

MATEMAATIKA-LOODUSTEADUSKOND
MATEMAATIKAINSTITUUT
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2013

1. 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. Teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

2.1 Struktuuriüksusesse kuuluvad uurimisgrupid (*kõik uurimisgrupid näidatakse aruandes eraldi, järgides alltoodud ülesehitust*).

Algebra ja geomeetria õppetool, Chair of Algebra and Geometry, Peeter Puusemp

- The aim of our scientific group is to develop the endomorphism theory of groups and quasigroups. We are finding some methods for describing these algebraic systems by their endomorphism semigroups
- *Results in 2013* The endomorphism algebra of idempotent medial quasigroup was introduced and it was proved that each idempotent medial quasigroup is determined by its endomorphism algebra in the class of all idempotent medial quasigroup. (Alar Leibak, Peeter Puusemp). It was proved that each group of order 32 which has a maximal subgroup isomorphic to the direct product of cyclic groups C_4 , C_2 and C_2 is determined by its endomorphism semigroup in the class of all groups. (Piret Puusemp and Peeter Puusemp). It was proved that a multiple wreath product of groups is determined by its endomorphism semigroup in the class of all groups. In particular, so is every Sylow subgroup of a finite symmetric group. (Peeter Puusemp).
- *Main publications*
 - Piret Puusemp, Peeter Puusemp. *On endomorphisms of groups of order 32 with maximal subgroups $C_4 \times C_2 \times C_2$* . Proc. Estonian Academy of Sciences, 2014, **63**, no 2. (to appear)
 - Alar Leibak, Peeter Puusemp. *On determinability of some classes of medial quasigroups by their endomorphisms*. Journal of Physics: Conference Series. (submitted)
 - Peeter Puusemp. *On the endomorphism semigroup of a multiple wreath product*. Communications in Algebra. (submitted)

Matemaatilise analüüsi õppetool, Chair of Mathematical Analysis, Gert Tamberg

- We study the generalized Shannon sampling operators that mean the representations of functions in terms of series, where the expansion coefficients are its samples and expansion functions are translates of a certain kernel function. Moreover, we study

generalized summability methods that mean the case if the elements of the sequence belong to the Banach space and the elements of the matrix are linear bounded operators.

- *Results in 2013* Sampling operators, defined using an even band-limited kernel function were considered. The truncation error, which is introduced when we use for some band-limited kernels finite sums instead of the sampling series for generalized sampling series and for Kantorovich-type sampling series was studied. Some estimates were proved and some exact norms of truncation error for some sampling series were computed. Approximation properties of generalized sampling operators in Lebesgue spaces were studied. The order of approximation by sampling operators via averaged modulus of smoothness and ordinary modulus of smoothness was estimated. (Gert Tamberg, Olga Orlova). The Tauberian remainder theorems in the case of the generalized methods of summability, especially for weighted means method was proved. The Tauberian conditions in the case of the generalized methods of summability were weakened (Ivar Tammeraid, Olga Meronen).
- *Main publications*
 - o Gert Tamberg. *Approximation error of generalized Shannon sampling operators with bandlimited kernels in terms of an averaged modulus of smoothness*. Dolomites Research Notes on Approximation, 2013, 6, 74 – 82.
 - o Gert Tamberg. *On some truncated Shannon Sampling Series*. Sampling Theory in Signal and Image Processing, 2013, 12, 21 - 32.
 - o Andi Kivinukk, Gert Tamberg. *Approximation by Shannon sampling operators in terms of an averaged modulus of smoothness*. In: Proceedings of 10th International Conference on Sampling Theory and Applications July 1st - July 5th, 2013 Jacobs University Bremen (Toim.) Massopust, P., Pfander, G., 2013, 540-543.
 - o Andi Kivinukk, Gert Tamberg. *On window methods in generalized Shannon sampling operators*. Schmeisser, G.; Zayed, A. (Toim.). New Perspectives on Approximation and Sampling Theory- Festschrift in honor of Paul Butzer's 85th birthday. Birkhäuser Verlag (to appear).
 - o Olga Orlova, Gert Tamberg. *On approximation properties of Kantorovich-type sampling operators*. Sampling Theory in Signal and Image Processing (submitted)

