3rd International Workshop on

SYMMETRIES OF GRAPHS AND NETWORKS

and PhD Summer School in

DISCRETE MATHEMATICS

Rogla, Slovenia, June 24 - June 30, 2012

INVITED SPEAKERS

J. H. Kwak, Pohang University of Science and Technology, South Korea
Y. S. Kwon, Yeungnam University, South Korea
J. Morris, University of Lethbridge, Canada
R. Nedela, Matej Bel University, Slovakia
T. Szőnyi, Eötvös Loránd University, Hungary
N. Seifter, University of Leoben, Austria
J. Širáň, Slovak University of Technology, Slovakia
P. Terwilliger, University of Wisconsin-Madison, USA
S. Wilson, Northern Arizona University, USA

MINICOURSES

The Polycirculant Conjecture
M. Giudici, University of Western Australia, Australia
Finite Geometries
G. Kiss, Eötvös Loránd University, Hungary
Graph Enumeration
S. Wagner, Stellenbosch University, South Africa

ORGANIZED BY

University of Primorska, Institute Andrej Marušič
University of Primorska, Faculty of Mathematics, Natural Sciences and Information Technologies

IN COLLABORATION WITH

University of Ljubljana, Faculty of Education, Centre for Discrete Mathematics

SPONSORED BY

Slovenian National Research Agency (ARRS)

SCIENTIFIC COMMITTEE

E. Dobson, A. Malnič, D. Marušič, Š. Miklavič

ORGANIZING COMMITTEE

K. Kutnar, B. Kuzman, P. Šparl

http://www.famnit.upr.si/si/konference/DM2012

SYGN@UPR.SI

3rd International Workshop on Symmetries of Graphs and Networks and PhD Summer School in Discrete Mathematics

Rogla, Slovenia, June 24 – June 30, 2012

UP FAMNIT & UP IAM

June 2012

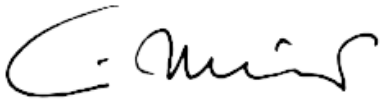
WELCOME

Dear Colleagues.

Some of us have gathered here for the fourth consecutive year. What was started as an informal research collaboration has now grown into a colorful series of international workshops and summer schools. We are glad to see many participants returning and several new ones joining the creative atmosphere of this event, which we will try to keep as relaxed and uplifting as in previous years. The organization of the meeting comes as a combined effort of the Andrej Marušič Institute (UP IAM) and the Faculty of Mathematics, Natural Sciences and Information Technologies (UP FAMNIT), two members of the University of Primorska, and is in line with our goal to create an international research center in algebraic combinatorics in this part of the world.

We wish you a pleasant and mathematically fruitful week at Rogla.

Dragan Marušič, Rector of the University of Primorska



Aleksander Malnič, Acting Director of UP IAM

Klavdija Kutnar, Dean of UP FAMNIT

General Information

3rd Workshop on Symmetries of Graphs and Networks and PhD Summer School in Discrete Mathematics

Hotel Planja, Rogla, Slovenia, June 24 – June 30, 2012.

Organized by UP FAMNIT *(University of Primorska, Faculty of Mathematics, Natural Sciences and Inf. Technologies)* and UP IAM *(University of Primorska, Andrej Marušič Institute)*. In Collaboration with Centre for Discrete Mathematics, UL PeF *(University of Ljubljana, Faculty of Education)*.

SYGN Workshop Invited Speakers:
Jin Ho Kwak, *Pohang University of Science and Technology, South Korea*
Young Soo Kwon, *Yeungnam University, South Korea*
Joy Morris, *University of Lethbridge, Canada*
Roman Nedela, *Matej Bel University, Slovakia*
Tamás Szőnyi, *Eötvös Loránd University, Hungary*
Norbert Seifter, *University of Leoben, Austria*
Jozef Širáň, *Open University, UK, and Slovak University of Technology, Slovakia*
Paul Terwilliger, *University of Wisconsin-Madison, USA*
Steve Wilson, *Northern Arizona University, USA*

PhD Summer School in Discrete Mathematics Minicourses:
The Polycirculant conjecture
Michael Giudici, *University of Western Australia, Australia*
Finite Geometries
György Kiss, *Eötvös Loránd University, Hungary*
Graph Enumeration
Stephan Wagner, *Stellenbosch University, South Africa*

Scientific Committee:
Edward Dobson, Aleksander Malnič, Dragan Marušič, Štefko Miklavič.

