

The 32nd KIAS Combinatorics Workshop

**Shilla Stay Haeundae
Busan, Korea
December 19–21, 2024**

Contents

1	General Information	3
2	Schedule and Abstracts	4
3	List of Participants	15

1 General Information

Title The 32nd KIAS Combinatorics Workshop

Date December 19–21, 2024

Venue Shilla Stay Haeundae, Busan

Homepage <http://events.kias.re.kr/h/combinatorics/>

Invited Speakers

Gi-Sang Cheon (Sungkyunkwan University)

Eric Dolores-Cuenca (Pusan National University)

Colin Geniet (IBS-DIMAG)

Maximilian Gorsky (IBS-DIMAG)

Soon-Yi Kang (Kangwon National University)

Byungchan Kim (Seoul National University of Science and Technology)

Hyemin Kwon (KIAS)

Hayan Nam (Duksung Women's University)

Boram Park (Ajou University)

Bjarne Schülke (IBS-ECOPRO)

Organizers

Jaehoon Kim (KAIST)

Jang Soo Kim (Sungkyunkwan University)

Jeong Han Kim (KIAS)

Seog-Jin Kim (Konkuk University)

Young Soo Kwon (Yeungnam University)

Sang June Lee (Kyung Hee University)

Jongyook Park (Kyungpook National University)

Seunghyun Seo (Kangwon National University)

2 Schedule and Abstracts

1st Day: December 19 (Thursday)

14:30 - 15:00 Registration and Opening

————— **Session A** ————— Chair: Seunghyun Seo

15:00 - 15:40 **Byungchan Kim.** *Reciprocal sums of parts of integer partitions*

————— **Session B** ————— Chair: Sang June Lee

15:50 - 16:30 **Hyemin Kwon.** *Odd coloring on planar graphs with bounded maximum degree*

16:30 - 16:50 Coffee break

16:50 - 17:30 **Maximilian Gorsky.** *Polynomial bounds for the graph minor structure theorem*

18:00 - Dinner

2nd Day: December 20 (Friday)

————— **Session C** ————— Chair: Jongyook Park

09:00 - 09:40 **Boram Park (talk for retirement of Suh-Ryung Kim).** *Competition graphs and beyond: honoring the contributions of Prof. Suh-Ryung Kim in graph theory*

09:50 - 10:30 **Hayan Nam.** *The largest size of certain core partitions*

10:30 - 10:50 Coffee break / Group Photo

————— **Session D** ————— Chair: Seog-Jin Kim

10:50 - 11:30 **Colin Geniet.** *A few problems on groups and some classical graph parameters*

11:40 - 12:40 **Gi-Sang Cheon (retirement farewell talk).** *The interaction between combinatorics and matrix theory*

12:40 - 14:00 Lunch

14:00 - 17:30 Free discussion

18:00 - Banquet

3rd Day: December 21 (Saturday)

————— **Session E** ————— Chair: Seunghyun Seo

09:20 - 10:00 **Soon-Yi Kang.** *From Euler to today: a journey through d -distinct partitions*

10:00 - 10:30 Coffee break

————— **Session F** ————— Chair: Young Soo Kwon

10:30 - 11:10 **Eric Dolores-Cuenca.** *One third of poset combinatorics was missing*

11:20 - 12:00 **Bjarne Schülke.** *The structure of hypergraph Turán densities*

12:00 - 13:00 Closing and Lunch

Speaker: Byungchan Kim

Affiliation: Seoul National University of Science and Technology

Title: Reciprocal sums of parts of integer partitions

Abstract

Integer partitions have been extensively studied with various constraints on the parts. However, conditions on the reciprocal sum of the parts, denoted by $\text{srp}(\lambda)$ for the partition λ , remain relatively unexplored. R. Graham proved that there is a partition λ of n into distinct part with $\text{srp}(\lambda) = 1$ if $n \geq 78$, but little is known beyond this. In this talk, we introduce recent results on how $\text{srp}(\lambda)$ is distributed and discuss related problems. This talk will be based on a joint work with Eunmi Kim and a joint work with Kathrin Bringmann and Eunmi Kim.

