Korea-Japan Workshop on Algebra and Combinatorics[1]

Second Announcement

The 6th Korea-Japan Workshop on Algebra and Combinatorics will take place at Department of Mathematics, Pusan National University, from 9-10 February 2009. The workshop is held twice a year, once in Korea, once in Japan. It is intended to provide researchers of both countries, especially young researchers including graduate students, with opportunities to exchange rather informal information of ongoing studies in the area.

Further information is available from the organizers below.

Organizing Committee:
Eiichi Bannai (Kyushu University)
Jung Rae Cho (Pusan National University)
Mitsugu Hirasaka (Pusan National University)
Tatsuro Ito (Kanazawa University)
Hyun Kwang Kim (POSTECH)
Jack Koolen (POSTECH)
Akihiro Munemasa (Tohoku University)

Place
Room C32-208 at Pusan National University

Accommodation
We strongly encourage participants to stay at Sangnam International House, which is very close to our campus
(see `http://www.sangnam.co.kr/`).
You can reserve your room by yourself on the web.

Satellite Seminar
There will be a satellite seminar for young researchers on 11th of February at Pusan National University. There will be at least 7 talks of 30 minutes.
Confirmed speakers are: Jongyook Park (POSTECH)
Please send the abstract of your talk to `hirasaka@pusan.ac.kr` if you want to give a talk there. The deadline is January 27, 2009.

[1]This meeting is partially supported by BK21, KRF and JSPS

Program

February 9 (Monday)

09:10 – 09:15 Opening

09:15 – 10:00 Suk-Geun Hwang (Kyungpook National University)
Combinatorial and spectral properties of partitioned matrices

10:15 – 11:00 Jeong-Yup Lee (KIAS)
When do substitution point sets have the Meyer property?

11:15 – 12:00 Byeong-Kweon Oh (Sejong University)
New infinite families of 3-designs from algebraic curves over finite fields

14:00 – 14:45 Sho Suda (Tohoku University)
Coherent configurations and triply regular association schemes obtained from spherical designs

15:00 – 15:45 Kenichiro Tanabe (Hokkaido University)
On modules for vertex algebras constructed from quadratic extensions of the polynomial ring in one variable

16:00 – 16:45 Masaaki Harada (Yamagata University, JST–PRESTO)
On the classification of extremal type II $\mathbb{Z}_4$-codes of length 24

17:00 – 17:45 Koichi Betsumiya (Jobu University)
Codes over integer residue rings constructed by bases of Galois rings

18:30 – 20:30 Banquet

February 10 (Tuesday)

09:15 – 10:00 Jong Yoon Hyun (Pohang Mathematics Institute)
The isometry group of an arbitrary poset-metric space

10:15 – 11:00 Chih-wen Weng (National Chiao Tung University)
The flipping puzzle on a simple graph

11:15 – 12:00 Akira Hiraki (Osaka Kyoiku University)
Completely regular subgraphs in distance-regular graphs

14:00 – 14:45 Jang-Soo Kim (KAIST)
A bijection between two variations of noncrossing partitions

15:00 – 15:45 Suyoung Choi (KAIST)
Cohomological rigidity of simple polytopes with few facets

16:00 – 16:45 Kenichi Kawagoe (Kanazawa University)
Homological representation of the Hecke algebras and the Temperley-Lieb algebras

17:00 – 17:45 Eiichi Bannai (Kyushu University)
Toy models for D. H. Lehmer's conjecture (joint work with Tsuyoshi Miezaki)

17:55 – 18:00 closing

Abstracts

Suk-Geun Hwang (Kyungpook National University)

Combinatorial and spectral properties of partitioned matrices

Abstract: Let (P, X, Q, R) denote the partitioned matrix

$$\begin{bmatrix} P & X \\ Y & Q \end{bmatrix}$$

where P and Q are nonvacuous square matrices. This partitioned matrix has some interesting properties when X and Y are of rank 1.

In this talk, we make use of the properties of partitioned matrix to discuss the connection between rook vector and permanent of a matrix. Specifically, we obtain the exact expression of the rook vector of a matrix A in terms of the permanents of some matrix associated with A. We also obtain some simple exact formulas for the permanent of square Toeplitz matrices of zeros and ones with comparatively large bandwiths.

Some spectral properties of the matrix (P, X, Y, Q) where X and Y are of rank 1 are also discussed.

Jeong-Yup Lee (KIAS)

When do substitution point sets have the Meyer property?