Organizing Committee:
Klavdija Kutnar, Boštjan Kuzman, Primož Šparl.

Sponsored by:
ARRS *(Slovenian Research Agency)*.

Website: www.famnit.upr.si/si/konference/dm2012
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TIMETABLE

Sunday, June 24

16.00 - 18.30 *Registration*
21.00 - 22.00 *Welcome Reception*

Monday, June 25

09:30 - 09:35 *Opening remarks*
09:35 - 10:05 J. H. Kwak: *Two group actions on the fibre*
10:10 - 10:40 Y. S. Kwon: *Regular embeddings of quotient graphs...*
10.40 - 11:10 - - - - - Coffee - - - - -
11:10 - 11:40 J. Morris: *Structure of circulant (di)graphs*
11:45 - 12:15 R. Nedela: *Maps, objects relating different fields of mathematics*
12.15 - 14.00 - - - - - Lunch - - - - -
14:00 - 15:15 *Student Talks* (1 – 4)
15:15 - 15:40 - - - - - Coffee - - - - -
15:40 - 16:15 *Student Talks* (5 – 6)

Tuesday, June 26

09:00 - 09:30 N. Seifter: *Vertex-transitive graphs with polynomial growth*
09:35 - 10:05 T. Szőnyi: *Stability theorems in combinatorics and finite geometry*
10:10 - 10:40 J. Širáň: *Algebraic techniques in the degree-diameter problem*
10.40 - 11:10 - - - - - Coffee - - - -
11:10 - 11:40 P. Terwilliger: *The universal Askey-Wilson algebra*
11:45 - 12:15 S. Wilson: *Tales From the Census*
12.15 - 14.30 - - - - - Lunch - - - - -
14:30 - 16:05 G. Kiss: *Finite Geometries* (1)
18:00 - *Workshop and Summer School dinner*

Wednesday, June 27

09:00 - 10:35 *Problem solving*
10.35 - 11:00 - - - - - Coffee - - - -
11:00 - 12:35 M. Giudici: *Polycirculant Conjecture* (1)
12.15 - 14.30 - - - - - Lunch - - - - -
14:30 - 16:05 S. Wagner: *Graph Enumeration* (1)

Thursday, June 28

09:00 - 10:35 G. Kiss: *Finite Geometries* (2)
10.35 - 11:00 - - - - - Coffee - - - -
11:00 - 12:35 S. Wagner: *Graph Enumeration* (2)
12.15 - 14.30 - - - - - Lunch - - - - -
14:30 - 16:05 M. Giudici: *Polycirculant Conjecture* (2)

Friday, June 29

09:00 - 10:35 M. Giudici: *Polycirculant Conjecture* (3)
10.35 - 11:00 - - - - - Coffee - - - -
11:00 - 12:35 S. Wagner: *Graph Enumeration* (3)
12:15 - 14:30 - - - - - Lunch - - - - -
14:30 - 16:05 G. Kiss: *Finite Geometries* (3)
16:05 - 16:15 *Closing remarks*
20:00 - 24:00 *Survivors workshop*

SYGN INVITED TALKS

Two group actions on the fibre

Jin Ho Kwak
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In this short talk, we review two group actions on the fibre of a covering: One is the covering transformation group action and the other is the action of the fundamental group, called the monodromy action. This is specially interested in the case of regular coverings.

Regular embeddings of quotient graphs and product of graphs

Young Soo Kwon
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In this talk, we will consider regular embeddings of quotient graphs by normal subgroups of automorphism groups and regular embeddings of product of some graphs which have regular embedding. Using some theoretical results, we classify regular embeddings of some graphs including folded n-cubes and product of cycles.

Structure of circulant (di)graphs

Joy Morris
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Some fairly recent deep results using Schur rings have provided a means of classifying circulant graphs and digraphs. I will present this classification, and discuss some asymptotic and other results that follow from it.

