Questionnaire
Summary of the main activities of a research institute of the Slovak Academy of Sciences

Period: January 1, 2012 - December 31, 2015

1. Basic information on the institute:

1.1. Legal name and address

Mathematical Institute of Slovak Academy of Sciences
Štefánikova 49, SK-81473 Bratislava, Slovakia

1.2. URL of the institute web site

http://www.mat.savba.sk/

1.3. Executive body of the institute and its composition

2012-2014:

Directoriat	Name	Age	Years in the position
Director	Anatolij Dvurečenskij	67	16
Deputy director	Karol Nemoga	63	16
Scientific secretary	Karol Nemoga	63	17

2015:

Directoriat	Name	Age	Years in the position
Director	Karol Nemoga	63	1
Deputy director	Anatolij Dvurečenskij	67	1
Scientific secretary	Karol Nemoga	63	17

1.4. Head of the Scientific Board

doc. RNDr. Ľubica Holá, DrSc.

1.5. Basic information on the research personnel

1.5.1. Number of employees with university degrees (PhD students included) engaged in research projects, their full time equivalent work capacity (FTE) in 2012, 2013, 2014, 2015, and average number of employees in the assessment period

	2012		2013		2014		2015		total		
	number	FTE	number	FTE	number	FTE	number	FTE	number	averaged number per year	averaged FTE
Number of employees with university degrees	55,0	31,600	57,0	29,470	54,0	29,710	53,0	30,880	**219,0**	**54,8**	**30,415**
Number of PhD students	11,0	8,000	9,0	7,666	9,0	8,333	8,0	6,666	**37,0**	**9,3**	**7,666**
Total number	66,0	39,600	66,0	37,136	63,0	38,043	61,0	37,546	**256,0**	**64,0**	**38,081**

1.5.2. Institute units/departments and their FTE employees with university degrees engaged in research and development

Research staff	2012		2013		2014		2015		average	
	No.	FTE	No.	FTE	No.	FTE	No.	FTE	No.	FTE
Institute in whole	55,0	31,600	57,0	29,470	54,0	29,710	53,0	30,880	**54,8**	**30,415**
MI SAS, Bratislava	29,0	15,770	31,0	14,810	28,0	14,900	27,0	15,690	**28,8**	**15,293**
Dpt. Of Informatics, Bratislava	8,0	5,080	8,0	5,000	8,0	5,020	8,0	5,020	**8,0**	**5,030**
MI SAS, Košice	12,0	8,060	12,0	7,030	12,0	7,160	12,0	7,880	**12,0**	**7,533**
MI SAS, Banská Bystrica	6,0	2,690	6,0	2,630	6,0	2,630	6,0	2,290	**6,0**	**2,560**

1.6. Basic information on the funding of the institute

Institutional salary budget and others salary budget

Salary budget	2012	2013	2014	2015	average
Institutional Salary budget *[thousands of EUR]*	495,941	501,070	500,361	522,894	**505,067**
Other Salary budget *[thousands of EUR]*	31,114	30,137	44,456	20,025	**31,433**

1.7. Mission Statement of the Institute as presented in the Foundation Charter

Mathematical Institute of the Slovak Academy of Sciences, is a scientific organization with the budgetary economy. It was founded on March 1, 1959. The Institute is concentrating to the basic research in mathematics (mainly logic and set theory, number theory, algebraic and topological structures, quantum

structures, discrete mathematics, real and functional analysis, dynamical systems, differential equations, probability theory and mathematical statistics). In computer science, the research is focused to theory of algorithms and computational complexity and to theory of formal languages, automata and numerical systems.

The Institute provides advisory and expert analysis concerning the main scientific activity in area of applications of mathematical methods. It could according to Act 133/2002 On Slovak Academy of Sciences perform enterprise activity with respect to its main scientific activity like performing program tools, their sale and updating in area of applied mathematics, and to organize specialized seminars and conferences, and publishing publications in area of applied mathematics.

The Institute participates on pedagogical process at PhD studies according to valid legal regulations.
The Institute ensures publications of results concerned with research activity through the mathematical journals.

1.8. Summary of R&D activity pursued by the institute during the assessment period in both national and international contexts, (recommended 5 pages, max. 10 pages)

In period 2012 -2015, the mathematical research was concentrated to the following groups.

- **Number theory and cryptography**
- **Uncertainty modeling by statistical methods, quantum structures, and fuzzy sets**
- **Ordered algebraic structures and discrete structures**
- **Dynamical systems, real and functional analysis, and topology**
- **Computer science and data processing**
- **Applications of mathematical research in praxis**

The most important results

2012

a. Results of Pure Mathematics

Complete metrizability of topologies of strong uniform convergence on bornologies

In the paper „G. Beer, S. Levi, Strong uniform continuity, Journal of Mathematical Analysis and Applications 350 (2009), 567-589" the metrizability of topologies of strong uniform convergence on bornologies was characterized and a compatible metric was displayed. Using shields we found necessary and sufficient conditions for completeness of the metric and for complete metrizability and for Polishness of topologies of strong uniform convergence on bornologies.

Author: Ľ. Holá
Projekt: Vega 2/0047/10
Reference: Ľ. Holá, *Complete metrizability of topologies of strong uniform convergence on bornologies,* Journal of Mathematical Analysis and Applications **387** (2012), 770-775.

Further properties of the lattice of torsion classes of abelian cyclically ordered groups

Following an our former paper, it has been continued in studying of the lattice T of torsion classes of abelian cyclically ordered groups. We described all atoms of this lattice, showed that T does not have any dual atom and proved complete distributivity of T.

Autors: Judita Lihová, Ján Jakubík
Projects: VEGA 2/0194/10, Center of Excellence SAS - Quantum Technologies
Reference: Judita Lihová, Ján Jakubík: *Further properties of the lattice of torsion classes of abelian cyclically ordered groups*, Mathematica Slovaca **65** (2015), 13-22.

Fuzzy concept lattices and their generalization

We described a generalization of fuzzy concept lattices based on dually isomorphic retracts of complete lattices. Within this framework we provided a generalization of the concept lattices with hedges (introduced by Bělohlávek and Vychodil) based on composition of interior operators with Galois connections.

Author: Jozef Pócs
Project: VEGA 2/0194/10, APVV-0035-10
Reference: J. Pócs, *On possible generalization of fuzzy concept lattices using dually isomorphic retracts*, Information Sciences **210** (2012), 89-98.

Representation and stability of solution of system of functional differential equations with multiple delays

We derived a matrix representation of a solution of nonhomogeneous system of differential equations with an arbitrary number of delays varying in time. With the aid of this matrix polynomial of time-dependent degree, we stated sufficient conditions for the exponential stability of the trivial solution of a system of nonlinear functional differential equations with time-dependent delays and the nonlinearity depending on or independent of the delays.

Authors: Michal Pospíšil
Project: VEGA-SAV 2/0124/10, APVV-0134-10
Reference: M. Pospíšil, *Representation and stability of solutions of systems of functional differential equations with multiple delays,* Electron. J. Qual. Theory Differ. Equ. **54** (2012) 1-30.

b. Results of Applied Mathematics

Flow imbalance problem in Slovak gas transmission network

The long-standing problem of imbalance of input and output flows of the Slovak gas transmission network has been solved, which has been caused by accumulated measurement errors that were in fact in the tolerated margin of error. The task has been to select those measurements with the greatest contribution to the flow imbalance. To solve the task a statistical model has been developed and several regularization methods have been implemented.

Authors: I. Mračka, A. Sedliak, M. Spál, G. Wimmer, T. Žáčik
Project: 1235 Gas transport optimization through transit pipelines
Referencia: Contract No. 183/12/EUS between Mathematical Institute of the Slovak Academy of Sciences and eustream, a.s., 2012

c. Results of International Projects

Bifurcations of periodic and chaotic oscillations in discontinuous dynamical systems

One of the methods on the study of dynamics of differential equations is a theory of bifurcation. This theory is already well developed when differential equations continuously depend on their variables and parameters. But there are many physical phenomena when this is not the case. For instance, in modeling dry frictions or in impact phenomena like in describing ring or billiard corresponding differential equations are discontinuous. At present, such differential equations are intensively studied. The paper is dealing with such problems. Conditions are derived for the existence and bifurcation of periodic and chaotic solutions as well in discontinuous systems. Theoretical results are presented on concrete examples.

Authors: Flaviano Battelli, Universita Politecnica delle Marche, Ancona, Taliansko; Michal Fečkan, MI SAS

Grants: VEGA-SAV 2/0125/10 and APVV-0134-10
Reference: F. Battelli, Fečkan, *Nonsmooth homoclinic orbits, Melnikov functions and chaos in discontinuous systems*, Physica D **241** (2012), 1962-1975.

Charakteristic rank of vector bundles over the Stiefel manifolds

The characteristic rank of a real vector bundle ξ over a compact connected cell-complex X is defined to be the greatest non-negative integer k among the integers that do not exceed dimension of the space X, such that each $(Z/2Z)$-cohomology class of degree $j$of the space X for $j = 0, 1, ..., k$ can be expressed as a polynomial in the Stiefel-Whitney characteristic classes of the bundle ξ. We determined the value of characteristic rank for almost all real vector bundles over any Stiefel manifold $V_m(F^n)$ of orthonormal m-frames in the space F^n of ordered n-tuples of elements of F, where F is either the field of real numbers, or the field of complex numbers, or the skew-field of quaternions.

Authors: Július Korbaš, Aniruddha Naolekar, Ajay Thakur
Project: VEGA 2/0124/10
Reference: J. Korbaš, A. Naolekar, A. Thakur: *Characteristic rank of vector bundles over Stiefel manifolds.* Archiv der Mathematik (Basel) **99** (2012), 577-581. DOI 10.1007/s00013-012-0454-3.

Dimension theory for generalized effect algebras

In our previous papers we generalized to effect algebras the Loomis-Maeda dimension theory for orthomodular lattices. In this paper we define and study dimension generalized effect algebras, i.e., Dedekind orthocomplete and centrally orthocomplete generalized effect algebras equipped with a dimension equivalence relation. Our theory is a bona fide generalization of the theory of dimension effect algebras , i.e., it is formulated so that, if a dimension generalized effect algebra happens to be an effect algebra (i.e., it has a unit element), then it is a dimension effect algebra. We prove that a dimension generalized effect algebra decomposes into type I, II, and III DGEAS in a manner analogous to the type I/II/III decomposition of a von Neumann algebra.

Authors: David J. Foulis (Univ. Amherst, USA), Sylvia Pulmannová (MÚ SAV)
Projects: Center of Excellence SAS - Quantum Technologies; ERDF OP R&D Project meta-QUTE ITMS 26240120022; the grant VEGA No. 2/0059/12 SAV; the Slovak Research and Development Agency under the contract APVV-0178-11.
Reference: D.J. Foulis, S. Pulmannova, *Dimension theory for generalized effect algebras*, Alg. Univers. **69** (2013), 357-386.

Multi-polar aggregation operators and multi-polar Choquet integral

We have explored the generalization of bipolar aggregation into multi-polar aggregation. We have introduced a notion of an m-polar aggregation operator as a generalization of aggregation operators and bipolar aggregation operators, and we have studied the main properties of these aggregation operators. Extensions of some (bipolar) aggregation operators to m-polar aggregation operators were described, and we have studied metrics on the category space $K \times [0, 1]$ related to m-polar aggregation. We explored the notion of multi-polarity in decision making by extending the notion of bipolar Choquet integrals to multi-polar Choquet integrals. We introduced extensions of basic bipolar Choquet integrals, the balancing Choquet integral and the Choquet integral with respect to a bi-capacity.

Authors: A. Zemánková (MÚ SAV), K. Ahmad (TCD Dublin, Írsko)
Project: AXA Research Fund, VEGA 2/0059/12, APVV-0178-11
References:

[1] Mesiarová-Zemánková, A. – Ahmad, K.: *Multi-polar aggregation.* Proc. PMU2012, Catania, Italy, 2012, pp. 379-387.
[2] Mesiarová-Zemánková, A. – Ahmad, K.: *Multi-polar Choquet integral*, Fuzzy Sets and Systems, **220** (2013), 1-20. doi: 10.1016/j.fss.2012.09.005.

