

MATEMAATIKA-LOODUSTEADUSKOND
MATEMAATIKAINSTITUUT
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2012

1. Instituudi struktuur

Matemaatikainstituut, Department of Mathematics
Instituudi direktor Jaan Janno

- Algebra ja geomeetria õppetool, Chair of Algebra and Geometry, Peeter Puusemp
- Matemaatilise analüüsi õppetool, Chair of Mathematical Analysis, Gert Tamberg
- Rakendusmatematika õppetool, Chair of Applied Mathematics, Jaan Janno
- Matemaatilise füüsika õppetool, Chair of Mathematical Physics, Eugen Paal

2. Instituudi teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

(NB! punktid 2.1- 2.6 täidab struktuuriüksus)

2.1 struktuuriüksuse koosseisu kuuluvate uurimisgruppide

2.1.1 teadustöö kirjeldus *(inglise keeles)*;

- *Chair of Algebra and Geometry* The main topic of the studies is group and semigroup theory
- *Chair of Mathematical Analysis* The main topics are summability theory and sampling operators with applications in imaging
- *Chair of Applied Mathematics* The main topics are inverse problems, integral equations and methods of mathematical statistics
- *Chair of Mathematical Physics* The main topic is the development of operad methods with the orientation to applications in natural sciences, physics and technology.

2.1.2 aruandeaastal saadud tähtsamad teadustulemused *(inglise keeles)*.

- *Chair of Algebra and Geometry* It was proved that each multiple wreath product of copies of a finite cyclic group of a prime power order is determined by its endomorphism monoid in the class of all groups. Using this result, it was proved that every Sylow subgroup of a finite symmetric group is determined by its endomorphism monoid in the class of all groups. It was concluded from these results that each finite p -group is embeddable into a finite p -group which is determined by its endomorphism monoid. Some results on endomorphism monoids of medial quasigroups were obtained. It was proved that medial quasigroups cannot be distinguished by their endomorphism monoids, but idempotent medial quasigroups can be determined by their endomorphism algebras which incorporate four algebraic operations. It was proved that idempotent medial commutative quasigroups with finite endomorphism monoids are also finite. (P. Puusemp). As an application to the Voronoi theory of perfect quadratic forms over algebraic number fields a method for subdividing the open polyhedral cone $(\mathbb{R}_+)^r$ by Voronoi perfect polyhedras was developed. The endomorphisms of medial idempotent quasigroups were studied. A counterexample

was found to demonstrate that neither finite deponent medial quasigroups nor finite commutative medial quasigroups are determined by their endomorphism monoids. The Baer-Kaplansky theorem for Abelian groups to idempotent medial quasigroups was generalized as follows: if the endomorphism algebras of idempotent medial quasigroups Q and Q' are isomorphic, then Q and Q' are isomorphic too (A. Leibak).