Maps, objects relating different fields of mathematics

Roman Nedela
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Regular maps and hypermaps are cellular decompositions of closed surfaces exhibiting the highest possible number of symmetries. The five Platonic solids present the most familiar examples of regular maps. The great dodecahedron, a 5-valent pentagonal regular map on the surface of genus 5 discovered by Kepler, is probably the first known non-spherical regular map. Modern history of regular maps goes back at least to Klein (1878) who described a regular map of type $(3,7)$ on the orientable surface of genus 3. In its early times, the study of regular maps was closely connected with group theory as one can see in Burnside's famous monograph, and more recently in Coxeter's and Moser's book. The present-time interest in

regular maps extends to their connection to Dyck's triangle groups, Riemann surfaces, algebraic curves, Galois groups and other areas including the Grothendieck theory. Many of these links are nicely surveyed in the recent papers by Jones and Jones and Singerman.

The presented survey talk is directed on one hand side, to show the relationship of (regular) maps and hypermaps to the above mentioned fields of mathematics. On the other hand, we want to stress some ideas and results that are important for understanding of the nature of these interesting mathematical objects.

Various aspects of vertex-transitive graphs with polynomial growth

Norbert Seifter
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Following M. Gromov's characterization of finitely generated groups with polynomial growth, V. I. Trofimov proved that the automorphism groups of locally finite vertex-transitive graphs with polynomial growth are closely related to finitely generated groups with polynomial growth. Trofimov's characterization opened a wide field of research and led to several nice results; among others to a recently developed asymptotic invariant of vertex-transitive graphs with polynomial growth which describes the large-scale geometry of these graphs.

Stability theorems in combinatorics and finite geometry

Tamás Szőnyi
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A stability theorem says that an 'almost nice' structure can be obtained from a 'nice structure' by a 'small' modification. Here a structure can be 'nice' if it has a large automorphism group, or it is very regular in the combinatorial sense, or it is simply extremal regarding the value of a certain (numerical) parameter. Of course, the key problem is to formulate precisely what 'almost nice' and 'small modification' mean. The prototype of such result is the stability theorem for the Turán-graphs, due to Erdös and Simonovits. In finite geometry, the results of B. Segre on embeddability of large arcs in (hyper)ovals are typical examples. The aim of the talk is to survey old and new stability results in various branches of discrete mathematics.

Algebraic techniques in the degree-diameter problem

Jozef Širáň
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The *degree-diameter* problem is to determine the largest order $n(d,k)$ of a graph of maximum degree $d \geq 3$ and diameter $k \geq 2$ and classify the corresponding graphs. Although the problem originated more than five decades ago and generated more than a hundred of papers on the topic, only seven exact values of $n(d,k)$ in the above range for d and k have been known. Nevertheless, a number of highly non-trivial bounds on $n(d,k)$ are available and most of these have been proved by algebraic techniques involving spectral theory and

group theory. The aim of the talk is to give an overview of the techniques and outline further research opportunities in this area.

The universal Askey-Wilson algebra

Paul Terwilliger
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The Askey-Wilson polynomials were introduced around 1985 and soon became a major topic in special functions. This topic became linked to representation theory around 1992 when A. Zhedanov introduced the Askey-Wilson algebra AW. The algebra AW is defined by generators and relations. The relations involve a scalar parameter q and a handful of extra scalar parameters. We introduce a central extension of AW, denoted Δ_q and called the universal Askey-Wilson algebra. Roughly speaking, up to normalization Δ_q is obtained from AW by interpreting the extra parameters as central elements in the algebra. By construction Δ_q involves no parameters besides q. In this talk we relate Δ_q to the following objects:

(i) Leonard pairs and Leonard triples of QRacah type;

(ii) Q-polynomial distance-regular graphs;

(iii) The modular group $PSL_2(Z)$;

(iv) The equitable presentation for the quantum group $U_q(sl_2)$;

(v) The double affine Hecke algebra of type $(C_1^\vee, C_1)$.

The talk will be very elementary; we do not assume exposure to the above topics.

Tales From the Census

Steve Wilson
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One topic of interest in the production of the census of edge-transitive teravalent graphs are semitransitive orientations which are graded. This means a directed graph whose group is transitive on vertices and (directed) edges for which there is a labelling of the vertices with numbers (mod k) (for some k at least 3) so that each edge points from a vertex labelled i to one labelled $i+1$. All tightly attached orientations are graded but there are many graded orientations which are not tightly attached.

We will first describe a construction by Casey Attebery which gives lots of graded orientations. We inserted many of these into the census, but, embarrassingly, a, um, programming flaw allowed into the census one example which fails the Attebery's construction, but is in the census anyway because it is, well, it is semisymmetric. Moreover, no other construction we know gives this interesting graph. How can we generalize it? Where did it come from, really? What is it like?

