# The Third Workshop on
# Spectral Graph Theory and Related Topics[1]

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| **Date** | : | March 13 (Fri)–15 (Sun), 2015 |
| **Venue** | : | Hiroshima Institute of Technology, Hiroshima Campus |
| | | Room 201 (Mar. 13, 14), Room 301 (Mar. 15) |
| | | `http://www.it-hiroshima.ac.jp/institution/hiroshima/` |

## Program

**Friday, March 13 (Room 201)**

**14:00–14:05**   Opening address
Tetsuji Taniguchi (Hiroshima Institute of Technology)

**14:05–14:45**   Etsuo Segawa (Tohoku University)
Quantum walk and graph Laplacian

**14:55–15:35**   Michio Seto (Shimane University)
Composition Operators Induced by Injective Homomorphisms on Infinite
Weighted Graphs

**15:45–16:15**   Keiji Ito (Aichi University of Education)
The skew energy of tournaments

**Saturday, March 14 (Room 201)**

**10:00–10:40**  Norihide Tokushige (University of the Ryukyus)
A semidefinite programming approach to a cross-intersection problem with measures

**10:50–12:20**  [**Special talk**]  Masato Mimura (Tohoku University)
An invitation to expander graphs

(Lunch)

**14:20–15:00**  Iwao Sato   National Institute of Technology, Oyama College
An invitation to expander graphs

**15:10–15:50**  Yusuke Ide (Kanagawa University)
Behaviors of quantum walks related to a type of partition of graphs

**16:00–16:40**  Hirotake Kurihara (National Institute of Technology, Kitakyushu College)
On the Euclidean distortions of distance-regular graphs of diameter three

**Sunday, March 15 (Room 301)**

**10:00–10:40**  Hiroshi Nozaki (Aichi University of Education)
Regular graphs with large spectral gap

**10:50–11:30**  Gary Greaves (Tohoku University)
Graphs with three eigenvalues and bounded second largest eigenvalue

**11:40–12:00**  Takuya Owa (National Institute of Informatics)
Simulated Annealing for Ising Model and Related Topics

**12:00–12:20**  Yoshio Sano (University of Tsukuba)
On graphs with smallest eigenvalue bounded from below

**12:20–12:25**  Closing address
Etsuo Segawa (Tohoku University)

# Abstract

Etsuo Segawa (Tohoku University)

**Title :** Quantum walk and graph Laplacian

**Abstract :** We connect a quantum walk to a graph Laplacian by adding the reversible measure to the original standard inner product. In my talk, I show that

(1) We see a discrete analogue of a wave equation under the quantum walk.

(2) The underlying graph Laplacian can be reproduced by the induced quantum walk.

(3) The localization of the quantum walk comes from two graph geometries; cycle and hyperbolicity, and eigenvalues of the underlying graph Laplacian.


Michio Seto (Shimane University)

**Title :** Composition Operators Induced by Injective Homomorphisms on Infinite Weighted Graphs

**Abstract :** Orthonormal bases and orthogonal projections are useful tools in linear algebra. However, it seems that they do not work well on Hilbert spaces constructed from graphs. In this talk, as an alternative plan suggested from functional analysis, reproducing kernels and de Branges-Rovnyak spaces are introduced to the study of injective graph homomorphisms, and we will explore its consequences.


Keiji Ito (Aichi University of Education)

**Title :** The skew energy of tournaments

**Abstract :** The skew energy of a digraph was defined by C. Adiga, R. Balakrishman and W. So. Adiga et al. also gave bounds for the skew energy of digraphs. In this talk I will present an improvement on the upper and lower bounds for the skew energy of tournaments.


Norihide Tokushige (University of the Ryukyus)

**Title :** A semidefinite programming approach to a cross-intersection problem with measures

**Abstract :** We present a semidefinite programming approach to bound the measures of cross-independent pairs in a bipartite graph. This can be viewed as a far-reaching extension of Hoffman's ratio bound on the independence number of a graph. As an application, we solve a problem on the maximum measures of cross-intersecting families of subsets with two different product measures, which is a generalized measure version of the Erdos-Ko-Rado theorem for cross-intersecting families with different uniformities. (This is joint work with Sho Suda and Hajime Tanaka.)