2013

a. Results of Pure Mathematics

Extremal generalized quantum measurements

In a series of papers, G. Chiribella, G.M. D' Ariano and P. Perinotti introduce the description of quantum protocols by positive operators and show that this description has important applications. A particular case are the so-called testers, representing measurements on protocols. The set of all operators describing a certain type of protocols forms a section of the space of states on some finite dimensional Hilbert space. For general sections, we introduced the notion of a measurement as an affine map into a probability simplex and found conditions for extremality of such measurements. We proved that measurements correspond to equivalence classes of testers, characterized testers representing an extremal measurement and showed that extremality of the tester is not sufficient for extremality of the measurement.

Author: A. Jenčová
Projects: VEGA 2/0059/12, APVV-0178-11
Reference: A. Jenčová, *Extremal generalized quantum measurements*, Linear Algebra and its Applications **439** (2013), 4070-4079.

Evaluating goodness-of-fit of discrete distribution models in quantitative linguistics and
Alternative methods of goodness-of-fit evaluation applied to word length data

The use of the Pearson chi-square goodness-of-fit test is questions for discrete models in linguistics. It is argued that the stochastic independence, one of necessary conditions for a correct application of the test, is not realistic for linguistic data. Several alternative possibilities (computational and empirical approaches) are suggested. Advantages and drawbacks of the alternatives are discussed. It is demonstrated is that using different methods for goodness-of-fit evaluation leads to different results. Distributions which achieve a satisfying fit respect to one method do not have to be among the best ones if another method is chosen. Also quite different parameter estimations can be obtained.

Authors: J. Mačutek, G. Wimmer
Project: VEGA 2/0038/12
References:

[1] J. Mačutek, G. Wimmer, *Evaluating goodness-of-fit of discrete distribution models in quantitative linguistics*, Journal of Quantitative Linguistics **20** (2013), 227-240.

[2] J. Mačutek, G. Wimmer, *Alternative methods of goodness-of-fit evaluation applied to word length data*, In: Studies in Quantitative Linguistics 13, Issues in Quantitative Linguistics 3 dedicated to Karl-Heinz Best on the occasion of his 70th birthday, Köhler, R., Altmann, G. (editors), RAM-Verlag, Lüdenscheid, 282-290.

On normality of the Wijsman topology

Let (X,d) be a metric space and $(CL(X),W_d)$ be a hyperspace equipped with the Wijsman topology. Wijsman topology is a classical hyperspace topology. We gave a partial answer to a question posed in Di Maio (Quaderni di Matematica, 3:55-92, 1998) whether the normality of the Wijsman topology is equivalent to its metrizability. Let (X,d) be a linear metric space. Then $(CL(X),W_d)$ is normal if and only if $(CL(X),W_d)$ is metrizable.

Authors: Ľ. Holá, B. Novotný
Project: VEGA 2/0047/10
Reference: Ľ. Holá, B. Novotný, *On normality of the Wijsman topology*, Annali di Matematica Pura ed Applicata **192** (2013), 349-359.

Discretization of Poincaré map

We analytically study the relationship between the Poincaré map and its one step discretization. Error estimates are established depending basically on the righthand side function of the investigated ordinary diferential equation and the given numerical scheme. Our basic tool is a parametric version of a Newton–Kantorovich type methods. As an application, in a neighborhood of a non-degenerate periodic solution a new type of step-dependent, uniquely determined, closed curve is detected for the discrete dynamics. The discretized Poincaré map is also a preparatory stage for further investigation of bifurcations of discrete dynamics near periodic solutions.

Authors: M. Fečkan, S. Kelemen
Project: VEGA 2/0029/13
Reference: M. Fečkan, S. Kelemen, *Discretization of Poincaré map*, Electronic Journal of Qualitative Theory of Diferential Equations, No. **60** (2013), 1-33.

b. Results of Applied Mathematics

Evolutionary optimization calculations for gas transmission networks

For the optimization of Slovak gas transmission network operation the algorithms based on dynamic programming are currently utilized. However, such algorithms are not suitable for complex cyclic networks and therefore new general computation methods based on evolution strategies had to be developed and implemented. They are a branch of nature-oriented algorithms emulating the population evolution and adaptation for better conditions by the principles of mutation, recombination and natural selection. While being more computationally demanding, their best advantage is the general usability and parallelizability, allowing the exploitation of full calculation potential of modern multi-core computer architecture. Apart from gas transmission network optimization with regards to overall costs or gas, electricity and energy consumption, the algorithms were utilized for maximal and minimal gas network line pack calculations. The resulting solutions conform to all technological, operational and user restrictions for the transport.

Authors: M. Bayer, R. Hajossy, I. Mračka, K. Nemoga, P. Somora, A. Sedliak, T. Sedláková, M. Spál, P. Vadovič, T. Žáčik (head)
Project: 1235 Gas transport optimization through transit pipelines
Reference: Contract 456/12/EUS between the Mathematical Institute of the Slovak Academy of Sciences and eustream, a.s.

c. Results of International Projects

State-morphism algebras

We studied different algebraic structures whose original language was extended by a fixed state-morphism, i.e. by an idempotent homomorphism. We presented a complete characterization of basic stone bricks - subdirectly irreducible elements of BL-algebras with state-morphisms. We defined diagonal state-morphism algebras a we have showed that every state-morphism algebra can be embedded into a diagonal one. We described generators of varieties of state-morphism algebras by diagonal state-morphism algebras and we have applied the result to BL-algebras, nonassociative BL-algebras and pseudo MV-algebras.

Authors: Anatolij Dvurečenskij (MI SAS), Michal Botur (Prir. Fak. Palackého Univ., Olomouc, ČR).
Projects: Center of Excellence SAS-Quantum Technologies-, ERDF OP R&D Project meta-QUTE ITMS 26240120022, the grant VEGA No. 2/0059/12 SAV
Reference: M. Botur, A. Dvurečenskij, *State-morphism algebras - general approach*, Fuzzy Sets and Systems **218** (2013), 90-102. DOI: http://dx.doi.org/10.1016/j.fss.2012.08.013

Exploring an unknown dangerous graph using tokens

The topic of the paper is exploration of an unknown graph (representing e.g. a computer network)

assuming one of the nodes is a so-called "black hole", i.e. a node which destroys without any observable trace any incoming entity (e.g. a software agent) that visits it. The task is to build a map of the graph and to identify the location of the black hole using a set of mobile agents while minimizing cost (number of agents enering the black hole, time, communication). This problem has been investigated in a model where the agents communicate using whiteboards located at the nodes. In this paper, it is shown that the black hole can be efficiently located also in a much weaker model in which the only means of communication are anonymous identical pebbles/tokens that the agents can place/remove from the nodes.

Authors: Stefan Dobrev (SAV Bratislava), Paola Flocchini (University of Ottawa, Ottawa, Kanada), Rastislav Královič (FMFI UK, Bratislava), Nicola Santoro (Carleton University, Ottawa, Kanada)
Project: VEGA 2/0136/12
Reference: S. Dobrev, P. Flocchini, R. Kráľovič, N. Santoro, *Exploring an unknown dangerous graph using tokens*, Theoretical Computer Science **472** (2013), 28-45.

Quotient Complexity of Ideal Languages

A language L over an alphabet A is a right (left) ideal if it satisfies L=LA* (L=A*L). It is a two-sided ideal if L=A*LA*, and an all-sided ideal if it is equal to the shuffle of A* with L. Ideal languages are not only of interest from the theoretical point of view, but also have applications to pattern matching. We study the state complexity of common operations in the class of regular ideal languages, but prefer to use the equivalent term ``quotient complexity'', which is the number of distinct left quotients of a language. We find tight upper bounds on the complexity of each type of ideal language in terms of the complexity of an arbitrary generator and of the minimal generator, and also on the complexity of the minimal generator in terms of the complexity of the language. Moreover, tight upper bounds on the complexity of union, intersection, set difference, symmetric difference, concatenation, star, and reversal of ideal languages are derived.

Authors: Galina Jirásková (Mi SAS), Janusz Brzozowski, Baiyu Li (David R. Cheriton School of Computer Science, University of Waterloo, Waterloo,Canada)
Project: VEGA 2/0111/09
Reference: J. Brzowski, G. Jirásková, B. Li, *Quotient Complexity of Ideal Languages*, Theoretical Computer Science **470** (2013) 36-52.

2014

a. Results of Pure Mathematic

Multi- and multi-polar capacities

We have shown applications of multi-polar aggregation introduced for fuzzy classification systems in the game theory, multi-criteria decision making and in election methods. We have defined multi- and (generalized) multi-polar capacities as a counterpart to capacities in the two models of multi-polarity and clarified their position between multi-polar Boolean functions and multi-polar aggregation. We have studied their basic properties and shown that although for $m > 2$ the behavior of multi- and multi-polar capacities is similar for $m = 2$ their structure is different.

Authors: A. Mesiarová-Zemánková, M. Hyčko
Projects: APVV-0178-11, VEGA 2/0049/14, VEGA 2/0059/12 and Program Fellowship of SAS.
Reference: A. Mesiarová-Zemánková, M. Hyčko, *Multi-capacities and multi-polar capacities*, Fuzzy Sets and Systems, **291** (2016), 18-32. http://dx.doi.org/10.1016/j.fss.2014.12.005

D-posets of fuzzy sets

D-posets, equivalently effect algebras, are quantum structures suitable to model and study processes with uncertainty. D-posets of fuzzy sets represent a particular case and have been succesfully utilized

within a categorical approach to probability. A classification of D-posets has been proposed and relationships among the corresponding categories have been described. Fuzzification of the two-valued Boolean cogenerator has been described. It has been proved that the generated Lukasiewicz tribes form an epireflective subcategory of the category of bold algebras. If probability measures are assumed to be morphisms, then the fuzzification of classical probability is shown to be forced. IF-probability can be studied within fuzzy probability. A tensor modification of fuzzy probability has been developed.

Authors: R. Frič a M. Papčo
Projects: VEGA 2/0046/11, APVV-0178-11
References:

[1] R. Frič, *D-posets of fuzzy sets*, Mathematica Slovaca **64** (2014), 545–554.
[2] R. Frič, M. Papčo, *On probability domains III*. Inter. J. Theor. Phys. **54** (2015), 4237-4246.

New Dynamic Orderings for the Parallel One-Sided Block-Jacobi SVD Algorithm

Five variants of a new dynamic ordering are presented for the parallel one-sided block Jacobi SVD algorithm. All variants of dynamic ordering are compared with a parallel cyclic ordering, two-sided block-Jacobi method with dynamic ordering and the ScaLAPACK routine PDGESVD with respect to the number of parallel iteration steps needed for the convergence and total parallel execution time. It turns out that the variant 3, for which a local optimality in some precisely defined sense can be proved, and its combination with variant 2, are the most efficient ones. For relatively small blocking factors, they outperform the ScaLAPACK procedure PDGESVD and are about 2 times faster.

Authors: M. Bečka, G.Okša, M. Vajteršic
Project: VEGA 2/0026/14
Reference: M. Bečka, G. Okša, M. Vajteršic: *New dynamic orderings for the parallel one-sided block-Jacobi SVD*. Algorithm Parallel Processing Letters **25** (2015), 1550003.

Distribution functions of sequences

Let *x(n)* be a van der Corput sequence, i.e. if the index n has a b-adic expansion *n=n(1)n(2)...n(k)*, then *x(n)* has opposite expansion *x(n)=0.n(k)(n(k-1)...n(1)*. In the paper we found concrete form of the distribution function *g(x,y,z)* of the 3-dimensional sequence *(x(n),x(n+1),x(n+2))*. It has 27 possibilities. It is connected with the von Neuman-Kakutani transformation. As an application we compute the limit of arithmetic means of the sum *F(x(n),x(n +1),(x(n+2))* as the Riemann-Stieltjes integral *F(x,y,z)* over *g(x,y,z)*, where *F(x,y,z)=max(x,y,z)* or *min(x,y,z)*.