MINICOURSE DESCRIPTIONS

The Polycirculant Conjecture

Michael Giudici
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In this series of lectures I will discuss the background and motivation behind the polycirculant conjecture, and survey results in the area. Topics will include:

- semiregular automorphisms,
- graphs of specified valency or order,
- elusive groups,
- 2-closed groups,
- primitive permutation groups,
- locally primitive graphs.

Finite Geometries (from the definitions to some applications)

György Kiss
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- Finite affine and projective planes and spaces.
- Collineations and polarities. Conics and quadrics.
- Arcs, ovals and caps. Generalized quadrangles.
- How can we organize a soccer championship?
- Turán-type problems and finite geometries.
- Moore graphs and cages arising from finite incidence structures.

Graph Enumeration

Stephan Wagner
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How many graphs are there? Infinitely many, of course, but how many non-isomorphic graphs, for instance, of order n? How many of them are connected, how many are trees, how many are Eulerian? In this short course, we will treat combinatorial, algebraic and analytic techniques to solve graph-theoretical counting problems:

- Labelled enumeration: Labelled graphs and digraphs, trees, acyclic digraphs, ...
- Unlabelled enumeration: Pólya's method, the number of unlabelled graphs and trees.
- Analytic methods: asymptotic approximation, generating function techniques.

The classical reference on this topic is *F. Harary and E. M. Palmer, Graphical enumeration. Academic Press, New York, 1973.*

SYGN STUDENT TALKS

Quantum Walks on Strongly Regular Graphs

Krystal Guo
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A quantum walk is a quantum process on graph. It is proposed by Emms, Hancock, Severini and Wilson in 2006, that the spectrum of a matrix based on the amplitudes of walks in the quantum walk, distinguishes strongly regular graphs. We will try to represent this matrix in terms of the incidence matrices of the graph and investigate the spectra of related matrices. We will also look at regular graphs on which this invariant fails.

Quasi m-Cayley Graphs

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A group G is said to act quasi-semiregularly on the finite set X if there exists some element in X which is fixed by all elements from G, and every non-identity element in G has no other fixed point. A graph is said to be *quasi m-Cayley* if there exists a subgroup of its automorphism group acting quasi-semiregularly with m non-trivial orbits. In this talk, I will describe some properties of such graphs, and also give a classification of Cayley graphs on a cyclic group which are quasi m-Cayley for $m = 2, 3$ or 4.

The Isomorphism Problem from Cyclic Configurations

Sergio Hiroki Koike Quintanar
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An incidence geometry consists on a set of points X of points and a set of lines (subsets of X), such that two lines intesect in at most one point. An incidence geometry is a *configuration* if every line has the same number of points and every point is incident with the same number of lines. A configuration is *cyclic* if its automorphism group contains a regular cyclic subgroup. The isomorphism problem for cyclic configurations asks for sufficient

conditions to check wether two cyclic configurations are isomorphic or not. We say that two cyclic configurations are *multiplier equivalent* if some element of the multiplicative group of Z_n induces an isomorphism. A related problem is that for which n two isomorphic cyclic configurations are multiplier equivalent. In this talk we present some partial results for the latter problem.

Small Subgraphs in Triangle Free Strongly Regular Graphs

Kristína Kováčiková
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Strongly regular graphs represent an important class of graphs which stands somewhere between higly symmetric and randomly generated graphs. Thanks to their remarkable properties, they found an application in many areas of science, for example in cryptography, group theory or theoretical chemistry. A graph G with parameters (n,k,μ,λ) is strongly regular, $SRG(n,k,\mu,\lambda)$, if it is k-regular on n vertices and it holds that: 1. Any two adjacent vertices have exactly μ common neighbors. 2. Any two nonadjacent vertices have exactly λ common neighbors. The most popular example of SRG is Petersen graph, whose parameters are $(10,3,0,1)$. The conditions above may be considered too strict and give the impression that we have enough information for construction of SRG, but in general this could be really hard problem. This is the reason, why it is useful to look for properties of SRG, omitting the construction itself. We will show that it is possible to determine the number of small induced subgraphs of SRG with using only the parameters n,k,λ,μ. The methods that we want to present are usable for all sets of parameters. Despite of this we will focus only on cases where $\mu = 0$.