Abstract: Meyer sets have appeared a lot in the study of long-range aperiodic order and quasicrystal theory, since they encompass an important level of order. A Meyer set is a discrete point set in $\mathbb{R}^d$ which is relatively dense and whose translational vectors of the points form a uniformly discrete set. In this talk, we consider substitution point sets and find equivalent conditions for the point sets to have the Meyer property. Furthermore we look at the algebraic structure of the substitution point sets and determine equivalent conditions on the expansive linear maps of the substitutions for the Meyer property when the maps are diagonalizable.

Byeong-Kweon Oh (Sejong University)

New infinite families of 3-designs from algebraic curves over finite fields

Abstract: In this talk, we give a simple method for computing the stabilizer subgroup of the set of solutions of certain algebraic curves in projective general linear group over finite fields. Using this we construct new infinite families of 3-designs.

Sho Suda (Tohoku University)

Coherent configurations and triply regular association schemes obtained from spherical designs

Abstract: Delsarte-Goethals-Seidel showed that if X is a spherical t-design with degree s satisfying $t \geq 2s-2$, X carries the structure of an association scheme. Also Bannai-Bannai showed that the same conclusion holds if X is an antipodal spherical t-design with degree s satisfying $t = 2s-3$. As a generalization of these results, we prove that a union of spherical designs with a certain property carries the structure of a coherent configuration. We derive triple regularity of tight spherical $4, 5, 7$-designs, mutually unbiased bases, linked symmetric designs with certain parameters.

Kenichiro Tanabe (Hokkaido University)

On modules for vertex algebras constructed from quadratic extensions of the polynomial ring in one variable

Abstract: A commutative associative algebra A over $\mathbb{C}$ with a derivation is a typical example of a vertex algebra. I will talk about modules for vertex algebra A. Every module for associative algebra A can be regarded as a module for vertex algebra A. However, in general, not all modules for vertex algebra A are modules for associative algebra A. It is not known when modules for vertex algebra A which are not modules for associative algebra A exist. Moreover, we have no non-trivial examples such that modules for vertex algebra A are well investigated, except that A is the polynomial ring in one variable $\mathbb{C}[s]$.

In this talk, I will discuss the case that $A = \mathbb{C}[s,t]/(t^2 - f(s))$ where $f(s) \in \mathbb{C}[s]$ is a square-free polynomial. I will give a necessary and sufficient condition for the existence of modules for vertex algebra A which are not modules for associative algebra A.

Masaaki Harada (Yamagata University, JST–PRESTO)

On the classification of extremal type II $\mathbb{Z}_4$-codes of length 24

Abstract: This talk is based on ongoing joint work with Akihiro Munemasa. Let C be the binary residue code of an extremal Type II $\mathbb{Z}_4$-code of length 24. Then C satisfies the properties that C has dimension at least 6, C is doubly even, C contains the all-one's vector and $C^{\perp}$ has minimum weight at least 4. We completed the classification of binary codes C satisfying these conditions. This was done by taking successively subcodes of codimension 1 starting from binary doubly even self-dual codes of length 24. In this talk, a classification of extremal Type II $\mathbb{Z}_4$-codes of length 24 such that the dimensions of the residue codes are $6, 7$ is presented.

Koichi Betsumiya (Jobu University)

Codes over integer residue rings constructed by bases of Galois rings

Abstract: Previously, we constructed Kerdock codes over Z_4 from trace orthogonal bases of extension fields of the binary field. In this talk, we introduce a generalization of this phenomenon. That is, we construct codes over Z_{2^e} from trace orthogonal bases of Galois Rings.

Jong Yoon Hyun (Pohang Mathematics Institute)

The isometry group of an arbitrary poset-metric space

Abstract: In this talk, I give a complete description of isometries of an arbitrary poset-metric space and present the structure of the isometry group as well as its size. The computation of its size for a special type of poset-metric spaces which were well-studied in the literature is also given.

Chih-wen Weng (National Chiao Tung University)

The flipping puzzle on a simple graph

Abstract: Let $X = (V, E)$ be a finite simple connected graph of order n. Every vertex of X is assigned to either black state or white state. A *move* is to select one vertex $v \in V$ having black state and then change those states of all neighbors of v. This is the *flipping puzzle* on X. A flipping puzzle is also called a *light-only σ-game* in [6, 8]. It implicitly appeared in M. Chuah and C. Hu's papers [4, 5] when they studied the equivalence classes of Vogan diagrams and extended Vogan diagrams, and it was first introduced into Chinese combinatorics people in Gerald Jennhwa Chang's talk "Graph Painting and Lie Algebra" in 2005 International and Third Cross-strait Conference on Graph Theory and Combinatorics.

