Program (Day 1)

Nov.29 (Fri) – Kawai Hall, Dept. of Math., Tohoku Univ.

9:25	Opening Address from Chair	
9:30	*Spectral mapping theorem and asymptotic behavior of quantum walks on infinite graphs*	Etsuo SEGAWA (Tohoku Univ., JAPAN)
10:10	Tea Break	
10:20	*Seidel matrices with precisely three distinct eigenvalues*	Gary GREAVES (Tohoku Univ., JAPAN)
11:00	Tea Break	
11:10	*On the characteristic of a multiple eigenvalue of an Hermitian matrix whose graph is a tree*	Kenji TOYONAGA (Kitakyushu National College of Tech., JAPAN)
11:50	Lunch	
14:00	*Spectral Properties of the Laplacian matrix of long kite graphs*	Sezer SORGUN (Nevsehir Univ., TURKEY)
14:40	Tea Break	
14:50	*A ratio bound for bipartite graphs*	Norihide TOKUSHIGE (Univ. of Ryukyus, JAPAN)
15:30	Tea Break	
15:40	*Combinatorial objects as finite algebraic varieties*	William J. MARTIN (Worcester Polytechnic Inst., USA)
16:30	Free Discussion	
18:00	Banquet	

Program (Day 2)

Nov.30 (Sat) – Kawai Hall, Dept. of Math., Tohoku Univ.

9:30	*Nonexistence results for complex equiangular tight frames*	Ferenc SZÖLLŐSI (Tohoku Univ., JAPAN)
10:10	Tea Break	
10:20	*On 2-walk-regular graphs*	Jongyook PARK (USTC, CHINA)
11:00	Tea Break	
11:10	*Nonlinear spectral gaps and some of their estimates*	Tetsu TOYODA (Suzuka National College of Tech., JAPAN)
11:50	Lunch	
14:00	*The relation between the eigenvalues of graph matrices with graph parameters*	Kinkar Ch. DAS (Sungkyunkwan Univ., KOREA)
14:40	Tea Break	
14:50	*Multi-way isoperimetries and imprimitive actions on graphs*	Masato MIMURA (Tohoku Univ., JAPAN)
15:30	Closing from Vice-Chair	

Spectral mapping theorem and asymptotic behavior of quantum walks on infinite graphs

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In my talk, we consider the quantum walks, called the Szegedy walk, on infinite graph G. For given a connected finite graph $G^{(o)} = (V^{(o)}, D^{(o)})$, we assign one-form $\theta : D^{(o)} \to \mathbb{R}$. We introduce a twisted Szegedy walk on the graph $G^{(o)}$ with one-form θ whose total state space is $\ell^2(D)$. At first we show a spectral mapping theorem from a twisted walk on $\ell^2(V^{(o)})$. Secondly as an application of this theorem, we show that as far as the fundamental graph of infinite graph G has two cycles, then the appropriate initial state provides localization of the Szegedy walk on G. Finally, as an example, in the Grover walk on $\mathbb{Z}^d$ case, we partially obtain an abstractive shape of the density function for the weak limit theorem which implies linear spreading and localization simultaneously.

Seidel matrices with precisely three distinct eigenvalues

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The study of the spectra of Seidel matrices is intimately connected with the study of equiangular line systems. Seidel matrices having precisely two distinct eigenvalues are of great interest and have received a great deal of attention. In this talk I will present some recent results about Seidel matrices and focus on Seidel matrices that have precisely three distinct eigenvalues.

On the characteristic of a multiple eigenvalue of an Hermitian matrix whose graph is a tree

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We consider the multiplicity of an eigenvalue for an Hermitian matrix whose graph is a tree and contains Parter vertices for an eigenvalue. we investigate the characteristics of a tree with a multiple eigenvalue, and multiplicity of an eigenvalue of an Hermitian matrix associated with the insertion and removal of some edges incident to a Parter vertex in a tree. Furthermore we show a relation between the cardinality of a Parter set and the number of branches at Parter vertices, which have the eigenvalue. Finally we show a result that there exists a graph with any cardinality k $(1 \leq k \leq n-1)$ of a Parter set for given multiplicity n. For an applied example, we show an example as numerical enclosure method for multiple eigenvalues of an Hermitian matrix whose graph is a tree.

Spectral Properties of the Laplacian Matrix of Long Kite Graphs

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Keywords: Laplacian Matrix, Cospectral graphs, Determined by spectrum

The long Kite graph, denoted by $Ki_{n,n-p}$, is obtained by appending a complete graph K_p to a pendant vertex of the path graph P_{n-p}. In this talk, we present some spectral properties of Laplacian matrix of long Kite graphs. Also we examine if the long Kite graphs are determined by their Laplacian spectrum.