Rakendusmatemaatika õppetool, Chair of Applied Mathematics, Jaan Janno

- The main topics are inverse problems, integral equations and methods of mathematical statistics.
- *Results in 2013* An inverse problem to determine two kernels and a coefficient in a parabolic integro-differential equation was studied in weak formulation. Frechet differentiability of the corresponding cost functional was proved and an adjoint problem for the Frechet derivative was deduced.(Jaan Janno, Kairi Kasemets). A new positivity principle for generalized fractional diffusion equations was proved. This principle is valid for a large class of quasilinear equations that contain integral term generalizing the fractional derivative. Unboundedness at the zero point of the kernel of

the integral term is not necessary in this result. (Jaan Janno). The cooperation continued with the Environmental Technology Institute of Tallinn University of Technology. This was implemented within the framework of nonparametric trend analyzes of Estonian rivers pollution load analysis. Mann-Kendall rank correlation was used primarily to test to investigate the flow of the rivers flowing into Lake Peipsi and the dynamics of the load over the last 40 years. (Margus Pihlak). The distributions of asymmetry and kurtosis measures were modeled. On this kind of modeling the central limit theorem was applied. These results will generalize to the multivariate case. Knowing distribution of symmetry and kurtosis measures (even approximate) of the statistical models residuals allows to significantly improves the diagnostic adequacy. (Margus Pihlak).

– *Main publications*

- Kairi Kasemets, Jaan Janno. *Inverse problems for a parabolic integro-differential equation in a convolutional weak form*. Abstract and Applied Analysis, 2013, Article ID 297104, 16 p.
- Kairi Kasemets, Jaan Janno. *Inverse problems for parabolic integro-differential equations with two kernels*. 18th International Conference Mathematical Modelling and Analysis and 4th International Conference Approximation Methods and Orthogonal Expansions, Tartu, 27-30.05.2013, 57.
- Arvo Iital, Marija Klõga, Margus Pihlak, Karin Pachel, Andre Zahharov, Enn Loigu. Exploring the impact of agricultural land use on the nitrogen content and trends in streams in Estonia. *Agriculture, Ecosystems & Environment* (submitted).
- Margus Pihlak. *Modeling of skewness measure distribution*. Statistics in Transition (submitted).

Matemaatilise füüsika õppetool, Chair of Mathematical Physics, Eugen Paal

- The main topic is the development of operad methods with the orientation to applications in natural sciences, physics and technology.
- *Results in 2013* The $*$ -representations for polynomial algebras on quantum matrix spaces were studied. The two special cases of the polynomial algebras were studied more closely, namely the algebra of polynomials on quantum complex matrices Mat_2 and on quantum complex symmetric matrices Mat^{sym} . For the second algebra all irreducible $*$ -representations by bounded operators in a Hilbert space (up to a unitary equivalence) were classified. Moreover, a construction of $*$ -representations of the above algebras which enables to obtain the full list of $*$ -representations (sometimes by passing to subrepresentations) were presented. (Olga Bershteyn). The operadic Heisenberg-like equation was proposed and studied (Eugen Paal). An embedding theorem for algebraic systems was presented, based on a certain old ultrafilter construction. As an application, alternative proofs of some results from the theory of PI algebras were outlined, and some properties of Tarski's monsters were presented. (Pasha Zusmanovich). An elementary heuristic reasoning based on Arnold's theory of versal deformations in support of a straightforward algorithm for finding a correlation matrix near a given symmetric one was presented. 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 whole algebra. (Pasha Zusmanovich). The following classes of Lie algebras were studied: anisotropic (i.e., Lie algebras for which each adjoint operator $\text{ad } x$ is semisimple), regular (i.e., Lie algebras in which each nonzero element is regular), minimal nonabelian (i.e., nonabelian Lie algebras all whose proper subalgebras are abelian), and algebras of depth 2 (i.e., Lie algebras all whose proper subalgebras are abelian or minimal nonabelian). All algebras, Lie and associative, were assumed to be finite-dimensional and defined over a fixed field of characteristic zero (though some of the results, in a weaker form or under additional restrictions, will hold also in positive characteristic). It must be stressed that the base field was not assumed to be algebraically closed (all the things considered here are collapsing to vacuous trivialities in the case of an algebraically closed base field). (Pasha Zusmanovich). It was demonstrated how a simple linear-algebraic technique used earlier to compute low-degree cohomology of current Lie algebras, can be utilized to compute other kinds of structures on such Lie algebras, and discuss further generalizations, applications, and related questions. While doing so, it is possible to study such seemingly diverse topics as associative algebras of infinite representation type, Hom-Lie structures, Poisson brackets of hydrodynamic type, Novikov algebras, simple Lie algebras in small characteristics, and Koszul dual operads. (Pasha Zusmanovich).