Masato Mimura (Tohoku University)

**Title :** An invitation to expander graphs

**Abstract :** "Expander graphs" are (a sequence of) graphs (with a fixed degree) with a uniform bound on their isoperimetric constants. In other words, those with a uniform bound from below on gaps between the first and the second largest eigenvalues of their adjacency matrices. This concept originates in computer science, and recently it has been of great importance in broad fields of mathematics. In this talk, we give an introduction to expander graphs, in relation to "distortions" in metric embeddings.

Iwao Sato   National Institute of Technology, Oyama College

**Title :** Quantum graph walk

**Abstract :** Under the similarity of the scattering matrix of a quantum graph and the time-evolution matrix of the discrete-time quantum walk on a graph, we consider a discrete-time quantum walk on a graph having the the scattering matrix of a quantum graph as the time-evolution matrix. We define the quantum graph walk, and treat the relation btween a quantum graph and a discrete-time quantum walk. Furthermore, we generalize the scattering matrix of a quantum graph.

Yusuke Ide (Kanagawa University)

**Title :** Behaviors of quantum walks related to a type of partition of graphs

**Abstract :** In this talk, we show a decomposition method for the Laplacian matrices which we call fully interconnected graph decomposition of given graphs[1]. By using this method, we show some relationships between graph structures and behaviors of quantum walks.

[1] Y. Ide, Local subgraph structure can cause localization in continuous-time quantum walk, Accepted for publication in Yokohama Mathematical Journal, arXiv:1406.0347.

Hirotake Kurihara (National Institute of Technology, Kitakyushu College)

**Title :** On the Euclidean distortions of distance-regular graphs of diameter three

**Abstract :** For a finite graph, the Euclidean distortion of the graph gives a similarity criterion between the graph and a Euclidean space as metric spaces. It is not easy to determine the Euclidean distortions of a given graph. In this talk, we give the exact value of the Euclidean distortions of distance-regular graphs of diameter three. In the calculation of the Euclidean distortions of distance-regular graphs of diameter three, an interesting inequality related to the intersection arrays and the eigenvalues of the graphs appears.

Hiroshi Nozaki (Aichi University of Education)

**Title :** Regular graphs with large spectral gap

**Abstract :** The spectral gap of a regular graph is the difference of the largest and second-largest eigenvalues. It is known that a graph with large spectral gap has high connectivity in some sense. We would like to find graphs with largest spectral gap for given degree and the number of nodes, or largest graphs for given degree and second-largest eigenvalue. In this talk, we introduce several new results about the two problems. This is partially a joint with Cioaba, Koolen, and Vermette.

Gary Greaves (Tohoku University)

**Title :** Graphs with three eigenvalues and bounded second largest eigenvalue

**Abstract :** I will present some recent results about graphs with three eigenvalues including a classification of such graphs whose second largest eigenvalue is at most 1.

Takuya Owa (National Institute of Informatics)

**Title :** Simulated Annealing for Ising Model and Related Topics

**Abstract :** It is known that some optimization problems (e.g. Max-cut Problem) can be converted to Ising models and we need an algorithm to find a solution of the Ising model. Simulated Annealing is a probabilistic method for finding a global minimum of a cost function and effective practical algorithm. In this talk I will introduce and discuss some mathematical problems of simulated annealing for Ising model.

Yoshio Sano (University of Tsukuba)

**Title :** On graphs with smallest eigenvalue bounded from below

**Abstract :** In this talk, we consider graphs with smallest eigenvalue bounded from below. I will explain the method to characterize the structure of such graphs by using "Hoffman graphs" and "generalizations of line graphs". This talk is based on joint work with Prof. Akihiro Munemasa (Tohoku University) and Prof. Tetsuji Taniguchi (Hiroshima Institute of Technology).