- *Chair of Mathematical Analysis* Sampling operators, defined using an even band-limited kernel function were considered. It was shown that the truncation error, which is introduced when we use for some band-limited kernels finite sums instead of the sampling series, decreases so fast that in practice there is not so much difference if we use kernels with finite support or rapidly decreasing band-limited kernels. Some estimates were proved and some exact norms of truncation error for some sampling series were computed. Some sampling operators with averaged kernels were studied. Some estimates of approximation error for generalized sampling series in terms of averaged modulus of smoothness were proved (G. Tamberg). Tauberian remainder theorems for Cesàro method of summability using the general control modulo of the oscillatory behaviour were studied. In particular, the ideas of İ. Çanak, Ü. Totur and M Dik were applied. Several new Tauberian remainder theorems for $(C,1)$ were proved (O. Meronen).
- *Chair of Applied Mathematics* The method to deduce adjoint problems for cost functionals of inverse problems for parabolic integro-differential equations that use instant and integral measurements of temperature was further developed. The method was generalized to the cases of nonlinear inverse problems of coefficient type (J. Janno, K. Kasemets). The nonparametric trend analyses were applied on Estonian rivers pollution load analysis. Mann-Kendall test based on rank correlation was mainly used on studying the dynamics of rivers loadings in last 40 years. The distributions of skewness and kurtosis measures were modelled. The central limit theorem was applied on this kind of modelling. Obtained results were generalized to multivariate asymmetric distributions. These results can significantly improve the diagnostic of statistical models (M. Pihlak).
- *Chair of Mathematical Physics* Function theory on quantum complex hyperbolic spaces was developed. Explicit formulas for invariant integrals on 'finite' functions on a quantum hyperbolic space and on the associated quantum isotropic cone were obtained. Also the principal series of $U_q(\mathfrak{su}_{n,m})$ -modules related to this cone were established, and the necessary conditions for those modules to be equivalent were obtained. It was proved that if the neutral component in a finitely-generated associative algebra graded by a finite group has a Shirshov base, then so does the Aho algebra. The following classes of Lie algebras were studied: anisotropic, regular, minimal nonabelian, and algebras of depth 2. A concept of Mal'tsev pair was presented and developed, which is based on the generalised Maurer-Cartan equations of the local analytic Moufang loop. The triality can be seen as a fundamental property of such pairs. Based on the triality the Yamagutian was constructed. Properties of the Yamagutian were studied (E. Paal, P. Zusmanovich, O. Bershteyn).

- *Chair of Algebra and Geometry*
 - 1) Väljas, M. (2012). Analüütiline geomeetria. Tallinn: Tallinna Tehnikaülikooli kirjastus.
 - 2) Puusemp, P. (2012). Üldalgebra alused. Tallinn: Tallinna Tehnikaülikooli kirjastus.
 - 3) Tamberg, Tatjana (2012). Some Classes of Finite 2-Groups and Their Endomorphism Semigroups., Tallinna Tehnikaülikool) Tallinn: TTU Press.
- *Chair of Mathematical Analysis*
 - 1) Tamberg, G. (2012). On approximation error of the truncated generalized Shannon sampling operators. In: 3rd Dolomites Workshop on Constructive Approximation and Applications (DWCAA12), Alba di Canazei, September 9-14, 2012: (Toim.) Marco Caliari. Padova: Università Degli Studi Di Padova, 2012, 99.
 - 2) Tamberg, G. (2012). Truncated Shannon sampling operators. In: III Jaen Conference on Approximation Theory Úbeda, Jaén, Spain, July 15th-20th, 2012: (Toim.) A. J. Lopez Moreno. Jaen: Universidad de Jaén, 2012, 40 – 42.
- *Chair of Applied Mathematics*
 - 1) Kasemets, K., Janno, J. (ilmumas) Inverse problems for a parabolic integro-differential equation in a convolutional weak form. Abstract and Applied Analysis (32p). <http://www.hindawi.com/journals/aaa/aip/297104/>.
 - 2) Leibak, A., Šeletski, A., Vaarmann, O. (2012). On a multi-level approach to the generation of Pareto points for complex systems. In: Параллельные вычисления и задачи управления - PACO'2012 : труды шестой международной конференции, Москва, 24-26 октября 2012 г. Том 2 [VI International Conference „Parallel Computing and Control Problems", October 24-26, 2012, Moscow, Russia]: Москва: ИПУ РАН, 2012, 11 - 20.
- *Chair of Mathematical Physics*
 - 1) Paal, E. (2012). Mal'tsev algebras and triality. Algebra, Geometry and Mathematical Physics, 6th Baltic-Nordic Workshop on Algebra, Geometry, Mathematical Physics (AGMP), held in Sven Loven Ctr Marine Sci, Sweden, 25-31.10. 2010. Proceedings (ed. Abramov, V. et al). Book Series: Journal of Physics Conference Series, Volume 346, Article Number: 012015.
 - 2) Bershtein, O., Sinel'shchikov, S. (2012) Function theory on a image-analog of complex hyperbolic space. Journal of Geometry and Physics, Vol. 62, 1323-1337.
 - 3) Petrov, F., Zusmanovich, P. (ilmumas) On Shirshov bases of graded algebras. Israel Journal of Mathematics.