– *Main publications*

- Olga Berhstein. O. *On *-representations of polynomial algebras in quantum matrix spaces of rank 2*. Algebra and Representation Theory, 2013 (June), DOI 10.1007/s10468-013-9433-z.
- Eugen Paal. *Operadic Heisenberg-like equation*. AstrAlgo cWeb, 2013 (GOL X), #1153.
- Pasha Zusmanovich. *On the utility of Robinson-Amitsur ultrafilters*. Journal of Algebra, 2013, 388, 268 – 286.
- Pasha Zusmanovich. *On near and the nearest correlation matrix*. Journal of Nonlinear Mathematical Physics, 2013, 20, 431 – 439.
- Fedor Petrov, Pasha Zusmanovich. *On Shirshov bases of graded algebras*. Israel Journal of Mathematics, 2013, 197(1), 23 – 28.

2.2 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustest.

- puuduvad

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

- Gert Tamberg on järgmiste välisorganisatsioonide liige: American Mathematical Society, European Mathematical Society, Society for Industrial and Applied Mathematics (SIAM), Institute of Electrical and Electronics Engineers (IEEE)

2.4 Soovi korral esitatakse aruandeaastal saadud T&A-ga seotud tunnustused (va punktis 2.3 toodud tunnustused), ülevaade teaduskorralduslikust tegevusest, teadlasmobiilsusest ning hinnang oma teadustulemustele.

- J. Janno on ajakirjade Mathematical Modelling and Analysis, Abstract and Applied Analysis ja The Open Acoustics Journal toimetuskolleegiumite liige.
- J. Janno on Eesti Operatsioonianalüüsi Seltsi juhatuse liige.

- J. Janno ja G. Tamberg on Eesti Matemaatika Seltsi juhatuse liikmed.
- J. Janno oli konverentsi 18th International Conference Mathematical Modelling and Analysis (MMA2013), Fourth International Conference Approximation Methods and Orthogonal Expansions (AMOE2013), 27 – 30.05.2013, Tartu, teaduskomitee liige.
- Matemaatilise füüsika õppetool osaleb rahvusvahelises teadusvõrgustikus AGMP.
- E. Paal on ajakirjade Journal of Generalized Lie Theory and Applications ja Journal of Physical Mathematics peatoimetaja.
- 29. mai 2013. K. Kasemetsa ettekanne „Inverse problems for parabolic integro-differential equations with two kernels” konverentsil 18th International Conference Mathematical Modelling and Analysis (MMA2013), Fourth International Conference Approximation Methods and Orthogonal Expansions (AMOE2013), May 27 - 30, 2013, Tartu, Estonia.
- 30. mai 2013. O. Orlova ettekanne „On approximation properties of Kantorovich-type sampling operators“ konverentsil 18th International Conference Mathematical Modelling and Analysis (MMA2013), Fourth International Conference Approximation Methods and Orthogonal Expansions (AMOE2013), May 27 - 30, 2013, Tartu, Estonia.
- 30. mai 2013. G. Tambergi ettekanne „On truncation error of Kantorovich-type sampling operators“ konverentsil 18th International Conference Mathematical Modelling and Analysis (MMA2013), Fourth International Conference Approximation Methods and Orthogonal Expansions (AMOE2013), May 27 - 30, 2013, Tartu, Estonia.
- 5. juuli 2013. G. Tambergi ettekanne „Approximation by Shannon sampling operators in terms of an averaged modulus of smoothness“ konverentsil 10th International Conference on Sampling Theory and Applications July 1st - July 5th, 2013 Jacobs University Bremen.
- 2. september 2013. O. Orlova stendiettekanne “On approximation properties of Kantorovich-type sampling operators” konverentsil Kangro-100, Methods of Analysis and Algebra, International conference dedicated to the centennial of professor Gunnar Kangro, Tartu, Estonia, September 1-6, 2013.
- 3. september 2013. G. Tambergi ettekanne “Approximation error of generalized Shannon sampling operators with bandlimited kernels in terms of an averaged modulus of smoothness” konverentsil „Kangro-100, Methods of Analysis and Algebra, International conference dedicated to the centennial of professor Gunnar Kangro, Tartu, Estonia, September 1-6, 2013.
- 9. september 2013. A. Leibaki ettekanne „Enumeration of perfect binary quadratic forms over real quadratic fields with discriminant < 40 “ konverentsil „International conference on Number Theory dedicated to the 65th birthday of professor Antanas Laurinčikas“, Siauliai, Lihtuania, September 9-12, 2013.
- 19. november 2013. M. Pihlaku ettekanne “Modelling of skewness measure distribution” konverentsil Multivariate Statistical Analysis (MSA) 2013, Lodz, Poola, 18.-20. November, Lodz University.

Hinnang instituudi teadustööle: 3,5 viieballises skaalas.