Authors: J. Fialová, O.Strauch (MÚ SAV), L. Mišík (University of Ostrava)
Projects: VEGA 1/1022/12, VEGA 2/0146/14. The paper is also a result of a cooperation between MÚ SAV and University of Ostrava.
Reference: FIALOVÁ, J. - MIŠÍK, L. - STRAUCH, O., *An asymptotic distribution function of the three-dimensional shifted van der Corput sequence*, Applied Mathematics **5** (2014), 2334–2359, http://dx.doi.org/10.4236/am.2014.515227.

b. Results of Applied Mathematics

The simulation of high-dynamic turbulent gas flow in pipelines

The complete, one-dimensional system of conservation equations with terms for pipe resistance, the influence of gravity and heat transfer through the pipe wall is modeled. Numerical simulation is based on central-upwind Godunov-type scheme and was implemented using various kinds of parallelization (CPU and also GP-GPU massive parallelization). The developed simulator is able to realistically model high-dynamic processes such as the rarefaction wave after pipeline rupture or the shock waves after opening valves. The simulator has been used for testing and development of methods for detection and localization of accidents on the distribution and transit pipelines. Obtained results have been presented at the international gas conference of the Pipeline Simulation Interesting Group (PSIG).

Authors: M. Bayer, R. Hajossy, I. Mračka, K. Nemoga, P. Somora, A. Sedliak, T. Sedláková, M. Spál, P. Vadovič, T. Žáčik (head)
Project: 1235 Gas transport optimization through transit pipelines
Reference: Hajossy, R., Mračka, I., Žáčik T.: *Cooling of a Wire as the Model for Rupture Location*. In: Pipeline Simulation Interest Group Annual Meeting 2014, May 6-9, Baltimore, Maryland, USA, PSIG-1408. https://www.onepetro.org/conference-paper/PSIG-1408

c. Results of International Projects

Travelling waves in nonlinear magnetic metamaterials

In the work, an infinite system of coupled scalar nonlinear differential equations of second order (system of nonlinear resonators) with outer forcing in a form of a travelling wave was investigated. Some results on the existence and uniqueness of periodic and asymptotic travelling waves were proved. The results for asymptotic waves were confirmed by a numerical experiment.

Authors: Josef Diblík (Brno University of Technology), Michal Fečkan (Mathematical Institute of the SAS, Comenius University), Michal Pospíšil (Mathematical Institute of the SAS, Brno University of Technology), Vassilios Rothos (Aristotle University of Thessaloniki), Hadi Susanto (University of Nottingham)
Project: VEGA 2/0029/13
Reference: J. Diblík, M. Fečkan, M. Pospíšil, V. Rothos, H. Susanto, *Travelling waves in nonlinear magnetic metamaterials*, "Localized Excitations in Nonlinear Complex Systems (LENCOS'12): Current State of the Art and Future Perspectives, Editors: R. Carretero-González, J. Cuevas-Maraver, D.J. Frantzeskakis, N. Karachalios, P.G. Kevrekidis, and F. Palmero. Series: Nonlinear Systems and Complexity, Volume 7, 2014. 432 p., 117 illus. in color, ISBN: 978-3-319-02057-0", 335–358.

Logarithmic Lambert W × F random variables for the family of chi-squared distributions and their applications

We introduce and characterize in details a new class of log-Lambert W × χ^2_v random variables, their distribution and characteristic function and other basic characteristics. These random variables naturally appear in the likelihood based inference. The obtained results are applied to solve some statistical inference tasks (distribution of the likelihood-ratio test (LRT) statistic for testing a single variance component, distribution of the LRT statistic for testing normal linear regression model parameters, distribution of the (restricted) LRT statistic for testing canonical variance components). Mentioned test statistics have exact (non-asymptotic) distributions.

Authors: Witkovský, V. (Institute of Measurement SAS), WIMMER, G. (Institute of Mathematics SAS), Duby, T. (Bicester,Oxfordshire,United Kingdom)
Projects: APVV-0096-10,SK-AT-0025-12, VEGA2/0038/12, VEGA2/0043/13
Reference: Witkovský. V., WIMMER, G., Duby, T.: *Logarithmic Lambert W × F random variables for the family of chi-squared distributions and their applications.* Statistics & Probability Letters **96** (2015), 223–231.

Unitizing of generalized pseudo effect algebras

As is well-known, every generalized pseudo effect algebra can be embedded as a maximal ideal in an effect algebra called its unitization. We have shown that a necessary and sufficient condition that a generalized pseudo effect algebra can similarly be embedded as a maximal ideal in a pseudo effect algebra is that it admits a so-called unitizing automorphism. On the other hand, we have shown that a pseudo effect algebra is a unitization of a generalized pseudo effect algebra if and only if it admits a two-valued state.

Authors: S. Pulmannová (Institute of Mathematics SAS), D.J. Foulis (Univ. Massachussett, USA)
Project: APVV-0178-11, VEGA No. 2/0059/12
Reference: D. J. Foulis, S. Pulmannová, *Unitizing a generalized pseudo effect algebra*, Order **32** (2015), 189-204. DOI 10.1007/s11083-014-9325-9.

State morphism BCK-algebras

We extended the notion of a state operator on BCK-algebras as an idempotent operator preserving basic BCK-operations which extends the language of BCK-algebras. The system of BCK-algebras is only a quasi-variety and not a variety, therefore, we cannot use automatically the techniques developed for varieties. We have shown that the diagonal state operators play a basic role, and we have described the subdirectly irreducible state BCK-algebras – building bricks of the theory. We have introduced adjoint pairs. We have found generators of quasi-varieties of state morphisms BCK-algebras.

Authors: R.A. Borzooei (Univ. Tehran, Iran), A. Dvurečenskij (Institute of Mathematics SAS), O. Zahiri (Univ. Tehran, Iran)
Projects: APVV-0178-11, VEGA No. 2/0059/12
Reference: R.A. Borzooei, A. Dvurečenskij, O. Zahiri, *State BCK-algebras and state-morphism BCK-algebras*, Fuzzy Sets and Systems **244** (2014), 86–105. DOI: 10.1016/j.fss.2013.12.007

2015

a. Results of Pure Mathematics

Topology of uniform convergence and Čech-Stone compactification

In this paper, the density of the topology of uniform convergence on the space of real-valued continuous functions on a completely regular space X is investigated. Apparently, this density plays a crucial role for many questions concerning cardinal invariants on various topologies on the space of continuous functions. Topology of uniform convergence is nowadays a classical notion and the notion of density can be considered as one of the basic notions in topology and is also important in mathematical analysis. Despite these factors, the density of the topology of uniform convergence is not very well known in the general case. In the paper, the relationship of this density to two other cardinal invariants is investigated. One is the weight of the Čech-Stone compactification of X and the other one is the compactness degree of X. For a metrizable or pseudocompact space X a specific formula have been found and for a countably paracompact normal space estimates.

Authors: Ľ. Holá, B. Novotný
Projects: VEGA 2/0018/13, APVV-0269-11
Reference: Ľ. Holá, B. Novotný: *Topology of uniform convergence and Čech-Stone compactification*, J. Math. Anal. Appl. **424** (2015), 470–474.

Lexicographic pseudo MV-algebras

A lexicographic pseudo MV-algebra is an algebra that is isomorphic to an interval in the lexicographic product of a unital linearly ordered group with an arbitrary l-group. We present conditions when a pseudo MV-algebra is lexicographic. We show that a key condition is the existence of a lexicographic ideal, or equivalently, a case when the algebra can be split into comparable slices indexed by elements of the interval [0, u] of some unital linearly ordered group (H, u). Finally, we show that fixing the unital linearly ordered group (H, u), the category of (H, u)-lexicographic pseudo MV-algebras is categorically equivalent to the category of l-groups.

Author: A. Dvurečenskij
Projects: APVV-0178-11, grant VEGA 2/0059/12 SAV
Reference: A. Dvurečenskij: *Lexicographic pseudo MV-algebras*, J. Appl. Logic **13** (2015), 825–841. DOI:10.1016/j.jal.2015.10.001

Boundaries of quantum convex structures

Convexity is one of unavoidable features of mathematical description of physical systems. Operationally, it expresses the ability to switch randomly between different physical devices of the same type and it has

been observed previously that some of importnat statistical properties of ensembles of devices, such as distinguishability, can be obtained solely from their convex structure. In a previous work by some of the authors, the concept of boundariness was introduced for interior points of convex sets, expressed by the most excentric decomposition into a convex combination of boundary points. We show that for sets of quantum devices, this decomposition always consits of boundary elements which are best resp. least distinguishable from the given interior point, and that boundariness expresses the smallest possible error probability. For quantum channels, it is shown that the best distinguishable element is always a unitary channel. Some properties of boundariness are also discussed.

Authors: Z. Puchala, A. Jenčová (MI SAS), M. Sedlák, M. Ziman
Projects: VEGA 2/0059/12, 2/0125/13, APVV-0178-11
Reference: Z. Puchala, A. Jenčová, M. Sedlák, M. Ziman: *Exploring boundaries of quantum convex structures: special role of unitary processes*, Phys. Rev. A **92** (2015), 012304.

Operations on self-verifying finite automata

We investigate the complexity of regular operations on languages represented by self-verifying automata. We get the tight bounds for complement, intersection, union, difference, symmetric difference, reversal, star, left and right quotients, and asymptotically tight bound for concatenation. To prove tightness, we use a binary alphabet in the case of boolean operations and reversal, and an alphabet that grows exponentially for the remaining operations. However, we also provide exponential lower bounds for these operations using a fixed alphabet.

Authors: J. Jirásek, G. Jirásková (MI SAS), A. Szabari
Projects: VEGA 2/0084/15, VEGA 1/0142/15
Reference: J. Jirásek, G. Jirásková, A. Szabari: *Operations on self-verifying finite automata*. In: Lev D. Beklemishev and Daniil V. Musatov (eds.) CSR 2015. Springer (2015) LNCS, vol. **9139**, pp. 231–261.

b. Results of Applied Mathematics

Depressurization of a gas reservoir by a pipe of arbitrary length

Depressurization of a gas reservoir or a compressor pipe yard is a frequently occurring process. In spite of this, the process was well described only in the case of a very short or a very long blow-off pipe. Therefore we dealt with a model of depressurization of reservoir through the pipe of an arbitrary length. We derived a simplified model of sonic and subsonic flow and its explicit approximation. The proposed model was verified by Frössel's formula and compared with known approximate models of reservoir depressurization through very long and very short pipes. Finally, we verified the model using real measurements. The model was applied to solve practical problems – it was necessary to determine the loss of technical gas during blow-off and blow-through procedures of pipe yards of real compressors.

Authors: M. Bayer, R. Hajossy, I. Mračka, K. Nemoga, P. Somora, A. Sedliak, T. Sedláková, T. Žáčik (head)
Project: 1235 Gas transport optimization through transit pipelines
Reference: R. Hajossy, I. Mračka, T. Žáčik: *Depressurization of a gas reservoir by a pipe of arbitrary length.* In: Pipeline Simulation Interest Group Annual Meeting 2015, May 12-15, New Orleans, Louisiana, USA, PSIG-1515. https://www.onepetro.org/conference-paper/PSIG-1515

c. Results of International Projects

Projections in synaptic algebras

P. Halmos (1969) studied two projections P and Q on a Hilbert space in so-called generic position, and proved a basic theorem, now called the CS-decomposition theorem, that expresses Q in terms P and positive contraction operators C and S, called the cosine and sine operators, respectively, for Q with respect to P. In [1], we proved a generalization
of the CS-decomposition theorem in the setting of a so-called synaptic algebra, which was introduced by Foulis (2010) as an abstract version of the partially ordered Jordan algebra of all bounded Hermitian

operators on a Hilbert space. Working only with a synaptic algebra, we had to forgo both Hilbert space and the operator matrix calculus, and use other methods, based mainly on the Peirce decomposition. In [2], we have shown that a version of Halmos's
CS-decomposition theorem applies also for a projection p and an effect e in a synaptic algebra, and we introduced and studied two candidates for a commutator projection for p and e.

Authors: S. Pulmannová (MÚ SAV), A. Jenčová (MÚ SAV), D.J. Foulis (Univ. Massachussett, USA)
Projects: Grant APVV-0178-11, VEGA 2/0059/12
References:

[1] D.J. Foulis, A. Jenčová, S. Pulmannová: *Two projections in a synaptic algebra,* Linear Algebra and its Applications **478** (2015), 162—187.
[2] D.J. Foulis, A. Jenčová, S. Pulmannová: *A projection and an effect in a synaptic algebra*, Linear Algebra and its Applications **485** (2015), 417—441.