Speaker: Hyemin Kwon

Affiliation: KIAS

Title: Odd coloring on planar graphs with bounded maximum degree

Abstract

Recently, odd coloring has been introduced, which is a relaxation of square coloring, and it has attracted the interest of many researchers. An odd coloring of a graph G is a proper coloring of G such that for each non-isolated vertex v , there is a color appearing an odd number of times in $N_G(v)$. The minimum k for which G has an odd coloring with k colors is the odd chromatic number of G , denoted by $\chi_o(G)$. For a planar graph G , Petruševski and Škrekovski showed that $\chi_o(G) \leq 9$ and then conjectured that five colors are enough for odd coloring. We study an odd coloring on planar graphs with bounded maximum degree.

Speaker: Maximilian Gorsky

Affiliation: IBS-DIMAG

Title: Polynomial bounds for the graph minor structure theorem

Abstract

The Graph Minor Structure Theorem, originally proven by Robertson and Seymour [JCTB, 2003], asserts that there exist functions $f_1, f_2: \mathbb{N} \rightarrow \mathbb{N}$ such that for every non-planar graph H with $t := |V(H)|$, every H -minor-free graph can be obtained via the clique-sum operation from graphs which embed into surfaces where H does not embed after deleting at most $f_1(t)$ many vertices and up to at most $t^2 - 1$ many “vortices” which are of “depth” at most $f_2(t)$. In the proof presented by Robertson and Seymour the functions f_1 and f_2 are non-constructive. Kawarabayashi, Thomas, and Wollan [arXiv, 2020] found a new proof showing that $f_1(t), f_2(t) \in 2^{\text{poly}(t)}$. While believing that this bound was the best their methods could achieve, Kawarabayashi, Thomas, and Wollan conjectured that f_1 and f_2 can be improved to be polynomials. We discuss our recent proof of this conjecture, ways of understanding the core theorem, and what this improvement might mean for applications. (This is joint work with Michał Seweryn and Sebastian Wiederrecht.)

Speaker: Boram Park (talk for retirement of Suh-Ryung Kim)

Affiliation: Ajou University

Title: Competition graphs and beyond: honoring the contributions of Prof. Suh-Ryung Kim in graph theory

Abstract

In this talk, we celebrate Professor Suh-Ryung Kim's impact on graph theory, focusing on her pioneering work in competition graphs. Her research has deepened our understanding of competition graphs, which model competitive relationships in ecological systems and have applications in fields like biology, computer science, and social networks. Beyond this, Professor Kim has contributed to a wide array of topics in graph theory. This presentation will highlight her key theoretical breakthroughs and lasting influence on graph theory, underscoring the importance of foundational research and its wide-ranging impact.

Speaker: Hayan Nam

Affiliation: Duksung Women's University

Title: The largest size of certain core partitions

Abstract

A partition of a positive integer n is a sequence $\lambda = (\lambda_1, \lambda_2, \dots, \lambda_\ell)$ such that $n = \lambda_1 + \lambda_2 + \dots + \lambda_\ell$ and $\lambda_1 \geq \lambda_2 \geq \dots \geq \lambda_\ell \geq 1$. For a positive integer t , a partition λ is called a t -core partition if none of the hook lengths in λ is a multiple of t . In this talk, we will discuss the largest size of $(t, t + d, t + 2d)$ -core partitions and the largest size of $(s, s + 2)$ -core partitions whose parts are of the same parity.

Speaker: Colin Geniet

Affiliation: IBS-DIMAG

Title: A few problems on groups and some classical graph parameters

Abstract

Cayley graphs are the classical way to construct graphs from groups. We consider some well-known graph notions applied to Cayley graphs. For instance, groups whose Cayley graphs have small tree-width are characterised by a simple property: being virtually free.

We are specifically interested in queue number and twin-width. Both parameters are unbounded on almost all 3-regular graphs, although no explicit construction is known. We lift this result to groups by combining it with counting arguments and an embedding theorem of Osajda.