2.3 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustest.

2.4 Loetelu struktuuriüksuse töötajatest, kes on välisakadeemiate või muude oluliste T&A-ga seotud välisorganisatsioonide liikmed.

- J. Janno, G. Tamberg ja P. Puusemp on Ameerika Matemaatikaühingu liikmed
- J. Janno, P. Puusemp, M. Pihlak ja G. Tamberg on Eesti Matemaatika Seltsi liikmelisuse kaudu Euroopa Matemaatika Seltsi liikmed.
- G. Tamberg on järgmiste rahvusvaheliste erialaliitude liige: Society for Industrial and Applied Mathematics (SIAM), Institute of Electrical and Electronics Engineers (IEEE).

2.5 Aruandeaasta tähtsamad T&A finantseerimise allikad.

2.6 Soovi korral lisada aruandeaastal saadud T&A-ga seotud tunnustusi (va punktis 2.3 toodud tunnustused), ülevaate teaduskorralduslikust tegevusest, teadlasmobiilsusest ning anda hinnang oma teadustulemustele.

- J. Janno sai 2012.a riigi teaduspreemia täppisteaduste alal uurimuste tsükli "Pöördülesanded mittehomoogeensete materjalide ja keskkondade omaduste määramiseks" eest.
- E. Paalile omistati Tallinna konverentsisaadiku nimetus.
- E. Paal on ajakirjade (Ashdin Publisher) Journal of Generalized Lie Theory and Applications ja Journal of Physical Mathematics peatoimetaja.
- J. Janno on ajakirjade Mathematical Modelling and Analysis, Abstract and Applied Analysis ja The Open Acoustics Journal toimetuskolleegiumite liige.
- Matemaatilise füüsika õppetool osaleb rahvusvaheliste koostöövõrgustike AGMP ja ISQS tegevuses, samuti rahvusvaheliste konverentsikogumike toimetamises.
- 2012.a toimus matemaatilise füüsika õppetooli korraldamisel Tallinnas rahvusvaheline konverents „3Quantum: Algebra, Geometry, Information“.
- Rakendusmatemaatika õppetool osaleb konverentsivõrgustiku Mathematical Modelling and Analysis töös.
- 2012.a toimus rakendusmatemaatika õppetooli korraldamisel Tallinnas rahvusvaheline konverents MMA2012.
- P. Puusemp viibis 1-9. 12.2012 Eesti ja Ungari Teaduste Akadeemiade teadlaste vahetusprogrammi raames teadustööl Ungari Teaduste Akadeemia Alfred Renyi Matemaatika Instituudis.
- P. Puusemp, J. Janno ja G. Tamberg on Eesti Matemaatika Seltsi juhatuse liikmed ja J. Janno on Eesti Operatsioonianalüüsi Seltsi juhatuse liige.

2.7 Instituudi teadus- ja arendustegevuse teemade ja projektide nimetused (*Eesti Teadusinfosüsteemi, edaspidi ETIS, andmetel*)

- Haridus- ja Teadusministeerium
 - sihtfinantseeritavad teemad:
T011, Algebra ja analüüsi kaasaegsed rakendusmeetodid diferentsiaal- ja integraalvõrrandite teoorias, matemaatilises füüsikas ja statistikas, Puusemp Peeter (2009 – 2014)
 - baasfinantseerimise toetusfondist rahastatud projektid (sh TTÜ tippkeskused):
 - riiklikud programmid:
 - Teiste ministeeriumide poolt rahastatavad riiklikud programmid:
 - Uuriija-professori rahastamine:
 - SA Eesti Teadusfond/Eesti Teadusagentuur
 - grandid:
ETF9038, Operaadid, deformatsioonid, dünaamika, Paal, Eugen (2012 – 2015)
ETF9383, Kaalutud keskmised, Tamberg Gert (2012 – 2015)
 - ühisgrandid välisriigiga:
 - järel doktorite grandid (SA ETF ja Mobilitas):