On lattices with a smallest set of aggregation functions

Aggregation represents the process of combining several values into single representative one, while the numerical function performing this process is called an aggregation function. Recently, the notion of aggregation function was extended and intensively studied within more general structures than the set of real numbers, on bounded lattices in particular. Given a bounded lattice, it is well known that the set of all polynomial functions preserving the universal bounds forms a natural subclass of the set of all aggregation functions. The main aim was to characterize all finite lattices, for which these two classes coincide, i.e., when the set of all aggregation functions is as small as possible. These lattices are shown to be completely determined by their reflexive, symmetric and compatible binary relations, commonly referred to as tolerances. Particularly, it has been proven that a finite lattice contains precisely the above mentioned polynomials as its aggregation function if and only if, it has only the trivial tolerances.

Authors: R. Halaš (Univ. Palackého, Olomouc, ČR), J. Pócs (MÚ SAV)
Projects: VEGA 2/0028/13, ESF Fund CZ.1.07/2.3.00/30.0041
Reference: R. Halaš, J. Pócs: *On lattices with a smallest set of aggregation functions*, Information Sciences **325** (2015), 316–323.

The statistical uncertainty of the Heydemann correction: a practical limit of optical quadrature homodyne interferometry

Although the Heydemann correction is widely used to demodulate the phase of quadrature homodyne interferometer and encoder signals, the related measurement uncertainty is considered only in a few publications. The statistical uncertainty of the Heydemann correction has been determined properly for the first time. Furthermore, for cases in which a number of points used in the fit is sufficiently large, a new, simple, analytic expression for the statistical uncertainty of the phase is derived. It represents a practical limit of optical quadrature displacement interferometry, which already has been reached experimentally. An improved ellipse fitting procedure using linearized nonlinear constraints was used to determine the influence of minimizing the algebraic distance instead of the geometric one. It provides unbiased linear estimators of the parameters exhibiting the minimal statistical uncertainty i.e. optimal estimators. In addition, for this method, the statistical uncertainty of the phase can be determined exactly using the error propagation law without any difficulties. The analytic expression provided here is new and represents a lower limit of the statistical uncertainty of the phase. It is also a major finding of the work. The Monte Carlo simulations do justify our procedures.

Authors: R. Köning (Physikalisch-Technische Bundesanstalt, Braunschweig, Germany), G. Wimmer (MÚ SAV), V. Witkovský (ÚM SAV)
Projects: grant APVV-0096-10 a granty VEGA 2/0047/15, VEGA 2/0043/13
References: R. Köning, G. Wimmer, V. Witkovský: *The statistical uncertainty of the Heydemann correction: a practical limit of optical quadrature homodyne interferometry*, Measurement Science and Technology **26** (2015), 084004, doi:10.1088/0957-0233/26/8/084004

Class number of real Abelian fields

The problem of class number of rings of integers in algebraic number fields is originally motivated by the effort to prove Fermat Last Theorem using the property of canonical decompositions of its elements. The principal problems of such proof consist in the fact that these decompositions are not necessary unique. Thus this research leads to the question to derive some conditions providing the uniqueness. During the history of this research the connection with the divisibility of Bernoulli's numbers was discovered. The achieved result is to derive a sufficient condition which guaranties non divisibility of first factor of class number by certain type of primes from arithmetic progressions.

Authors: S. Jakubec (MÚ SAV), M. Paštéka (MÚ SAV), A. Schinzel (MÚ PAN, Warszawa, Poland)
Project: VEGA 2/0146/14
Reference: S. Jakubec, M. Paštéka, A. Schinzel: *Class number of real Abelian fields*. Journal of Number Theory **148** (2015), 365–371.

2. Partial indicators of main activities:

2.1. Research output

2.1.1. Principal types of research output of the institute: basic research/applied research, international/regional (ratios in percentage)

basic research (90%) vs. applied research (10 %)
international (100 %) vs. regional (0 %)

2.1.2 List of selected publications documenting the most important results of basic research. The total number of publications listed for the assessment period should not exceed the average number of employees with university degrees engaged in research projects. The principal research outputs (max. 5, including Digital Object Identifier - DOI) should be underlined

2012

1. BOTUR, M. - DVUREČENSKIJ, Anatolij - KOWALSKI, T. On normal-valued basic pseudo hoops. In Soft Computing, 2012, vol. 16, s. 635-644. (1.880 - IF2011). (2012 - Current Contents). ISSN 1432-7643.
2. BUHAGIAR, D. - CHETCUTI, E. - DVUREČENSKIJ, Anatolij. Quasi-splitting subspaces and Foulis-Randall subspaces. In Journal of Mathematical Physics, 2011, vol. 52, č. 123508-07. (1.291 - IF2010). (2011 - Current Contents). ISSN 0022-2488.
3. DJIDJEV, H.N. - VRŤO, Imrich. Planar crossing numbers of graphs of bounded genus. In Discrete and Computational Geometry, 2012, vol. 48, s. 393-415. (0.938 - IF2011). (2012 - Current Contents). ISSN 0179-5376.
4. DVUREČENSKIJ, Anatolij - RACHUNEK, J. - ŠALOUNOVÁ, D. State operators on generalizations of fuzzy structures. In Fuzzy Sets and Systems, 2012, vol. 187, s. 58-76. (1.759 - IF2011). (2012 - Current Contents). ISSN 0165-0114.
5. JENČOVÁ, Anna. Generalized channels: Channels for convex subsets of the state space. In Journal of Mathematical Physics, 2012, vol. 53, art. no. 012201. (1.291 - IF2011). (2012 - Current Contents). ISSN 0022-2488.
6. JIRÁSKOVÁ, Galina - MASOPUST, T. On a structural property in the state complexity of projected regular languages. In Theoretical Computer Science, 2012, vol. 449, s. 93-105. (0.665 - IF2011). (2012 - Current Contents). ISSN 0304-3975.
7. KARABÁŠ, Ján - NEDELA, Roman. Archimedean maps of higher genera. In Mathematics of Computation, 2012, vol. 81, no. 277, s. 569-583. (1.313 - IF2011). (2012 - Current Contents). ISSN 0025-5718.
8. KÖNING, R. - KAROVIČ, Karol - WIMMER, Gejza - WITKOVSKÝ, Viktor. Estimating the standard uncertainty contribution of the straight-line fit algorithm used to determine the position and the width of a graduation line. In Metrologia, 2012, vol. 49, no. 3, p. 169-

179. (1.750 - IF2011). (2012 - Current Contents). ISSN 0026-1394.
9. MESIAR, R. - MESIAROVÁ-ZEMÁNKOVÁ, Andrea. The Ordered Modular Averages. In IEEE Transactions on Fuzzy Systems, 2011, vol. 19, no. 1, s. 42-50. (2.683 - IF2010). (2011 - Current Contents). ISSN 1063-6706.
10. MESIAROVÁ-ZEMÁNKOVÁ, Andrea - AHMAD, K. Differences between t-norms in fuzzy control. In International Journal of Intelligent Systems, 2012, vol. 27, no. 7, s. 662-679. (1.653 - IF2011). (2012 - Current Contents). ISSN 0884-8173.
11. PÓCS, Jozef. On possible generalization of fuzzy concept lattices using dually isomorphic retracts. In Information Sciences, 2012, vol. 210, s. 89-98. (2.833 - IF2011). (2012 - Current Contents). ISSN 0020-0255.
12. PÓCS, Jozef. Note on generating fuzzy concept lattices via Galois connections. In Information Sciences, 2012, vol. 185, no. 1, s. 128-136. (2.833 - IF2011). (2012 - Current Contents). ISSN 0020-0255.
13. POSPÍŠIL, Michal - MEDVEĎ, Milan. Sufficient conditions for the asymptotic stability of nonlinear multidelay differential equations with linear parts defined by pairwise permutable matrices. In Nonlinear Analysis: Theory, Methods & Applications, 2012, vol. 75, no. 7, s. 3348-3363. (1.536 - IF2011). (2012 - Current Contents). ISSN 0362-546X.
14. PULMANNOVÁ, Sylvia - VINCEKOVÁ, Elena. Abelian extensions of partially ordered partial monoids. In Soft Computing, 2012, vol. 16, s. 1339-1346. (1.880 - IF2011). (2012 - Current Contents). ISSN 1432-7643.

2013

1. BERKA, T. - KOLLIAS, G. - HAGENAUER, H. - VAJTERŠIC, Marián - GRAMA, A. Concurrent programming constructs for parallel MPI applications: The MPI library. T. Berka, G. Kollias, H. Hagenauer, M. Vajtersic, A. Grama. In Journal of Supercomputing, 2013, vol. 63, s. 385-406. (0.917 - IF2012). (2013 - Current Contents). ISSN 0920-8542.
2. BOTUR, M. - DVUREČENSKIJ, Anatolij. State-morphism algebras - general approach. In Fuzzy Sets and Systems, 2013, vol. 218, s. 90-102. (1.749 - IF2012). (2013 - Current Contents). ISSN 0165-0114.
3. CHOVANEC, Ferdinand - JURČKOVÁ, Mária. Fractal properties of MV-algebra pastings. In Fuzzy Sets and Systems, 2013, vol. 232, s. 46-61. (1.749 - IF2012). (2013 - Current Contents). ISSN 0165-0114.
4. DIBLÍK, J. - FEČKAN, Michal - POSPÍŠIL, Michal. Representation of a solution of the Cauchy problem for an oscillating system with multiple delays and pairwise permutable matrices. In Abstract and applied analysis, 2013. (1.102 - IF2012). (2013 - Current Contents). ISSN 1085-3375.
5. DVUREČENSKIJ, Anatolij. Kite Pseudo Effect Algebras. In Foundations of Physics, 2013, vol. 43, s. 1314-1338. (1.170 - IF2012). (2013 - Current Contents). ISSN 0015-9018.
6. DVUREČENSKIJ, Anatolij - XIE, Y. - YANG, A. Discrete (n + 1)-valued states and nperfect pseudo-effect algebras. In Soft Computing, 2013, vol. 17, s. 1537-1552. (1.124 - IF2012). (2013 - Current Contents). ISSN 1432-7643.
7. DVUREČENSKIJ, Anatolij - XIE, Y. Atomic effect algebras with the Riesz decomposition property. In Foundations of Physics, 2012, vol. 47, s. 1078-1093. (1.055 - IF2011). (2012 - Current Contents). ISSN 0015-9018.
8. FEČKAN, Michal - POSPÍŠIL, Michal. Discretization of dynamical systems with first integrals. In Discrete and Continuous Dynamical Systems, 2013, vol. 33, s. 3543-3554. (1.005 - IF2012). (2013 - Current Contents). ISSN 1078-0947.
9. FEČKAN, Michal - WANG, J. - ZHOU, Y. Controllability of fractional functional evolution equations of Sobolev type via characteristic solution operators. In Journal of Optimization Theory and Applications, 2013, vol. 156, s. 79-95. (1.423 - IF2012). (2013 - Current Contents). ISSN 0022-3239.
10. FOULIS, D.J. - PULMANNOVÁ, Sylvia. Type-decompositions of a synaptic algebra. In Foundations of Physics, 2013, vol. 43, s. 948-986. (1.170 - IF2012). (2013 - Current Contents). ISSN 0015-9018.

11. MESIAROVÁ-ZEMÁNKOVÁ, Andrea - AHMAD, K. Multi-polar Choquet integral. In Fuzzy Sets and Systems, 2013, vol. 220, s. 1-20. (1.749 - IF2012). (2013 - Current Contents). ISSN 0165-0114.
12. RIEČAN, Beloslav. Variation on a Poincaré theorem. In Fuzzy Sets and Systems, 2013, vol. 232, s. 29-35. (1.749 - IF2012). (2013 - Current Contents). ISSN 0165-0114.
13. WANG, J. - ZHOU, Y. - FEČKAN, Michal. Nonlinear impulsive problems for fractional differential equations and Ulam stability. In Computers & Mathematics with Applications, 2012, vol. 64, s. 3389-3405. (1.747 - IF2011). (2012 - Current Contents). ISSN 0898-1221.
14. WANG, J. - ZHOU, Y. - FEČKAN, Michal. On recent developments in the theory of boundary value problems for impulsive fractional differential equations. In Computers & Mathematics with Applications, 2012, vol. 64, s. 3008-3020. (1.747 - IF2011). (2012 - Current Contents). ISSN 0898-1221.