Twin-width and queue number of groups can be redefined with permutations, without referring graphs. This helps to show that they are bounded for many well-known classes of groups. It also suggests natural strengthenings, called uniform queue number and uniform twin-width. We ask whether any of these parameter are equal, and present some first results.

This is based on work with Édouard Bonnet, Ugo Giocanti, Romain Tessera, and Stéphan Thomassé.

Speaker: Gi-Sang Cheon (retirement farewell talk)

Affiliation: Sungkyunkwan University

Title: The interaction between combinatorics and matrix theory

Abstract

Matrices are often used to represent combinatorial objects by studying matrix invariants (e.g., determinants, permanents, ranks, eigenvalues), and their properties are studied to derive combinatorial results. These matrices provide powerful algebraic tools for solving combinatorial problems, while combinatorial structures provide insight into the properties of matrices. This interaction between combinatorics and matrix theory occurs in areas such as graph theory, combinatorial design, enumeration, optimization, and algebraic structures. Through this synergy, many combinatorial problems can often be transformed into problems involving matrices, and matrix theory provides new ways to understand and solve them. This symbiotic relationship is the underlying theme of combinatorial matrix theory. This talk is an overview of how the two fields influence and reinforce each other.

Speaker: Soon-Yi Kang

Affiliation: Kangwon National University

Title: From Euler to today: a journey through d -distinct partitions

Abstract

Partitions of n into parts at least d apart is one of the oldest subjects in partition theory. Euler, Rogers–Ramanujan, and Schur established partition identities for d -distinct partitions when $d = 1, 2, 3$, respectively. These identities were extended to a partition inequality for d -distinct partition for $d > 2$ by Alder, Andrews, Yee and more. In recent years, numerous researchers have developed analogous and generalized versions of Alder-type partition inequalities. In this talk, we try to provide a comprehensive survey of the findings pertaining to d -distinct partitions.

Speaker: Eric Dolores-Cuenca

Affiliation: Pusan National University

Title: One third of poset combinatorics was missing

Abstract

The work of Loeb introduces six binomial coefficients, three of them with integer values. Several results in poset combinatorics define polynomials, which can be written in a basis formed by binomials or multisets. We argue that the reciprocity of Stanley and the reciprocity of Earhart–Macdonald describe an equivalence between combinatorics involving two different notions of binomials with integer values. We interpret the third binomial with integer values in terms of order polynomials, Ehrhart theory, and shuffles. We conjecture that if the definition of an object depends on order and its combinatorics depends on the binomial coefficients, then there are three variants of the object, one for each interpretation of the binomial coefficient.

Speaker: Bjarne Schülke

Affiliation: IBS-ECOPRO

Title: The structure of hypergraph Turán densities

Abstract

Since suggested by Turán in 1941, determining the Turán density of hypergraphs has been a notoriously difficult problem at the center of extremal combinatorics. Roughly speaking, the Turán density $\pi(F)$ of a hypergraph F is the threshold of the edge density above which large hypergraphs are guaranteed to contain a copy of F . Over the past decade, some progress was made in understanding the set of all Turán densities, i.e.,

$$\Pi^{(k)} = \{\pi(F) : F \text{ is a } k\text{-uniform hypergraph}\},$$

as well as its variants. In this talk we discuss recent results and methods that are part of this development.

Based on joint works with Conlon, Piga, King and Sales, and Liu, Wang, Yang, and Zhang.

