked about a quotient structure of a Takasaki quandle defined by a subquandle which is also a subgroup of the given abelian group in the last year. In this talk, we will study about a relationship between two different quotient structure on Takasaki quandles.

### **Toric ideal and toric variety**

Hideya Kuwata (Osaka City University, D1)

In algebraic geometry, a toric variety is defined as follows: toric variety is a normal variety  $X$  that contains algebraic torus  $T$  as open dense subset, together with an action of  $T$  on  $X$  that extends the natural action of  $T$  on itself. Unlike this, we define a toric variety to be a variety which is the zero set of toric ideal, where toric ideal is defined by a matrix (or a configuration)  $A$ . In other words, we define a toric variety to be an affine or projective variety which is parametrized by a set of monomials. I will talk about relations between toric variety and toric ideal or matrix  $A$  by using some examples.

### **The normal braid presentation of an $n$ -twist spun trefoil**

Sungwon Kwon (Kyungpook National University, M1)

An  $n$ -twist spun trefoil is a 2-knot which is constructed by twisting  $n$ -times while spinning. It is well known that we can find a normal braid form of an  $n$ -twist spun trefoil by using Kamada chart for given oriented surface. S.Kamada introduced a 2-twist spun trefoil in a normal braid form. In this talk, we will talk an  $n$ -twist spun trefoil in a normal braid form.

### **The parity writhe polynomials for (flat) virtual knots**

Dong Soo Lee (Pusan National University, M2)

We introduce a polynomial invariant with two variables for an oriented virtual knot, which refines the odd writhe polynomial with one variable due to Cheng by using a modified version of the warping degree. Our invariant is a Vassiliev invariant of degree one, reduces to one variable for a checkerboard colorable virtual knot, vanishes for classical knots, and detects non-invertibility and non-amphicheirality for some cases. Moreover we define a similar invariant for a flat virtual knot and show that the polynomial is equivalent to an affine index polynomial invariant introduced by Kauffman.

### **Error corrected method for pricing American options under Merton Jump-diffusion model**

Seung Jun Lee (Kyungpook National University, M2)

In this talk, we consider pricing of American put option with Merton Jump-diffusion model. The American option problem is linear complementary problem (LCP). The derivatives in the partial integro-differential operator are discretized by using the finite difference. The discretization has full matrix linear systems. In order to reduce the required computational cost, we applied the error corrected method (ECM). This method doesn't require Iteration. It asks only tridiagonal solver. The early exercise constraint is treated using operator splitting methods. Numerical test results are presented to show the proposed method has second order convergence in time and space.

### **Parities and invariants for virtual links**

Sunho Lee (Pusan National University, D3)

Manturov studies parities and weak parities of virtual knots and free knots. We give some (weak) parities for virtual links and invariants, and consider some applications.

### **Goeritz invariant of a link**

Satoshi Matsumura (Osaka City University, M1)

There are several well known link invariants, which are powerful but difficult to calculate. We introduce the Goeritz invariant, which is calculated easily from a checkerboard coloring of a link diagram.

### **On relationships between canonical genus and flat Seifert surfaces**

Takahiro Miura (Kobe University, D3)

The canonical genus of a knot is defined as the minimal genus of all surfaces obtained by applying Seifert's algorithm to diagrams of the knot. It is known that the half of the highest degree on  $z$  of the HOMFLY polynomial gives a lower bound of the canonical genus. (Morton's inequality) The flat Seifert surface is defined as a surface obtained by applying Seifert's algorithm to a diagram which has no nested Seifert circles. It is known that any knot  $K$  has a flat Seifert surface  $F$ . In this talk, we study sufficient conditions that the canonical genus of  $K$  is equal to the genus of  $F$ , by using Morton's inequality.

### **Positive solutions of Kirchhoff type elliptic equations involving a critical Sobolev exponent**

Daisuke Naimen (Osaka City University, D1)

In this talk we investigate Kirchhoff type elliptic equations involving a critical Sobolev exponent. In particular we show the existence of positive solutions of our problems. The main argument lies in proving the PS conditions for the associated functional.

### **The transformation theory of surfaces in Lie geometry**

Yuta Ogata (Kobe University, M2)

I introduce several classes of surfaces in Lie geometry, for example, isothermic surfaces,  $\Omega$  surfaces and linear Weingarten surfaces. And we shall discuss construction of the transformation theory for these. In this talk, I especially consider Christoffel transformations, Calapso transformations and others. At the end of this talk, I will report on some results about them.

### **Mathematical modeling on Inflammatory Bowel Disease**

Anna Park (Pusan National University, M2)

Inflammatory Bowel Disease (IBD) are chronic, relapsing, immunologically mediated disorders. The exact cause of IBD is unknown. According to various factors T cell produces diverse proinflammatory cytokines and these cytokines are causatively associated with many symptom of IBD. In this talk, we study mathematical analysis for the global dynamic of the mathematical model. We describe the mathematical model of T cell and the cytokines secreted by T cell with IBD using ordinary differential equation and prove that the model is positively invariant. We find an equilibrium and show globally asymptotically stability of the equilibrium using Liapunov stability theorem.