2014

1. BATTELLI, F. - FEČKAN, Michal. Melnikov theory for nonlinear implicit ODEs. In Journal of differential equations, 2014, vol. 256, s. 1157-1190. (1.570 - IF2013). (2014 - Current Contents). ISSN 0022-0396.
2. BORZOOEI, R.A - DVUREČENSKIJ, Anatolij - ZAHIRI, O. State BCK-algebras and state-morphism BCK-algebras. In Fuzzy Sets and Systems, 2014, vol. 244, s. 86-105. (1.880 - IF2013). (2014 - Current Contents). ISSN 0165-0114.
3. BUTKA, P. - PÓCS, Jozef - PÓCSOVÁ, J. On equivalence of conceptual scaling and generalized one-sided concept lattices. In Information Sciences, 2014, vol. 259, s. 57-70. (3.893 - IF2013). (2014 - Current Contents). ISSN 0020-0255.
4. DANCA, M.-F. - FEČKAN, Michal - ROMERA, M. Generalized form of Parrondo's paradoxical game with applications to chaos control. In International Journal of Bifurcation and Chaos, 2014, vol. 24. (1.017 - IF2013). (2014 - Current Contents). ISSN 0218-1274.
5. DANČÍK, Vladimír - CARREL, H. - BODYCOMBE, N.E. - SEILER, K.P. - FOMINA-YADLIN, D. - KUBICEK, S.T. - HARTWELL, K. - SHAMJI, A.F. - WAGNER, B. K. - CLEMONS, P.A. Connecting Small Molecules with Similar Assay Performance Profiles Leads to New Biological Hypotheses. In Journal of Biomolecular Screening, 2014, vol. 19, no. 5, s. 771-781. (2.012 - IF2013). (2014 - Current Contents). ISSN 1087-0571.
6. DVUREČENSKIJ, Anatolij - KUKOVÁ, M. Observables on quantum structures. In Information Sciences, 2014, vol. 262, s. 215-222. (3.893 - IF2013). (2014 - Current Contents). ISSN 0020-0255.
7. GHISELLI RICCI, R. - MESIAR, R. - MESIAROVÁ-ZEMÁNKOVÁ, Andrea. Lipschitz Triangular Subnorms. In Fuzzy Sets and Systems, 2014, vol. 240, s. 51-65. (1.880 - IF2013). (2014 - Current Contents). ISSN 0165-0114.
8. JENČOVÁ, Anna. Base norms and discrimination of generalized quantum channels. In Journal of Mathematical Physics, 2014, vol. 55, 022201. (1.176 - IF2013). (2014 - Current Contents). ISSN 0022-2488.
9. KÖNING, R. - WIMMER, Gejza - WITKOVSKÝ, Viktor. Ellipse fitting by nonlinear constraints to demodulate quadrature homodyne interferometer signals and to determine the statistical uncertainty of the interferometric phase. In Measurement Science and Technology, 2014, vol. 25, no. 11, p. 115001. (1.352 - IF2013). (2014 - Current Contents). ISSN 0957-0233.
10. MESIAROVÁ-ZEMÁNKOVÁ, Andrea - AHMAD, K. Extended multi-polarity and multi-polar-valued fuzzy sets. In Fuzzy Sets and Systems, 2014, vol. 234, s. 61-78. (1.880 - IF2013). (2014 - Current Contents). ISSN 0165-0114.

11. MESIAROVÁ-ZEMÁNKOVÁ, Andrea. Multi-polar aggregation operators in reasoning methods for fuzzy rule-based classification systems. In IEEE Transactions on Fuzzy Systems, 2014, vol. 22, no. 6, s. 1569-1584. (6.306 - IF2013). (2014 - Current Contents). ISSN 1063-6706.
12. PULMANNOVÁ, Sylvia - VINCEKOVÁ, Elena. State-morphism pseudo-effect algebras. In Soft Computing, 2014, vol. 18, s. 5-13. (1.304 - IF2013). (2014 - Current Contents). ISSN 1432-7643.
13. WAWER, M. J. - JARAMILIO, D. E. - DANČÍK, Vladimír - FASS, D. M. - HAGGARTY, S. J. - SHAMJI, A. F. - WAGNER, B. K. - SCHREIBER, S. L. - CLEMONS, P. A. Automated Structure-Acitivity Relationship Mining: Connecting Chemical Structure to Biological Profiles. M. J. Wawer, D. E. Jaramilio, V. Dancik, D. M. Fass, S. J. Haggarty, A. F. Shamji, B. K. Wagner, S. L. Schreiber and P. A. Clemons. In Journal of Biomolecular Screening, 2014, vol. 19, no. 5, s. 738-748. (2.012 - IF2013). (2014 - Current Contents). ISSN 1087-0571.

2015

1. BORZOOEI, R.A. - DVUREČENSKIJ, Anatolij - ZAHIRI, O. L-ordered and L-lattice ordered groups. In Information Sciences, 2015, vol. 314, s. 118-134. (4.038 - IF2014). (2015 - Current Contents, WOS, SCOPUS). ISSN 0020-0255.
2. DIBLIK, J. - FEČKAN, Michal - POSPÍŠIL, Michal. Nonexistence of periodic solutions and S-asymptotically periodic solutions in fractional difference equations. In Applied Mathematics and Computation, 2015, vol. 257, p. 230-240. (1.551 - IF2014). (2015 - Current Contents). ISSN 0096-3003.
3. DVUREČENSKIJ, Anatolij. On a new construction of pseudo effect algebras. In Soft Computing, 2015, vol. 19, s. 517-529. (1.271 - IF2014). (2015 - Current Contents, WOS, SCOPUS). ISSN 1432-7643.
4. DVUREČENSKIJ, Anatolij. States on quantum and algebraic structures and their integral representation. In Fuzzy Sets and Systems, 2015, vol. 259, s. 56-67. (1.986 - IF2014). (2015 - Current Contents, WOS, SCOPUS). ISSN 0165-0114.
5. DVUREČENSKIJ, Anatolij. On a new construction of pseudo BL-algebras. In Fuzzy Sets and Systems, 2015, vol. 271, s. 156-167. (1.986 - IF2014). (2015 - Current Contents, WOS, SCOPUS). ISSN 0165-0114.
6. HALAŠ, Radomír - PÓCS, Jozef. Generalized one-sided concept lattices with attribute preferences. In Information Sciences, 2015, vol. 303, p. 50-60. (4.038 - IF2014). (2015 - Current Contents, WOS, SCOPUS). ISSN 0020-0255.
7. JENČOVÁ, Anna - PULMANNOVÁ, Sylvia. Effect algebras with state operator. In Fuzzy Sets and Systems, 2015, vol. 260, s. 43-61. (1.986 - IF2014). (2015 - Current Contents, WOS, SCOPUS). ISSN 0165-0114.
8. KÖNING, R. - WIMMER, Gejza - WITKOVSKÝ, Viktor. The statistical uncertainty of the Heydemann correction: A practical limit of optical quadrature homodyne interferometry. In Measurement Science and Technology, 2015, vol. 26, no. 8, p. 084004. (1.433 - IF2014). (2015 - Current Contents). ISSN 0957-0233.
9. MESIAROVÁ-ZEMÁNKOVÁ, Andrea - HYČKO, Marek. Aggregation on Boolean multi-polar space: Knowledge-based vs. category-based ordering. In Information Sciences, 2015, vol. 309, s. 163-179. (4.038 - IF2014). (2015 - Current Contents, WOS, SCOPUS). ISSN 0020-0255.
10. MESIAROVÁ-ZEMÁNKOVÁ, Andrea. Multi-polar t-conorms and uninorms. In Information Sciences, 2015, vol. 301, s. 227-240. (4.038 - IF2014). (2015 - Current Contents, WOS, SCOPUS). ISSN 0020-0255.

11. MESIAROVÁ-ZEMÁNKOVÁ, Andrea - AHMAD, Khurshid. Averaging operators in fuzzy classification systems. In Fuzzy Sets and Systems, 2015, vol. 207, s. 53-73. (1.986 - IF2014). (2015 - Current Contents, WOS, SCOPUS). ISSN 0165-0114.
12. PUCHAŁA, Zbigniew - JENČOVÁ, Anna - SEDLÁK, Michal - ZIMAN, Mário. Exploring boundaries of quantum convex structures : Special role of unitary processes. In Physical Review A, 2015, vol. 92, no. 1, art. no. 012304. (2.808 - IF2014). (2015 - Current Contents). ISSN 1050-2947.
13. WAWER, Mathias J. - LI, Kejie - GUSTAFSDOTTIR, Sigrun M. - LJOSA, Vebjorn - BODYCOMBE, Nicole E. - MARTON, Melissa A. - SOKOLNICKI, Katherine L. - BRAY, Mark-Anthony - KEMP, Melissa M. - WINCHESTER, Ellen - TAYLOR, Bradley - GRANT, George B. - HON, Suk-Yee C. - DUVALL, Jeremy - WILSON, Anthony J. - BITTKER, Joshua A. - DANČÍK, Vladimír - NARAYAN, Rajiv - SUBRAMANIAN, Aravind - WINCKLER, Wendy - GOLUB, Todd R. - CARPENTER, Anne E. - SHAMJI, Alykhan F. - SCHREIBER, Stuart L. - CLEMONS, Paul A. Toward performance-diverse small-molecule libraries for cell-based phenotypic screening using multiplexed high-dimensional profiling. In Proceedings of the National Academy of Sciences of the United States of America, 2014, vol. 111, no. 30, p. 10911-10916. (9.809 - IF2013). (2014 - Current Contents). ISSN 0027-8424.

The principal research outputs (max. 5 items)

1. DVUREČENSKIJ, Anatolij - RACHUNEK, J. - ŠALOUNOVÁ, D. State operators on generalizations of fuzzy structures. In Fuzzy Sets and Systems, 2012, vol. 187, s. 58-76. (1.759 - IF2011). (2012 - Current Contents). ISSN 0165-0114. DOI:10.1016/j.fss.2011.05.023
2. FOULIS, D.J. - PULMANNOVÁ, Sylvia. Type-decompositions of a synaptic algebra. In Foundations of Physics, 2013, vol. 43, s. 948-986. (1.170 - IF2012). (2013 - Current Contents). ISSN 0015-9018. DOI: 10.1007/s10701-013-9727-3
3. MESIAROVÁ-ZEMÁNKOVÁ, Andrea. Multi-polar aggregation operators in reasoning methods for fuzzy rule-based classification systems. In IEEE Transactions on Fuzzy Systems, 2014, vol. 22, no. 6, s. 1569-1584. (6.306 - IF2013). (2014 - Current Contents). ISSN 1063-6706. DOI: 10.1109/TFUZZ.2014.2298878
4. JENČOVÁ, Anna. Base norms and discrimination of generalized quantum channels. In Journal of Mathematical Physics, 2014, vol. 55, 022201. (1.176 - IF2013). (2014 - Current Contents). ISSN 0022-2488. DOI: 10.1063/1.4863715
5. BATTELLI, F. - FEČKAN, Michal. Melnikov theory for nonlinear implicit ODEs. In Journal of differential equations, 2014, vol. 256, s. 1157-1190. (1.570 - IF2013). (2014 - Current Contents). ISSN 0022-0396. DOI: 10.1016/j.jde.2013.10.012

Besides theses representative results, the collaborators of MI SAS achieved a lot of other results which are note presented in this report and they can be found in annual reports for individual years 2012-2015. In addition, many results were obtained in a close collaboration with domestic but also with important mathematical centers in Europe and the whole world. We are also glad that we have a long-year scientific collaboration with Slovak Gas Company.

For the Mathematical Institute SAS, the most important part of its publishing activity is in publishing mathematical monographs, where results of many - year activity are concentrated. Nevertheless they are not listed at CC/WOS databases, for us they present the highlight of our activity.

2.1.3 List of monographs/books published abroad

1. PAŠTÉKA, Milan. On Four Approaches to density : SPECTRUM SLOVAKIA Series, Volume 3. Frankfurt am Main, Germany: Peter Lang, 2013. 95 s. ISBN 978-3-631-64941-1.

2.1.4. List of monographs/books published in Slovakia

1. CHOVANEC, Ferdinand. Diferenčné posety a ich grafická reprezentácia. L. Mikuláš: AOS gen. M.R. Štefánika, 2013. 247 s. ISBN 978-80-8040-479-6.

2. WIMMER, Gejza - PALENČÁR, R. - WITKOVSKÝ, Viktor - ĎURIŠ, S. Vyhodnotenie kalibrácie meradiel : Štatistické metódy pre analýzu neistôt v metrológii. Recenzenti: L. Kubáček, M. Terek, M. Dovica. Bratislava : Nakladateľstvo STU, 2015. xviii, 173 s. ISBN 978-80-227-4374-7.