ERMOS7, Zusmanovich Pasha, Lie algebrate kohomoloogia, mitteassotsiatiivsed struktuurid, dünaamilised süsteemid ja operaadid. (1.12.2010 - 30.11.2013)

ERMOS83, Bershtein Olya, Kvant-Harish_Chandra moodulite geomeetrilised realisatsioonid, mittekommutatiivne kompleks ja harmooniline analüüs (1.12.2011 - 1.12.2013)

– tippteadlase grandid (Mobilitas):

- Ettevõtluse Arendamise SA

– eeluuringud:

– arendustoetused:

- SA Archimedesega sõlmitud lepingud

– infrastruktuur (nn „mini-infra“, „asutuse infra“):

– Eesti tippkeskused:

– riiklikud programmid:

– muud T&A lepingud:

- SA Keskkonnainvesteeringute Keskusega sõlmitud lepingud:

- Siseriiklikud lepingud:

- EL Raamprogrammi projektid:

- Välisriiklikud lepingud:

2.8 Struktuuriüksuse töötajate poolt avaldatud eelretsenseeritavad teaduspublikatsioonid (*ETIS klassifikaatori alusel 1.1, 1.2, 1.3, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1 ja 5.1*).

1.1

Bershtein, O., Sinel'shchikov, S. (2012) Function theory on a image-analog of complex hyperbolic space. Journal of Geometry and Physics, Vol. 62, 1323-1337.

Kasemets, K., Janno, J. (ilmumas) Inverse problems for a parabolic integro-differential equation in a convolutional weak form. Abstract and Applied Analysis (32p).

<http://www.hindawi.com/journals/aaa/aip/297104/>

Petrov, F., Zusmanovich, P. (ilmumas) On Shirshov bases of graded algebras. Israel Journal of Mathematics.

1.2

1.3

2.1

2.2

Väljas, M. (2012). Analüütiline geomeetria. Tallinn: Tallinna Tehnikaülikooli Kirjastus

2.3

Tamberg, T. (2012). Some Classes of Finite 2-Groups and Their Endomorphism Semigroups., Tallinna Tehnikaülikool) Tallinn: TTU Press.

3.1

Paal, E. (2012). Mal'tsev algebras and triality. Algebra, Geometry and Mathematical Physics, 6th Baltic-Nordic Workshop on Algebra, Geometry, Mathematical Physics (AGMP), held in Sven Loven Ctr Marine Sci, Sweden, 25-31.10. 2010. Proceedings (ed. Abramov, V. et al). Book Series: Journal of Physics Conference Series, Volume 346, Article Number: 012015.

Zusmanovich, P. (ilmumas) Lie algebras with given properties of subalgebras and elements, Proceedings of the Conference "Algebra - Geometry - Mathematical Physics" (Mulhouse, 2011), Springer Proceedings in Mathematics and Statistics.

3.2

Janno, Jaan (2012). Teaduspreemia täppisteaduste alal uurimuste tsükli "Pöördülesanded mittehohogeensete materjalide ja keskkondade omaduste määramiseks" eest. Villems, Richard (Toim.). Eesti Vabariigi Teaduspreemiad 2012 (40 - 58). Tallinn: Eesti Teaduste Akadeemia

Tamberg, G. (2012). Tuulegeneraatoritest ja Lamb'i lainetest. K. Kaarli, R. Palm (Toim.). Eesti Matemaatika Selts. Aastaraamat 2010 (10 - 19). Tartu: Eesti Matemaatika Selts

3.3

3.4

Leibak, A., Šeletski, A., Vaarmann, O. (2012). On a multi-level approach to the generation of Pareto points for complex systems. In: Параллельные вычисления и задачи управления - РАСО'2012 : труды шестой международной конференции, Москва, 24-26 октября 2012 г. Том 2 [VI International Conference „Parallel Computing and Control Problems", October 24-26, 2012, Moscow, Russia]: Москва: ИПУ РАН, 2012, 11 - 20.