A configuration of the flipping puzzle of X described above is naturally associated with a column vector u in the n-dimensional vector space F_2^n over F_2, where $u_i = 1$ iff the vertex $i \in V$ is black. Each move is then naturally associated with an $n \times n$ matrix in $\mathrm{GL}_n(F_2)$ that acts on F_2^n by left multiplication. Let $\mathbf{W}$ denote the *flipping group* of X, which by definition is the subgroup of $\mathrm{GL}_n(F_2)$ generated by the matrices associated with the moves on the graph X, and we refer the orbits of F_2^n under $\mathbf{W}$ to the *flipping classes* of X. In this talk, we introduce some recent results on the flipping group of X and flipping classes of X [7, 1, 2, 3]. Some open problems are given. This is a joint work with Hau-wen Huang.

References

[1] Hau-wen Huang and Chih-wen Weng, Combinatorial representations of Coxeter groups over a field of two elements, arXiv:0804.2150, 14 Apr., 2008.

[2] Hau-wen Huang and Chih-wen Weng, The flipping puzzle of a graph, arXiv:0808.2104, 15 Aug., 2008.

[3] Hau-wen Huang and Chih-wen Weng, The flipping group of a line graph, arXiv:0809.4399, 25 Sep., 2008.

[4] Meng-Kiat Chuah and Chu-Chin Hu, Equivalence classes of Vogan diagrams, *Journal of Algebra* 279(2004), 22–37.

[5] Meng-Kiat Chuah and Chu-Chin Hu, Extended Vogan diagrams, *Journal of Algebra* 301(2006), 112–147.

[6] Xinmao Wang and Yaokun Wu, Minimum light number of lit-only σ-game on a tree, *Theoretical Computer Science* 381 (2007) 292–300.

[7] Hsin-Jung Wu and Gerard J. Chang, *A study on equivalence classes of painted graphs*, Master Thesis, NTU, Taiwan, 2006.

[8] Yaokun Wu, Lit-only sigma game on a line graph, *European Journal of Combinatorics*, 30 (2009) 84–95.

Akira Hiraki (Osaka Kyoiku University)

Completely regular subgraphs in distance-regular graphs

Abstract: We study a distance-regular graph Γ of diameter $d = d(\Gamma) \geq 3$ which satisfies the following two conditions:

- For any integer j with $1 \leq j \leq d-1$ and for any pair of vertices at distance j in Γ there exists a strongly closed subgraph of diameter j containing them.
- There exists a strongly closed subgraph Δ which is completely regular in Γ.

We give several examples of such a pair (Γ, Δ) and show several results.

Jang-Soo Kim (KAIST)

A bijection between two variations of noncrossing partitions

Abstract: A (set) *partition* of $[n] = \{1, 2, \ldots, n\}$ is a collection of disjoint subsets, called *blocks*, of $[n]$ whose union is $[n]$. We will write a partition as a sequence of blocks $(B_1, B_2, \ldots, B_k)$ such that $\min(B_1) < \min(B_2) < \cdots < \min(B_k)$.

There are two natural representations of a partition. Let $\pi = (B_1, B_2, \ldots, B_k)$ be a partition of $[n]$. The *partition diagram* of π is the simple graph with vertex set $V = [n]$ and edge set E, where $(i, j) \in E$ if and only if i and j are in the same block which does not have an integer between them.

The *canonical word* of π is the word $a_1a_2 \cdots a_n$, where $a_i = j$ if $i \in B_j$. For instance, the canonical word of the above partition is 123124412. For a word τ, a partition is called τ*-avoiding* if the canonical word of the partition does not contain a subword which is order-isomorphic to τ.

A partition is *noncrossing* if the edges of the partition diagram of the partition do not intersect. It is easy to see that a partition is noncrossing if and only if it is 1212-avoiding. We will focus on two recent variations of noncrossing partitions.

Drake and Kim [1] defined the following. Let π be a partition and let k be a nonnegative integer. A *k-distant crossing* of π is a set of two edges (i_1, j_1) and (i_2, j_2) of the partition diagram of π satisfying $i_1 < i_2 \le j_1 < j_2$ and $j_1 - i_2 \ge k$. A partition π is called *k-distant noncrossing* if π has no k-distant crossings.