The monograph
DVUREČENSKIJ, Anatolij - PULMANNOVÁ, Sylvia. New Trends in Quantum Structures. Dordrecht: Kluwer Academic; Bratislava: Ister Science, 2000. 541+xvi. pp. ISBN 0-7923-6471-6.

was reedited by Springer-Science+Business Media, B.V. in 2013 and 2014, ISBN 978-90-481-5525-5, ISBN 978-94-017-2422-7 (eBook), DOI 10.1007/978-94-017-2422-7.

The monograph
DVUREČENSKIJ, Anatolij. Gleason's Theorem and Its Applications, Kluwer Academic Publisher, Dordrecht/Boston/London, Ister Science Press, Bratislava, 1993, 325+xv.
Was reedited by -Science+Business Media, LLC in 2013, ISBN 978-90-481-4209-5, ISBN 978-94-015-8222-3 (e-Book), DOI 10.1007/978-94-015-8222-3.

2.1.5. List of other scientific outputs specifically important for the institute, max. 10 items

1. Collaboration with eustream a.s. Nitra on Applications of mathematical methods to solve of gas transport optimization – almost 20 years of collaboration.
2. Development, computer-aided implementation and placing in praxis of algorithms for pipe gas leaks, contract with CSE-Control, Nitra.
3. Development of modules of gas leaks for Great Britain and Yemen.
4. Cryptographic methods in public administration. Collaboration with National Security Bureau of SR.
5. IT security – collaboration with Ministry of Defence of the Slovak Republic.
6. Mathematical Institute SAS is the headquarter of the Slovak Association for the Club of Rome.
7. Mathematical methods of diagnostic systems in the primary circuit of nuclear power plants. We design and implement the algorithms for digital signal processing which are used in the diagnostic systems installed in the nuclear power plants (Slovak Republic, Czech Republic, China).

2.1.6. List of patents, patent applications, and other intellectual property rights registered abroad, incl. Revenues

No patents

2.1.7. List of patents, patent applications, and other intellectual property rights registered in Slovakia, incl. revenues

No patents

2.1.8. Table of research outputs (as in annual reports).

Papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) have to be listed separately.

None

Scientific publications	2012			2013			2014			2015			total			
	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	averaged number per year	av. No. / FTE	av. No. / salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad *(AAA, ABA)*	0,0	0,000	0,000	1,0	0,027	0,002	0,0	0,000	0,000	1,0	0,027	0,002	**2,0**	**0,5**	**0,013**	**0,001**
Scientific monographs and monographic studies in journals and proceedings published in Slovakia *(AAB, ABB)*	0,0	0,000	0,000	2,0	0,054	0,004	0,0	0,000	0,000	1,0	0,027	0,002	**3,0**	**0,8**	**0,020**	**0,001**
Chapters in scientific monographs published abroad *(ABC)*	2,0	0,051	0,004	3,0	0,081	0,006	1,0	0,026	0,002	6,0	0,160	0,011	**12,0**	**3,0**	**0,079**	**0,006**
Chapters in scientific monographs published in Slovakia *(ABD)*	0,0	0,000	0,000	0,0	0,000	0,000	0,0	0,000	0,000	0,0	0,000	0,000	**0,0**	**0,0**	**0,000**	**0,000**
Scientific papers published in journals registered in Current Contents Connect *(ADCA, ADCB, ADDA, ADDB)*	38,0	0,960	0,077	41,0	1,104	0,082	32,0	0,841	0,064	40,0	1,065	0,076	**151,0**	**37,8**	**0,991**	**0,075**
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS *(ADMA, ADMB, ADNA, ADNB)*	24,0	0,606	0,048	24,0	0,646	0,048	28,0	0,736	0,056	20,0	0,533	0,038	**96,0**	**24,0**	**0,630**	**0,048**
Scientific papers published in other foreign journals (not listed above) *(ADEA, ADEB)*	2,0	0,051	0,004	13,0	0,350	0,026	7,0	0,184	0,014	5,0	0,133	0,010	**27,0**	**6,8**	**0,177**	**0,013**
Scientific papers published in other domestic journals (not listed above) *(ADFA, ADFB)*	0,0	0,000	0,000	0,0	0,000	0,000	1,0	0,026	0,002	0,0	0,000	0,000	**1,0**	**0,3**	**0,007**	**0,000**
Scientific papers published in foreign peer-reviewed proceedings *(AEC, AECA)*	22,0	0,556	0,044	12,0	0,323	0,024	11,0	0,289	0,022	8,0	0,213	0,015	**53,0**	**13,3**	**0,348**	**0,026**
Scientific papers published in domestic peer-reviewed proceedings *(AED, AEDA)*	3,0	0,076	0,006	3,0	0,081	0,006	0,0	0,000	0,000	1,0	0,027	0,002	**7,0**	**1,8**	**0,046**	**0,003**
Published papers (full text) from foreign and international scientific conferences *(AFA, AFC, AFBA, AFDA)*	7,0	0,177	0,014	6,0	0,162	0,012	7,0	0,184	0,014	7,0	0,186	0,013	**27,0**	**6,8**	**0,177**	**0,013**
Published papers (full text) from domestic scientific conferences *(AFB, AFD, AFBB, AFDB)*	0,0	0,000	0,000	0,0	0,000	0,000	2,0	0,053	0,004	2,0	0,053	0,004	**4,0**	**1,0**	**0,026**	**0,002**

- **Supplementary information and/or comments on the scientific outputs of the institute.**

In the previous assessed five year period 2007-2011, the number of SCI citations was 1822 and the average number per year was 364,4. In the present assessed four year period 2012-2015 the number of SCI citations is 2170 and the average number of citations per year is 542,8 which is an 119 % increase, and the average year increase is even 149%. In addition, the number of SCOPUS citations was 188, the average number per year was 37,5. Now, the number of SCOPUS citations is 464, which is 116 citations per year, and the year increase is to 309%.

The number of CC publications in the previous five year period was 156 and the average number per year was 31,2. Now it is 152 for the four year period which means the average number per year 38,4 and the year increase is to 123 %.

2.2. Responses to the research outputs (citations, etc.)

2.2.1. Table with citations per annum.

Citations of papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) have to be listed separately.

Citations, reviews	2011		2012		2013		2014		total		
	number	No. / FTE	number	No. / FTE	number	No. / FTE	number	No. / FTE	number	averaged number per year	av. No. / FTE
Citations in Web of Science Core Collection (1.1, 2.1)	459,0	11,591	488,0	13,141	659,0	17,323	565,0	15,048	**2171,0**	**542,8**	**14,252**
Citations in SCOPUS (1.2, 2.2) if not listed above	59,0	1,490	118,0	3,178	159,0	4,179	128,0	3,409	**464,0**	**116,0**	**3,046**
Citations in other citation indexes and databases (not listed above) (3.2,4.2,9,10)	0,0	0,000	0,0	0,000	1,0	0,026	0,0	0,000	**1,0**	**0,3**	**0,007**
Other citations (not listed above) (3, 4, 3.1, 4.1)	46,0	1,162	79,0	2,127	149,0	3,917	105,0	2,797	**379,0**	**94,8**	**2,488**
Reviews (5,6)	0,0	0,000	0,0	0,000	0,0	0,000	0,0	0,000	**0,0**	**0,0**	**0,000**

2.2.2. List of 10 most-cited publications, with number of citations, in the assessment period (2011 – 2014).

1. DVUREČENSKIJ, Anatolij - PULMANNOVÁ, Sylvia. New Trends in Quantum Structures. Dordrecht : Kluwer Academic ; Bratislava : Ister Science, 2000. 541+xvi pp. ISBN 0-7923-6471-6.

   2011 – 38, 2012 – 41, 2013 – 38, 2014 – 33
   Total: 150

2. DANČÍK, Vladimír - ADDONA, T.A. - CLAUSER, K.R. - VATH, J.E. - PEVZNER, P.A. De novo peptide sequencing via tandem mass spectrometry. In Journal of Computational Biology, 1999, vol. 6, s. 327-342. ISSN 1066-5277.

   2011 – 23, 2012 – 8, 2013 – 10, 2014 – 21
   Total: 62

3. ROSA, Alexander. On certain valuations of the vertices of graph. In Theory of Graphs, International Symposium, ICC Rome. - Paris : Dunod-Gordon and Breach, 1967, s. 349-355.

   2011 – 13, 2012 – 18, 2013 – 16, 2014 – 7
   Total: 54

4. PÁZMAN, Andrej. Foundations of Optimum Experimental Design. Dordrecht : Reidel Publ. Comp, 1987. 286 s.

   2011 – 13, 2012 – 16, 2013 – 7, 2014 – 14
   Total: 50

5. DANČÍK, Vladimír - SEILER, Kathlen Petri - YOUNG, Damian W. - SCHREIBER, Stuart L. - CLEMONS, Paul A. Distinct Biological Network Properties between the Targets of Natural Products and Disease Genes. In Journal of the American Chemical Society, 2010, vol. 132 /27/, s. 9259-9261. (8.580 - IF2009). (2010 - Current Contents). ISSN 0002-7863.

   2011 – 0, 2012 – 19, 2013 – 0, 2014 – 12
   Total: 30

6. PÓCS, Jozef. Note on generating fuzzy concept lattices via Galois connections. In Information Sciences, 2012, vol. 185, no. 1, s. 128-136. (2.833 - IF2011). (2012 - Current Contents). ISSN 0020-0255.

   2011 – 0, 2012 – 8, 2013 – 13, 2014 – 10
   Total: 31

7. DVUREČENSKIJ, Anatolij - VETTERLEIN, Thomas. Pseudoeffect Algebras. I. Basic properties. In International Journal of Theoretical Physics, 2001, vol. 40, s. 685-701. ISSN 0020-7748.

   2011 – 5, 2012 – 9, 2013 – 5, 2014 – 7
   Total: 26

8. KOREC, Ivan. Small universal register machines. In Theoretical Computer Science, 1996, vol. 168, s. 267-301. ISSN 0304-3975.

   2011 – 4, 2012 – 2, 2013 – 3, 2014 – 16
   Total: 25

9. CLEMONS, P. A. - WILSON, J. A. - DANČÍK, Vladimír - MULLER, S. -CARRINSKI, H. A. - WAGNER, B. K. - KOEHLER, A. N. - SCHREIBER, S. L.Quantifying structure and performance diversity for sets of small moleculescomprising small-molecule screening collections. P. A. Clemons, J. A. Wilson, V.Dančík, S. Muller, H. A. Carrinski, B. K. Wagner, A. N. Koehler, S. L. Schreiber. InProceedings of the National Academy of Sciences of the United States of America,PNAS, 108 (17). - 2011, s. 6817-6822. ISSN 0027-8424.

   2011 – 0, 2012 – 8, 2013 – 0, 2014 – 16
   Total: 24

10. RASPAUD, A. - SCHRÖDER, H. - SÝKORA, O. - TÖRÖK, Ľubomír - VRŤO, Imrich. Antibandwidth and cyclic antibandwidth of meshes and hypercubes. In Discrete Mathematics, 2009, vol. 309, s. 3541-3552. (0.502 - IF2008). ISSN 0012-365X.

    2011 – 3, 2012 – 3, 2013 – 7, 2014 – 7
    Total: 22

11. WANG, J. - ZHOU, Y. - FEČKAN, Michal. On recent developments in the theory of boundary value problems for impulsive fractional differential equations. In Computers & Mathematics with Applications, 2012, vol. 64, s. 3008-3020. (1.747 - IF2011). (2012 - Current Contents). ISSN 0898-1221.

    2011 – 0, 2012 – 1, 2013 – 11, 2014 – 10
    Total: 22

2.2.3. List of most-cited authors from the Institute (at most 10 % of the research employees with university degree engaged in research projects) and their number of citations in the assessment period (2011– 2014).