4.1

(2012). 17th International Conference Mathematical Modelling and Analysis. June 6-9, 2012, Tallinn, Estonia . Tallinn: Tallinn University of Technology

5.1

5.2

Kasemets, K., Janno, J. (2012). Inverse problems for parabolic integro-differential equations with instant and integral conditions. In: 17th International Conference on Mathematical Modelling and Analysis : June 6-9, 2012, Tallinn, Estonia, Abstracts: Tallinn: Tallinn University of Technology, 2012, 68.

Leibak, A: (2012). Subdividing the positive cone $(\mathbb{R}_+)^r$ by Voronoi perfect polyhedras and totally positive algebraic integers. In: 17th International Conference on Mathematical Modelling and Analysis : June 6-9, 2012, Tallinn, Estonia, Abstracts: Tallinn: Tallinn University of Technology, 2012, 78.

Leibak, A., Šeletski, A., Vaarmann, O. (2012). On a hierarchical approach to the generation of pareto points for complex systems. In: MCDA-75 : 75th Meeting of the European Working Group on Multiple Criteria Decision Aiding, Book of Abstracts, Tarragona, Catalonia, Spain, April 12th-14th, 2012:, 2012, 43.

Meronen, O., Tammeraid, I. (2012). Moderately Oscillatory Control Modulo and Tauberian Remainder Theorems for $(C, 1)$ Summability. 17th International Conference "Mathematical Modelling and Analysis", June 6-9, Tallinn, Estonia: (Toim.) G. Tamberg. Tallinn: Tallinn University of Technology. , 2012, 86 – 86.

Tamberg, G. (2012). On approximation error of the truncated generalized Shannon sampling operators. In: 3rd Dolomites Workshop on Constructive Approximation and Applications

(DWCAA12), Alba di Canazei, September 9-14, 2012: (Toim.) Marco Caliari. Padova: Università Degli Studi Di Padova, 2012, 99.

Tamberg, G. (2012). Truncated Shannon sampling operators. In: III Jaen Conference on Approximation Theory Úbeda, Jaén, Spain, July 15th-20th, 2012: (Toim.) A. J. Lopez Moreno. Jaen: Universidad de Jaén, 2012, 40 - 42.

Tamberg, G. (2012). Truncated Shannon sampling operators. In: 17th International Conference "Mathematical Modelling and Analysis", June 6-9, Tallinn, Estonia: (Toim.) G. Tamberg. Tallinn: Tallinn University of Technology, 2012, 126.

6.2

Puusemp, P. (2012). Üldalgebra alused. Tallinn: Tallinna Tehnikaülikooli kirjastus.

2.9 Struktuuriüksuses kaitstud doktoriväitekirjade loetelu (*NB! struktuuriüksus lisab struktuuriüksuse töötaja juhendamisel mujal kaitstud doktoriväitekirjade loetelu*)

Tatjana Tamberg, matemaatikainstituut

Teema: *Some Classes of Finite 2-Groups and Their Endomorphism Semigroups* (Mõnedest lõplike 2-rühmade klassidest ja nende endomorfismipoolrühmadest)

Juhendaja: prof Peeter Puusemp

Kaitses: 9.05.2012

Omistatud kraad: filosoofiadoktor (rakendusmatemaatika)

2.10 Struktuuriüksuses järeldoktorina T&A-s osalenud isikute loetelu (*ETIS-e kaudu esitatud taotluste alusel*)

Zusmanovich Pasha, Lie algebrate kohomoloogia, mitteassotsiatiivsed struktuurid, dünaamilised süsteemid ja operaadid. (1.12.2010 - 30.11.2013)

Bershtein Olya, Kvant-Harish_Chandra moodulite geomeetrilised realisatsioonid, mittekommutatiiivne kompleks ja harmooniline analüüs (1.12.2011 - 1.12.2013)

2.11 Struktuuriüksuses loodud tööstusomandi loetelu

3. Struktuuriüksuse infrastruktuuri uuendamise loetelu