By finding a generating function, Drake and Kim [1] showed that the number of 2-distant noncrossing partitions of $[n]$ is equal to the number of Schröder paths of length $2n-2$ with no peaks at even level, which is A007317 in [4]. Using the kernel method, Mansour and Severini [3] proved that this number is equal to the number of 12312-avoiding partitions of $[n]$.

In this talk, we provide a bijection between 2-distant noncrossing partitions and 12312-avoiding partitions, which is a composition of 5 bijections. One of our ingredients is the bijection of Yan [5] from the set of UH-free Schröder paths of length $2n-2$ to the set of 12312-avoiding partitions of $[n]$.

References

[1] Dan Drake and Jang Soo Kim. k-distant crossings and nestings of partitions, arxiv:0812.2725. 2008.

[2] Anisse Kasraoui and Jiang Zeng. Distribution of crossings, nestings and alignments of two edges in matchings and partitions. *Electron. J. Combin.*, 13(1):Research Paper 33, 12 pp. (electronic), 2006.

[3] T. Mansour and S. Severini. Enumeration of $(k, 2)$-noncrossing partitions. *Discrete Math.*, page doi:10.1016/j.disc.2007.08.068, 2007.

[4] N. J. A. Sloane. The on-line encyclopedia of integer sequences. *http://www.research.att.com/∼njas/sequences/*.

[5] Sherry H.F. Yan. Schröder paths and pattern avoiding partitions, arxiv:0805.2465. 2008.

Suyoung Choi (KAIST)

Cohomological rigidity of simple polytopes with few facets

Abstract: A simplicial complex of dimension $n-1$ is called *Cohen-Macaulay* if there is a length n regular sequence in the face ring(or Stanley-Reisner ring) $k(K)$ where k is a field. An $(n-1)$-dimensional Cohen-Macaulay complex K is *cohomologically rigid* if for any $(n-1)$-dimensional Cohen-Macaulay complex K' and for ideals $J \subset k(K)$ and $J' \subset k(K')$ generated by linear regular sequences of length n, $k(K)/J \cong k(K')/J'$ implies $k(K) \cong k(K')$. Let P be a simple polytope of dimension n. Note that a dual of ∂P is a Cohen-Macaulay simplicial complex. Hence, a simple polytope P is called *(cohomologically) rigid* if a dual of its boundary is cohomologically rigid. Not every simple polytope is rigid, but some important polytopes such as simplices or a product of simplices are known to be rigid. In this talk, we discuss about the cohomologically rigidity of simple n-polytopes with $n+3$ facets.

Kenichi Kawagoe (Kanazawa University)

Homological representation of the Hecke algebras and the Temperley-Lieb algebras

Abstract: Associated with a Selberg-type integral, we can define a locally finite twisted homology group. The braid group(or the Hecke algebra) acts on this twisted homology group. In this talk, we show that the representation is the same as the action to the Temperley-Lieb algebras.

Eiichi Bannai (Kyushu University)

Toy models for D. H. Lehmer's conjecture (joint work with Tsuyoshi Miezaki)

Abstract: Let $\Delta_{24}(z) = q^2 \prod_{m \geq 1}(1-q^{2m}) = \sum_{m \geq 1} \tau(m) q^{2m}$ with $q = e^{\pi i z}$ be the modular form of weight 12. Lehmer's conjecture (1947) says that $\tau(m) \neq 0$ for any positive integer m, where the values of the Ramanujan function $\tau(m)$ are the Fourier coefficients of $\Delta_{24}(z)$.

Let L be the E_8-lattice in R^8. It is known by Venkov that all the shells $L_{2m} = \{x \in L \mid ||x||^2 = 2m$ of L are spherical 7-designs. It is known

by Venkov-de la Harpe-Pache that $\tau(m) = 0$ if and only if the shell L_{2m} is a spherical 8-design. So, Lehmer's conjecture is reformulated in terms of spherical designs. It is still too difficult to answer whether there is any shell L_{2m} which is an 8-design (hence to answer Lehmer's conjecture).

Here, we answer some similar type of questions for some lattices in R^2, i.e., for toy models. Namely, we obtained the following two results.
(1) All the shells $(Z^2)_m$ of the Z^2-lattice are spherical 3-designs, but non of them can be a 4-design.
(2) All the shells $(A_2)_{2m}$ of the A_2-lattice are spherical 5-designs, but non of them can be a 6-design.
We want to discuss our (so far unsuccessful) attempt to try to get similar results for some other lattices.
(This is joint work with Tsuyoshi Miezaki of Kyushu University.)