3 List of Participants

Number	Last Name	First Name	한글 이름	Affiliation
1	Ahn	Jungho	안정호	KIAS
2	Chae	Jihyo	채지효	Yonsei University
3	Chang	Yeonsu	장연수	Hanyang University
4	Cheon	Gi-Sang	천기상	Sungkyunkwan University
5	Cho	Hyunsoo	조현수	Ewha Womans University
6	Cho	Inho	조인호	Inha University
7	Cho	Eun-Kyung	조은경	Hanyang University
8	Cho	Minho	조민호	IBS ECOPRO
9	Choi	Wansoo	최완수	Seoul National University
10	Choi	Mujin	최무진	KAIST & IBS DIMAG
11	Choi	Myungho	최명호	Seoul Science High School
12	Chu	Hojin	추호진	Seoul National University
13	Clemen	Felix Christian		IBS ECOPRO
14	Dolores-	Eric		Pusan National University
15	Eom	Taehyun	엄태현	Chonnam National University
16	Geniet	Colin		IBS DIMAG
17	Gorsky	Maximilian		IBS-DIMAG
18	Heo	Cheolwon	허철원	KIAS
19	Hong	Taehee	홍태희	Seoul National University
20	Hwang	Jinik	황진익	Inha University
21	Im	Bokhee	임복희	Chonnam National University
22	Jeong	Sangtae	정상태	Inha University
23	Jin	Youngjune	진영준	Seoul National University
24	Kang	Bumtle	강범틀	Korea Science Academy of KAIST
25	Kang	Dongyeap	강동엽	IBS ECOPRO

Number	Last Name	First Name	한글 이름	Affiliation
26	Kang	Soon-Yi	강순이	Kangwon National University
27	Kim	JeongHan	김정한	KIAS
28	Kim	Jinha	김진하	Chonnam National University
29	Kim	Minki	김민기	GIST
30	Kim	Boran	김보란	Kyungpook National University
31	Kim	ringi	김린기	Inha University
32	Kim	Donggyu	김동규	KAIST & IBS DIMAG
33	Kim	Sangwook	김상욱	Chonnam National University
34	Kim	Seokbeom	김석범	KAIST & IBS DIMAG
35	Kim	Byungchan	김병찬	SeoulTech
36	Kim	Seog-Jin	김석진	Konkuk University
37	Kim	Hyobin	김효빈	Kyungpook National University
38	Koh	Doowon	고두원	Chungbuk National University
39	Kwon	Young Soo	권영수	Yeungnam University
40	Kwon	Yongjae	권용재	Inha University
41	Kwon	Gukwon	권국원	Sungkyunkwan University
42	Kwon	Hyemin	권혜민	KIAS
43	Lee	Kyeongjun	이경준	Yonsei University
44	Lee	Hojoon	이호준	Sungkyunkwan University
45	Lee	Jae-Ho	이재호	University of North Florida/POSTECH
46	Lee	Myounghwan	이명환	Hanyang University
47	Lee	Tae Young	이태영	Binghamton University
48	Lee	Dohyeon	이도현	KAIST / IBS DIMAG
49	Lee	Hyunwoo	이현우	KAIST / IBS ECOPRO
50	Lee	Sang June	이상준	Kyung Hee University

Number	Last Name	First Name	한글 이름	Affiliation
51	Manaloto	Korina Ernjulie		Kyungpook National University
52	Moon	Sunyo	문선요	KIAS
53	Nam	Hayan	남히얀	Duksung Women's University
54	Oum	Sang-il	엄상일	IBS DIMAG
55	Park	Hyemi	박혜미	Hanyang University
56	Park	Boram	박보람	Ajou University
57	Park	Jeong Rye	박정례	Kyungpook National University
58	Park	Jongyook	박종육	Kyungpook National University
59	Park	Boram	박보람	Ajou University
60	Park	Jihye	박지혜	Yeungnam University
61	Ryu	Homoon	류호문	Seoul National University
62	Sato	Chelsea	첼시	Syracuse University
63	Schülke	Bjarne		IBS-ECOPRO
64	Seo	Jaehyeon	서재현	Yonsei University
65	Seo	Seunghyun	서승현	Kangwon National University
66	Shin	Heesung	신희성	Inha University
67	Siggers	Mark	마크 시거스	KNU
68	Song	Minho	송민호	Sungkyunkwan University
69	Song	Seok-zun	송석준	Jeju National University
70	Xi	Changqing		Hanyang University
71	Yoo	Semin	유세민	IBS DIMAG