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A ratio bound for bipartite graphs

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The independence number of a graph can be bounded by using spectra of the graph, which is called the Hoffman's ratio bound. Wilson used the ratio bound to prove the famous Erdos-Ko-Rado theorem for intersecting families. In this talk, I will present a bipartite version of the ratio bound which is an extension of the original one, and I use the new bound to show some Erdos-Ko-Rado type inequalities for cross intersecting families.

Combinatorial objects as finite algebraic varieties

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Let $X \subset \mathbb{R}R^m$ be a finite set of vectors representing a combinatorial object. Examples include spherical codes, the rows of the incidence matrix of a design, graph or partially ordered set, the rows of the adjacency matrix of a graph, the codewords in a binary code, or the shortest vectors in a lattice. In this talk, we consider the ideal of all polynomials in m variables which vanish on X. We wish to identify properties of this ideal that reflect combinatorial structure. In many cases, we find the following two parameters of interest:
(i) the smallest degree of a non-trivial polynomial in the ideal, and
(ii) the smallest k for which the ideal admits a generating set of polynomials all of degree k or less.

For example, when X is the set of shortest vectors of the E_6, E_7, E_8 or Leech lattice, these two parameters coincide. As time permits, we will also mention a connection to homotopy. The investigation is just beginning and many open questions remain.

Part of this talk is based on joint work with my student Corre Steele and another part is taken from joint work with Doug Stinson.

Nonexistence results for complex equiangular tight frames

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A finite complex equiangular tight frame (ETF) is a collection of n complex unit vectors $\varphi_1, \varphi_2, \ldots, \varphi_n$ in $\mathbb{C}^m$ having mutual inner product (or "angle" between distinct vectors φ_i and φ_j) as small as possible in absolute value. In particular, for complex ETFs the Welch bound is attained and one has

$$|\langle \varphi_i, \varphi_j \rangle| = \sqrt{\frac{n-m}{m(n-1)}} \qquad \text{for } 1 \leq i < j \leq n.$$

We study the Gram matrices of complex equiangular tight frames and describe some new algebraic features of theirs which subsequently lead on the one hand to the nonexistence of several low dimensional complex ETFs; and on the other hand to the full algebraic classification of all complex ETFs in $\mathbb{C}^3$. We use computer aided methods, in particular, Gröbner basis calculations to conclude our results.

On 2-walk-regular graphs

Jongyook Park
(Joint work with M. Camara, E van Dam and J. H. Koolen.)

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A t-walk-regular graph is a graph for which the number of walks of given length between two vertices depends only on the distance between these two vertices, as long as this distance is at most t. Such graphs generalize distance-regular graphs and t-arc-transitive graphs. In this talk, we study analogues of certain results that are important for distance-regular graphs.

Nonlinear spectral gaps and some of their estimates

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The nonlinear spectral gaps are nonlinear analogues of the linear spectral gap of a finite connected graph. Recently, estimation of such invariants is required in various contexts in geometric group theory and metric geometry.

In this talk, we first introduce the nonlinear spectral gaps and briefly outline what kinds of their estimates are required. Then, we present some of the recent estimates obtained in a joint work with Takefumi Kondo (Tohoku University).

The relation between the eigenvalues of graph matrices with graph parameters

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Keywords: Graph, Adjacency eigenvalues, Laplacian eigenvalues, Signless laplacian eigenvalues, diameter, girth, maximum degree, minimum degree

Let $G = (V, E)$ be a simple graph. Denote by $D(G)$ the diagonal matrix of its vertex degrees and by $A(G)$ its adjacency matrix. Then the Laplacian matrix of G is $L(G) = D(G) - A(G)$ and the signless Laplacian matrix of G is $Q(G) = D(G)+A(G)$. In this talk we present some relation between eigenvalues of graph matrices with graph parameters such as girth (g), diameter (d), connectivity (vertex and edge), maximum degree (Δ), minimum degree (δ) etc. We show some relation between eigenvalues of different graph matrices. Moreover, we obtain an upper bound on the spectral radius of weighted graphs, where the edge weights are positive definite matrices. Finally, we give some open problems.

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Multi-way isoperimetries and imprimitive actions on graphs

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For n at least 2, the n-way isoperimetirc constant $h_n(G)$ for a finite regular graph G is defined as the minimum of the maximum of the ratio $\frac{|\partial A_j|}{|A_j|}$ over $1 \leq j \leq n$, here $\{A_j\}_{1\leq j\leq n}$ runs over all of the decompositions of the vertex set into n nonempty partitions, and ∂A_j denotes the edge boundary. The h_n is non-decreasing on n, but in general it is unable to bound h_{n+1} from h_n above. Koji Fujiwara has asked whether there exists a non-trivial estimate in that direction for finite connected Cayley graphs. We shall answer this question in the affirmative, and furthermore show that a certain explicit gap between h_{n+1} and h_n implies the imprimitivity of group actions for vertex-transitive graphs.