1. prof. RNDr. Anatolij Dvurečenskij, DrSc. – 617 citations
2. doc. RNDr. Sylvia Pulmannová, DrSc. – 320 citations
3. RNDr. Imrich Vrťo, DrSc. – 202 citations
4. prof. RNDr. Michal Fečkan, DrSc. – 188 citations
5. RNDr. Martin Kochol, PhD., DSc. – 140 citations
6. RNDr. Vladimír Dančík, PhD. – 134 citations
7. prof. RNDr. Beloslav Riečan, DrSc. – 114 citations
8. Mgr. Andrea Zemánková, PhD. – 99 citations
9. RNDr. Galina Jirásková, CSc. – 98 citations
10. RNDr. Jozef Pócs, PhD. – 93 citations
11. prof. RNDr. Gejza Wimmer, DrSc. – 87 citations

- **Supplementary information and/or comments on responses to the scientific output of the institute.**

The paper

> **A. Dvurečenskij**, Pseudo *MV-algebras are intervals in l-groups*. J. Austral. Math. Soc. **72** (2002), 427-445.

was the sixth most cited paper of the Slovak independent researcher within the period 2001-2013, see D. Fiala, Y.S. Ho, Comparison of Czech and Slovak independent research in the 21st century. Current Science 110 (2016), 1524--l531.

In addition, seven researchers of the Institute have their H-index of ten or more:
A. Dvurečenskij – 17, R. Nedela – 16, S. Pulmannová – 15, V. Dančík – 14, M. Fečkan – 13, M. Kochol – 12, I. Vrťo – 10.

2.3. Research status of the institute in international and national contexts

- **International/European position of the institute**

2.3.1. List of the most important research activities demonstrating the international relevance of the research performed by the institute, incl. major projects (details of projects should be supplied under Indicator 2.4). Max. 10 items.

1. Geometric representations and symmetries of graphs, maps and other discrete structures and applications in science (Geometrické reprezentácie a symetrie grafov, máp a iných diskrétnych štruktúr s aplikáciami vo vede), EUROGIGA, ESF-EC-0009-10, 5/2011–4/2014, R. Nedela –investigator. A multilateral international project supported by European Science Foundation
2. International Visegrad Found – the 12th Central Europena Conference on Cryptology, 2012, Funding for the Institute 2595 Eur, Coordinator K. Nemoga
3. Number Theory and Cryptology, MAD project with Institute of Informatics Academy of the Czech Republic. 2012-2014, Coordinator O. Strauch
4. Fuzzy Logics and Their Applications, MAD project with the Institute of Informatics of the Academy of the Czech Republic. 2011-2013 Coordinator M. Duchoň.
5. Fuzzy Systems and Their Applications, , MAD project with the Institute of Informatics of the Academy of the Czech Republic. Coordinator M. Duchoň
6. Measures in Vector Spaces and Fuzzy Measures, Univ. Leuwen, Belgium, Coordinator M. Duchoň
7. Operators in Banach spaces, geometry of Banach spaces, topology, harmonic analysis of vector measures, applications, Institute of Informatics of the Academy of the Czech Republic. Coordinator M. Duchoň
8. Intuitionistic fuzzy sets - theory and applications, MAD Project with Bulgarian Academy of Sciences, Sofia, 2012-2014, Coordinator B. Riečan
9. Dealing with uncertain and imprecise information through algebraic structures, MAD Project with Polish Academy of Sciences 2013-2015, Coordinator B. Riečan
10. Vector-valued measures and integration in polarized vector spaces, MAD project with Ukraine 2014-2016, Coordinator J. Haluška

2.3.2. List of international conferences (co)organised by the institute.

1. FSTA 2012 - 11.th International Cnference of Fuzzy Sets and Systems and Their Applications Liptovský Ján, 80 participants, 30.01.-03.02.2012
2. 40 years of Limits to growth - 40 years of the first report for the Club of Rome, Malé kongresové centrum SAV, Bratislava, 40 participants, 13.03.-13.03.2012
3. Third International Conference On Uniform Distribution, Smolenice, 50 participants, 25.06.-29.06.2012
4. The 12th Central European Conference on Cryptology, Smolenice, 50 participants, 01.07.-04.07.2012
5. 26th Conference on Real Functions, Stará Lesná, 70 participants, 02.09.-07.09.2012
6. Graph Embeddings and Maps on Surfaces, Smolenice, 50 participants, 14.07.-19.07.2013
7. Summer School: Topology of high-dimensional manifolds, Bonn, Nemecko, 50 participants, 26.08.-30.08.2013
8. 27th Conference of Theory of Real Functions, Niedzica, Poľsko, participants, 01.09.-07.09.2013
9. International Minoconference "Automata and optimalization", Slezká universita Opava, ČR, 8 participants, 26.11.-27.11.2013
10. 21st Czech and Slovak International Conference on Number Theory, Ostravice, Czech Republic, 60 participants, 02.09.-06.09. 2013
11. Spring Conference on Computer Graphics 2014 (SCCG 2014), Smolenice, 60 participants, 28.05.-30.05.2014
12. 28th Conference on Real Functions, Stará Lesná, 31.08.-05.09.2014
13. Summer School on Algebra and Ordered Sets, Stará Lesná, 65 participants, 06.09.-12.09.2014

14. Mathematical methods in Economy and Industry, Smolenice, 60 participants, 08.09.-12.09.2014
15. 31st Spring conference on Computer Graphics, Smolenice, 40 participants, 27.04.-29.04.2015
16. 22nd Czech-Slovak International Conference of Number Theory, Liptovský Ján, 50 participants, 31.08.-04.09.2015

2.3.3. List of edited proceedings from international scientific conferences.

1. Tatra Mountains Mathematical Publications Vol 51 (2012): Conference Probastat 2011. Editors: J. Volaufová, V. Witkovský.
2. Tatra Mountains Mathematical Publications Vol 52 (2012): Real Functions '11 Riemann Derangement Theorem, Multifunctions, Generalized Continuities, Vector Measures and Functions. Editors: **J. Borsík**, J. Jedrzejewski
3. Tatra Mountains Mathematical Publications Vol 53 (2012): TatraCrypt '12. Editors: O. Grošek, **K. Nemoga**, P. Zajac
4. Mathematica Slovaca, Vol 62 No 6 (2012) Dedicated to Prof. David James Foulis, Eds. **A. Dvurečenskij, S. Pulmannová**
5. Tatra Mountains Mathematical Publications Vol 54 (2013): Conference" Differntial and Difference Equations and Applications. Eds. M. Růžičková, J. Diblík.
6. Tatra Mountains Mathematical Publications Vol 55 (2013): Real Functions 2012 — Topology, Generalized Continuity, Infinite Series, Functional Equations. Editor: **J. Borsík**
7. M. Kovačka, **A. Dvurečenskij**, A. Kacian eds. *Beloslav Riečan - ale najväčšia z nich je láska*. Martin: Alfa print s.r.o., 2013. 139 s. ISBN 978-80-971399-9-5.
8. Tatra Mountains Mathematical Publications,Volume **55**, **Real Functions**, Editor: **J. Borsík**.
9. Tatra Mountains Mathematical Publications,Vol **56**, **Number Theory**, 2013, Editors: **S. Jakubec, K. Nemoga**, Š. Porubský.
10. Tatra Mountains Mathematical Publications,Vol. **57**, **Cryptology**, 2013, Editors: O. Grošek, **K. Nemoga**, P. Zajac
11. A. **Dvurečenskij**, J. Kuhr eds., *Proceedings of the 10th Biennial Meeting of the International Quantum Structure Association*, Olomouc, June 2014, In: International Journal of Theoretical Physics Vol. **54**, 2015. Tatra Mountains Mathematical Publications Vol 58 (2014): Real Functions '13 — Real Functions, Topology, Real and Functional Analysis, Locally Convex Spaces. Editors: **J. Borsík**, J. M. Jędrzejewski
12. Tatra Mountains Mathematical Publications Vol 59 (2014): Number Theory' 14. Editors: **S. Jakubec, K. Nemoga**
13. Tatra Mountains Mathematical Publications Vol 60 (2014): Cryptology'14. Editors: O. Grošek, **K. Nemoga,** P. Zajac
14. Tatra Mountains Mathematical Publications Vol 61 (2014): Applied Mathematics'14. Editors: M. Kalina, **K. Nemoga**
15. Tatra Mountains Mathematical Publications Vol 62 (2015): Real Functions'14 — Measure and Category, Real Functions, Density Topologies, Generalized Continuity. Editors: **J. Borsík**
16. Tatra Mountains Mathematical Publications Vol 63 (2014): Conference" PDifferntial and Difference Equations and Applications. Editor. M. Růžičková.
17. Vol 64 (2015): Number Theory and Cryptology '15. Editors: O. Grošek, S. Jakubec, **K. Nemoga,** P. Zajac
18. Tatra Mountains Mathematical Publications Vol 58 (2014): Real Functions '13 — Real Functions, Topology, Real and Functional Analysis, Locally Convex Spaces. Editors: **J. Borsík**, J. M. Jędrzejewski

19. Tatra Mountains Mathematical Publications Vol 59 (2014): Number Theory' 14. Editors: **S. Jakubec, K. Nemoga**
20. Tatra Mountains Mathematical Publications Vol 60 (2014): Cryptology'14. Editors: O. Grošek, **K. Nemoga,** P. Zajac
21. Tatra Mountains Mathematical Publications Vol 61 (2014): Applied Mathematics'14. Editors: M. Kalina, **K. Nemoga**
22. Mathematica Slovaca, Vol 64 no. 2 (2014) Dedicated to Prof. Richard N. Ball. Eds. **A. Dvurečenskij, R. Frič, M. Ploščica**
23. Tatra Mountains Mathematical Publications Vol 62 (2015): Real Functions'14 — Measure and Category, Real Functions, Density Topologies, Generalized Continuity. Editors: **J. Borsík**
24. Vol 64 (2015): Number Theory and Cryptology '15. Editors: O. Grošek, S. Jakubec, **K. Nemoga,** P. Zajac
25. Mathematica Slovaca, Vol 65 No. 2. (2015) Dedicated to professor Richard N. Ball Eds. **A.Dvurečenskij**, A. Pultr

2.3.4. List of journals edited/published by the institute:

2.3.4.1. WOS (IF of journals in each year of the assessment period)

Mathematica Slovaca, founded 1951, large spectral journal, since 2007 published with Springer-Versita, since 2015 published by De Gruyter – Versita. Indexed in SCI, SCOPUS, IF(2011)= 0,269, IF(2012)=0,394, IF(2013)= 0,451, IF(2014)=0,409
http://maslo.mat.savba.sk
http://www.springer.com/mathematics/journal/12175
http://www.springerlink.com/content/120745/
http://www.degruyter.com/j/ms

2.3.4.2. SCOPUS

Tatra Mountains Mathematical Publications, founded 1991, each volume is focused to a special topic, since 2008 it is indexed in WOS (Web of Science) and CPCI (Conference Proceedings Citation Index), since 2011 it is indexed in SCOPUS.
http://tatra.mat.savba.sk

2.3.4.3. other databases

Uniform Distribution Theory, founded 2006, focused to Number Theory, indexed by Zentralblatt MATH and Mathematical Reviews.
http://udt.mat.savba.sk
http://www.boku.ac.at/MATH/udt

Zentralblatt MATH, Slovak Unit,
responsible for reviewing Slovak mathematical journals.

2.3.4.4. not included in databases

Obzory matematiky, fyziky a informatiky (in Slovak), co-publisher journal for high-school teacher of mathematics, physics, and information.

- **National position of the institute**

2.3.5. List of selected projects of national importance

1. **meta-QUTE Center of excellency of quantum technologies** (meta-QUTE –Centrum excelentnosti kvantových technológií), IMTS 26240120022, 3/2010 –5/2013, Role Coordinator. A. Dvurečenskij. The project financed with Structural Foundations, joint project with Institute of Physics SAS, Prof.V. Bužek is the PI.
2. **Center of excellency SAS - Quantum Technologies**, A. Dvurečenskij, joint project with Institute of Physics SAS, 2009-2013, Prof. V. Bužek is the PI.
3. **APVV-0178-11** Neurčitosť z pohľadu pravdepodobnosti, algebry, samoadjun-govaných operátorov a kvantových štruktúr
   (Uncertainity from point of view of probability, algebra, selfadjoint operatorov and qunatum strictures)**Coordinator** MI SAS, Bratislava
   Institute principal investigator: A. Dvurečenskij **Duration:** 2012-2015
4. **APVV-0035-10** Algoritmy, automaty a diskrétne dátové štruktúry
   (Algorithms, automatons and discrete data structures) **Coordinator:** Univ. of Pavol Jozef Šafárik, Košice, **Institute principal investigator:** G. Jirásková
   Duration: 2011-2014
5. **APVV-0269-11** Funkcionálne priestory, bornológie, hyperpriestory a topologické štruktúry (Function spaces, bornologies, hyperspaces and topological structures)
   Coordinator: MI SAS, Bratislava, **Institute principal investigator:** Ľ. Holá
   Duration: 2012-2015
6. **1235 Gas transport optimization through transit pipelines,** Collaboration with eustream a.s. Nitra on Applications of mathematical methods to solve of gas transport optimization – almost 20 years of collaboration.
7. Development, computer-aided implementation and placing in praxis of algorithms for pipe gas leaks, contract with CSE-Control, Nitra.
8. Mathematical methods of diagnostic systems in the primary circuit of nuclear power plants. We design and implement the algorithms for digital signal processing which are used in the diagnostic systems installed in the nuclear power plants (Slovak Republic, Czech Republic, China).
9. Cryptographic methods in public administration. Collaboration with National Security Bureau of SR.
10. IT security – collaboration with Ministry of Defence of the Slovak Republic.