On $\psi\omega$-perfect graphs

Christian Rubio
National Autonomous University of Mexico, Mexico
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Let $a,b \in \{\psi,\alpha,\Gamma,\chi,\omega\}$ be where ψ is the pseudoachromatic number, α is the achromatic number, Γ is the Grundy number, χ is the chromatic number and ω is the clique number. A graph G is *ab-perfect* if for every induced subgraph H, $a(H) = b(H)$. We prove characterizations of the $\psi\omega$-perfect graphs.

Enumeration of Schur rings over A_5

Matan Ziv-Av
Department of Mathematics, Ben-Gurion University of the Negev, Israel
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A Schur ring (briefly S-ring) over a group H (in the sense of Schur-Wielandt) is one of the classical concepts in the area of Algebraic graph theory. It is equivalent to a translation scheme, that is to an association scheme, which is invariant with respect to a regular action of group H. In other words, an S-ring over H is equivalent to a merging scheme of the thin

association scheme generated by the regular action of H (group ring over H in one more alternative terminology).

Complete catalogues of S-rings are known for relatively small orders of group H (see e.g. site of Hanaki and Miyamoto). Recently, S. Reichard announced complete enumeration of S-rings over all groups H of order up to 44. For simple groups no such an information was known before, though M. Muzychuk long time ago described all primitive S-rings over alternating group $H = A_5$ of order 60.

Using computer algebra packages GAP and COCO-II (Reichard), we enumerated all S-rings over the group A_5, as mergings of the group ring $Z(A_5)$. There are 2847 S-rings (162 up to the action of the group $S_5 = Aut(A_5)$), 505 of those S-rings are non-Schurian (19 up to the action of S_5). We provide general information about reasonably interesting classes of detected S-rings, paying special attention to the set N of non-Schurian ones.

It turns out that each of the 19 S-rings in N appears also via merging of classes in the centralizer algebra of one of four suitable overgroups (G,H) of group (H,H). Here groups G have orders 1920, 7680, 720, 1320. Moreover, 9 of the S-rings in N appear also as algebraic mergings of one of the above 4 centralizer algebras. Some other properties of described S-rings will be mentioned in conjunction with information about few interesting combinatorial structures defined in terms of A_5.

This is a part of a graduate project, fulfilled under direction of Mikhail Klin.

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A FEW WORDS ABOUT THE UNIVERSITY OF PRIMORSKA

Established in 2003, the University of Primorska (UP) is the youngest of the three state universities in Slovenia. It consists of six Faculties: Faculty of Mathematics, Natural Sciences, and Information Technologies (UP FAMNIT), Faculty of Education, Faculty of Humanities, Faculty of Management, Faculty of Tourism, and Faculty of Health Sciences; and two research institutes, the Science and Research Centre, and the Andrej Marušič Institute (UP IAM).

With their international faculty and many research links all over the world, UP FAMNIT and its research counterpart UP IAM are at the forefront of the academic development of UP. Student enrollment at UP FAMNIT has grown from approximately 100 in its first academic year (2007/08), to more than 550 in the current academic year (2011/12).

UP FAMNIT offers BSc, MSc and PhD Degree programs in Mathematics, while faculty members carry out their research at UP IAM. Thus far, collaboration between UP FAMNIT and UP IAM has resulted in the following Graph Theory conferences and meetings:

- AC^2 – Algebraic Combinatorics on the Adriatic Coast, Koper, Slovenia: 2003, 2004, 2008, 2009.
- CoCoMat – 1st Korea - Slovenia International Conference On Combinatorial and Computational Mathematics, Koper, Slovenia, 2007.
- International Workshop on Symmetries of Graphs and Networks SYGN 2010, Rogla, Slovenia, 2010.
- Algebraic Graph Theory Summer School, Rogla, Slovenia 2011.
- 7th Slovenian International Conference on Graph Theory, Bled, Slovenia, 2011.
- Graph Theory Semester, Koper, May-June 2012.

Visit `www.famnit.upr.si` for more information on UP FAMNIT's graduate programs in mathematics and related fields. Visit `www.iam.upr.si` for more information on research.