### **On the Newton potential of a uniformly continuous function**

Megumi Sano (Osaka City University, M1)

The Newton potential  $u$  of a function  $f$  is defined by the convolution of the fundamental solution of Laplace's equation with  $f$ . It is well known that  $u$  is in  $C^2(\mathbb{R}^n)$  and satisfies the Poisson equation  $\Delta u = -f$  in  $\mathbb{R}^n$ , when  $f$  is Hölder continuous. However, if  $f$  is only uniformly continuous, the Newton potential of  $f$  may not be in  $C^2$ . In my talk, I will introduce a simple example of such  $f$ .

## **On some connections between adjacency operators and infinite directed graphs**

Minjung Seo (Kyungpook National University, D3)

Fujii defined adjacency operators on infinite directed graphs and developed some relations between graphs and adjacency operators in the case that adjacency operators were bounded. In this talk, we introduce weighted adjacency operators on infinite directed graphs which are the generalization of adjacency operators on infinite directed graphs. We discuss some properties of weighted adjacency operators. In addition, some connections between weighted adjacency operators and graphs are studied and in particular we characterize the normality of weighted adjacency operators in the case that weighted adjacency operators are bounded.

## **Newton's method for solving a QME with special coefficient matrices**

Sang-hyup Seo (Pusan National University, D2)

We consider the iterative solution of a quadratic matrix equation with special coefficient matrices which arises in the quasi-birth and death problem. In this paper, we show that the elementwise minimal positive solvent of the quadratic matrix equations can be obtained using Newton's method if there exists a positive solvent and the convergence rate of the Newton iteration is quadratic if the Fréchet derivative at the elementwise minimal positive solvent is nonsingular. Although the Fréchet derivative is singular, the convergence rate is at least linear. Numerical experiments of the convergence rate are given.

## **Transition functions of Grassmann manifolds**

Yusuke Suyama (Osaka City University, M1)

The Grassmann manifold  $Gr_d(K^{d+r})$  is the set of all  $d$ -dimensional subspaces of  $K^{d+r}$ . In this talk, we give an atlas of the Grassmann manifold and find its transition functions.

## **Signature of a knot**

Kota Takahashi (Osaka City University, M1)

In this talk, we introduce a signature of a knot. It is not only easy to calculate but very useful. For example, the right hand trefoil and the left hand trefoil are distinguished by the signature. We give further properties.

## **A duality theorem in Functional Analysis – an application of Hahn-Banach Theorem –**

Kohei Tanaka (Osaka City University, M1)

We consider a duality theorem in Functional Analysis. Duality theorems are important in many branches of mathematics, such as Game Theory, Minimizing Problem, Linear Programming, and so on. In this talk, we prove the Fenchel-Moreau theorem by applying the geometric form of Hahn-Banach theorem, which is one of basic principles in Functional Analysis.

## **Euler-Maruyama scheme for SDE**

Yuta Tanaka (Osaka City University, M1)

A stochastic differential equations (SDE) is a differential equations with some noises which determines the stochastic process. If the SDE satisfies both the Lipschitz condition and the linear growth condition, there exists the unique solution. We shall construct approximation sequence in order to analyze the sample path of the solution. The most basic way is the Euler-Maruyama scheme on the numerical simulation of the solution to the SDE. In this talk, I will introduce the error estimate between the solution process and the approximation process. The order of the estimate is less than square root of  $h$  in  $L^1$ , where  $h$  is the length of the time discretization.

## **Global dimensions of quasi hereditary algebras**

Mayu Tsukamoto (Osaka City University, M1)

Following Cline-Parshall-Scott, I would like to introduce the notion of quasi hereditary algebras. It is known that quasi hereditary algebras have finite global dimensions. So I will show this property in an example.

## **Quandles of cyclic type on finite fields**

Koshiro Wada (Hiroshima University, D2)

In knot theory, quandles with finite cardinality play important roles. A quandle with cardinality  $n$  is said to be of cyclic type if all right multiplications are cyclic permutations of order  $n - 1$ . The quandle structure of quandles of cyclic type is manageable. We construct quandle structures of cyclic type on all finite fields of order greater than two. This gives many examples of quandles of cyclic type.

### **Links of the flat plumbing basket number 4 or less**

Hyungjoon Yang (Gyeonggi Science High School)

We first explain how flat plumbing basket surfaces can be presented by two permutations. We also provide how these permutations can be encoded to DT code. At last we provide a few methodologies which can identify knots from DT code including knotfinder of knotscape. We also find a list of links of the flat plumbing basket number 4 or less.

### **Some properties of quasi- $A(n, k)$ class operators**

Hye Yeong Yun (Kyungpook National University, D2)

To study the operator inequalities, the notions of class  $A$  operators and quasi-class  $A$  operators are developed up to recently. In this paper, quasi- $A(n, k)$  class operator for  $n \geq 2$  and  $k \geq 0$  is introduced as a new notion, which generalizes the quasi-class  $A$  operator. We obtain some structural properties of these operators. Also we characterize quasi- $A(n, k)$  classes for  $n$  and  $k$  via backward extension of weighted shift operators. Finally, we give a simple example of quasi- $A(n, k)$  operators with two variables.

### **Toric origami manifolds and quasitoric manifolds**

Haozhi Zeng (Osaka City University, D1)

The definition of toric origami manifolds was introduced by A.Cannas.Silva, V.Guillemin and A.R.Pires, and they have also shown that by moment map, toric origami manifolds can be completely determined by origami templates. From M.Masuda and S.Park's recent results, we know that all the four dimensional quasitoric manifolds have toric origami structure. In this talk, we will discuss the toric origami structures on higher dimensional quasitoric manifolds by examples.