UPCOMING EVENTS

COMPUTERS IN SCIENTIFIC DISCOVERY 6

Portorož, Slovenia, August 21 - August 25, 2012

KEYNOTE SPEAKERS:
Nobelist Harold Kroto (Florida State University, USA)
Oswin Aichholzer (University of Technology Graz, Austria)
Alexandru Balaban (Texas A&M University at Galveston, USA)
Gunnar Brinkmann (Universiteit Gent, Belgium)
Arnout Ceulemans (K.U.Leuven, Belgium)
Ernesto Estrada (University of Strathclyde, UK)
Patrick Fowler (University of Sheffield, UK)
Ante Graovac (University of Split, Croatia)
Adalbert Kerber (University of Bayreuth, Germany)
Bojan Mohar (Simon Fraser University, Canada & IMFM, Slovenia)
Milan Randić (National Institute of Chemistry, Slovenia)
Dragan Stevanović (University of Niš, Serbia & UP, Slovenia)
Ian Wanless (Monash University, Australia)
Jure Zupan (National Institute of Chemistry, Slovenia)

See the webpage `http://csd6.imfm.si` for details on the scientific programme, venue, accommodation, registration and travel options. Please email your inquiries to `csd6@upr.si`.

26TH LJUBLJANA-LEOBEN SEMINAR ON GRAPH THEORY

Bovec, Slovenia, September 24-26, 2012.

This year, the traditional bilateral meeting of Slovenian and Austrian graph theorists will take place in Bovec, a resort in the heart of Julian Alps. International participants are welcome. For more information, contact Primož Potočnik and Aleksander Malnič.

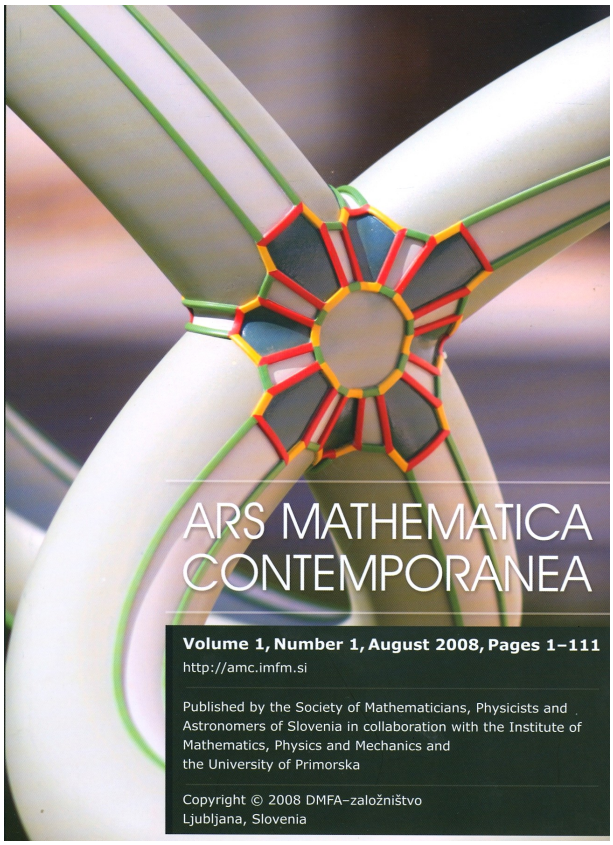
ARS MATHEMATICA CONTEMPORANEA

*A*rs Mathematica Contemporanea (AMC) is an international journal, published by the DMFA, the Slovenian Society of Mathematicians, Physicists and Astronomers. The Founding Editors and Editors-in-Chief of AMC are Dragan Marušič and Tomaž Pisanski and its Editorial Board includes a number of internationally recognized mathematicians and affiliations.

The aim of AMC is to publish peer-reviewed high-quality articles in contemporary mathematics that arise from the discrete and concrete mathematics paradigm. It favors themes that combine at least two different fields of mathematics. In particular, papers intersecting discrete mathematics with other branches of mathematics, such as algebra, geometry, topology, theoretical computer science, and combinatorics, are most welcome.

For more information on submissions, please refer to the AMC website

`http://amc.imfm.si`.



3rd International Workshop on Symmetries of Graphs and Networks and PhD Summer School in Discrete Mathematics.
Rogla, Slovenia, 24–30 June 2012.

Edited by B. Kuzman, K. Kutnar and P. Šparl.
Ljubljana, June 2012.

IAM University of Primorska
Andrej Marušič Institute

University of Primorska
Famnit
Faculty of Mathematics, Natural Sciences
and Information Technologies

Pedagoška fakulteta, Univerza v Ljubljani