2.3.6. Projects of the Slovak Research and Development Agency (APVV)

1. **APVV-0035-10**
   Title: Algoritmy, automaty a diskrétne dátové štruktúry
   (Algorithms, automatons and discrete data structures)
   Coordinator: Univ. of Pavol Jozef Šafárik, Košice
   Institute principal investigator: Galina Jirásková
   Duration: 2011-2014
2. **APVV-0096-10**
   Title: Štatistické metódy pre analýzu neistôt v metrológii
   (Statistical methods for uncertainty analysis in metrology)
   Coordinator: Intst. of Measurement, SAS, Bratislava
   Institute principal investigator: Gejza Wimmer
   Duration: 2011-2014
3. **APVV-0134-10**
   Title: Nelineárne javy v spojitých a diskrétnych dynamických systémoch (Nonlinear phenomena in continuous and discrete dynamical systems),
   Coordinator: FMFI UK Bratislava,

Institute principal investigator: N. Dilna,
Duration: 2011-2014

4. **APVV-0178-11**
   Title: Neurčitosť z pohľadu pravdepodobnosti, algebry, samoadjun-govaných operátorov a kvantových štruktúr
   (Uncertainity from point of view of probability, algebra, selfadjoint operatorov and qunatum strictures)
   Coordinator: MI SAS, Bratislava
   Institute principal investigator: Anatolij Dvurečenskij
   Duration: 2012-2015
5. **APVV-0269-11**
   Title: Funkcionálne priestory, bornológie, hyperpriestory a topologické štruktúry
   (Function spaces, bornologies, hyperspaces and topological structures)
   Coordinator: MI SAS, Bratislava
   Institute principal investigator: Ľubica Holá
   Duration: 2012-2015
6. **APVV-0219-12**
   Title: Automatizované spravovávanie trasologických objektov
   (Automatic processing of traceology objects)
   Coordinator: Faculty on Natural Sciences, Univ. Matej Bel, Banská Bystrica
   Institute principal investigator: Ondrej Šuch
   Duration: 2013-2017

2.3.7. Projects of the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA)

1. VEGA 2/0047/10
   Title: Funkcionálne priestory a topologické štruktúry
   (Functional spaces and topological structures)
   Coordinator: MI SAS, Bratislava
   Institute principal investigator: Ľubica Holá
   Duration: 2010-2012
2. VEGA 2/0118/10
   Title: Toky a farbenie grafov
   (Flows and Graph Coloring)
   Coordinator: MI SAS, Bratislava
   Institute principal investigator: Martin Kochol
   Duration: 2010-2013
3. VEGA 2/0124/10
   Title: Kvalitatívne vlastnosti a bifurkácie diferenciálnych rovníc a dynamických systémov
   (Qualitative properties and bifurcations of differential equations and dynamical systems)
   Coordinator: MI SAS, Bratislava
   Institute principal investigator: Michal Fečkan
   Duration: 2010-2012
4. VEGA 2/0194/10
   Title: Reprezentačné a klasifikačné problémy algebraických štruktúr
   (Representation and classification problems of algebraic structures)
   Coordinator: MI SAS, Bratislava
   Institute principal investigator: Miroslav Ploščica
   Duration: 2010-2012
5. VEGA 2/0206/10
   Title: Teória čísel a jej aplikácie
   (Number Theory and Its Applications)

Coordinator: MI SAS, Bratislava
Institute principal investigator: Stanislav Jakubec
Duration: 2010-2013

6. VEGA 2/0212/10
   Title: Niektoré otázky funkcionálnej, harmonickej a stochastickej analýzy
   (Some questions of functional, harmonic and stochastic analysis)
   Coordinator: MI SAS, Bratislava
   Institute principal investigator: Miloš Duchoň
   Duration: 2010-2013
7. VEGA 1/0753/10
   Title: Rozdelenie postupností a zovšeobecnené hustoty množín prirodzených čísel
   (Distribution of sequences and generalized densities of sets of natural numbers)
   Coordinator: Univ. Selye, Komárno
   Institute principal investigator: Oto Strauch
   Duration: 2010-2012
8. VEGA 2/0003/11
   Title: Paralelné blokové algoritmy na výpočet SVD/EVD veľkých hustých matíc
   (Parallel block algorithms for computing the SVD/EVD of large and dense matrices)
   Coordinator: MI SAS, Bratislava
   Institute principal investigator: Gabriel Okša
   Duration: 2011-2014
9. VEGA 2/0035/11
   Title: Integrálne a diferenciálne operátory a ich algebry
   (Integral and differential operators and their algebras)
   Coordinator: MI SAS, Bratislava
   Institute principal investigator: Ján Haluška
   Duration: 2011-2013
10. VEGA 2/0046/11
    Title: Fuzzy štruktúry s usporiadaním a diferenciou
    (Fuzzy structures with order and difference)
    Coordinator: MI SAS, Bratislava
    Institute principal investigator: Roman Frič
    Duration: 2011-2014
11. VEGA 2/0112/11
    Title: Grupy a ich geometrické realizácie
    (Groups and their geometric realisations)
    Coordinator: MI SAS, Bratislava
    Institute principal investigator: Ondrej Šuch
    Duration: 2011-2014
12. VEGA 2/0183/11
    Title: Zložitostné problémy v triede regulárnych jazykov
    (Complexity problems in the class of regular languages)
    Coordinator: MI SAS, Bratislava
    Institute principal investigator: Galina Jirásková
    Duration: 2011-2014
13. VEGA 1/0002/12
    Title: Teoreticko-množinové metódy v topológii a analýze
    (Set-theoretic methods in topology and analysis)
    Coordinator: Univ. of Pavel Jozef Šafárik, Košice
    Institute principal investigator: Miroslav Repický
    Duration: 2012-2014
14. VEGA 2/0038/12
    Title: Nové metódy matematickej štatistiky
    (New methods of mathematical statistics)

Coordinator: Inst. of Measurement SAS, Bratislava
Institute principal investigator: Gejza Wimmer
Duration: 2012-2014

15. VEGA 2/0059/12
Title: Matematické modely kvantových štruktúr a neurčitosti
(Mathematical models of quantum structures and uncertainty)
Coordinator: MI SAS, Bratislava
Institute principal investigator: Silvia Pulmannová
Duration: 2012-2015

16. VEGA 2/0136/12
Title: Grafovo-teoretické a algoritmické problémy v distributívnych a senzorických sieťach
(Theoretical and algorithmic topics in distributed networks)
Coordinator: MI SAS, Bratislava
Institute principal investigator: Stefan Dobrev
Duration: 2012-2015

17. VEGA 2/0177/12
Title: Zovšeobecnenia spojitosti a konvergencia
(Generalizations of continuity and convergence)
Coordinator: MI SAS, Bratislava
Institute principal investigator: Ján Borsík
Duration: 2012-2014

18. VEGA 1/1022/12
Title: Rozdelenie postupností a ich aplikácie, aditívne miery množín prirodzených čísel (Distribution of sequences and their applications, additive measures on the set of natural numbers)
Coordinator: Univ. Selye, Komárno
Institute principal investigator: Oto Strauch
Duration: 2012-2014

19. VEGA 2/0018/13
Title: Topologické štruktúry na priestoroch funkcií
(Topological structures on functional spaces)
Coordinator: MI SAS, Bratislava
Institute principal investigator: Ľubica Holá
Duration: 2013-2015

20. VEGA 2/0028/13
Title: Reprezentačné a klasifikačné problémy algebraických štruktúr
(Representation and classification problems in the theory of algebraic structures)
Coordinator: MI SAS, Bratislava
Institute principal investigator: Miroslav Ploščica
Duration: 2013-2015

21. VEGA 2/0029/13
Title: Kvalitatívne vlastnosti a bifurkácie diferenciálnych rovníc a dynamických systémov
(Qualitative properties and bifurcations of differential equations and dynamical systems)
Coordinator: MI SAS, Bratislava
Institute principal investigator: Michal Fečkan
Duration: 2013-2015

22. VEGA 2/0125/13
Title: Kvantovo-informatické konvexné štruktúry
(Quantum-theoretical convex structures)
Coordinator: Inst. of Physics SAS, Bratislava
Institute principal investigator: Anna Jenčová
Duration: 2013-2015

23. VEGA 1/0853/13
    Title: Výskum mikroštruktúr, elektrických a optických vlastností polovodičovo-dielektrických systémov
    (Research of microstructure, electronic and optical properties of semiconductor-dielectric systems)
    Coordinator: Univ. of Žilina, Žilina
    Institute principal investigator: Mária Jurečková
    Duration: 2013-2015
24. VEGA 2/0017/14
    Title: Tokové a chromatické problémy v kombinatorike
    (Flow and chromatic problems in combinatoris)
    Coordinator: MI SAS, Bratislava
    Institute principal investigator: Martin Kochol
    Duration: 2014-2017
25. VEGA 2/0026/14
    Title: Paralelné blokové algoritmy pre kanonické dekompozície tenzorov
    (Parallel block algorithms for the canonical decomposition of tensors)
    Coordinator: MI SAS, Bratislava
    Institute principal investigator: Gabriel Okša
    Duration: 2014-2016
26. VEGA 2/0049/14
    Title: Agregácia vstupov z viacerých kompetitívnych a/alebo kooperatívnych kategórií1022/12
    (Aggregation of inputs from multiple competitive and/or cooperative categories)
    Coordinator: MI SAS, Bratislava
    Institute principal investigator: Andrea Zemánková
    Duration: 2014-2017
27. VEGA 2/0146/14
    Title: Algebraická a pravdepodobnostná teória čísela ich aplikácie
    (Algebraic and probabilistic number theory and their applications)
    Coordinator: MI SAS, Bratislava
    Institute principal investigator: Stanislav Jakubec
    Duration: 2014-2017
28. VEGA 2/0178/14
    Title: Niektoré otázky funkcionálnej, harmonickej a stochastickej analýzy
    (Some questions concerning functional, harmonic and stochastic analysis)
    Coordinator: MI SAS, Bratislava
    Institute principal investigator: Miloslav Duchoň, since 2015 Ján Haluška
    Duration: 2014-2017
29. VEGA 2/0031/15
    Title: Parciálne operácie, kvantové štruktúry a kategoriálne metódy v pravdepodobnosti
    (Partial operations, quantum structures, and categorical methods in probability)
    Coordinator: MI SAS, Bratislava
    Institute principal investigator: Roman Frič
    Duration: 2015-2017
30. VEGA 2/0047/15
    Title: Diskrétne a spojité pravdepodobnostné modely a ich aplikácie
    (Discrete and continuous probabilistic models and their applications)
    Coordinator: MI SAS, Bratislava
    Institute principal investigator: Gejza Wimmer
    Duration: 2015-2017
31. VEGA 2/0050/15
    Title: Zovšeobecnenie spojitosti funkcií
    (Generalization of Comtinuity of Functions)

Coordinator: MI SAS, Bratislava
Institute principal investigator: Ján Borsík
Duration: 2015-2018

32. VEGA 2/0084/15
Title: Popisná zložitosť formálnych systémov
(Descriptional Complexity of Formal Systems)
Coordinator: MI SAS, Bratislava
Institute principal investigator: Galina Jirásková
Duration: 2015-2018

2.3.8. Projects of SAS Centres of Excellence

Title: Centre of Excellence SAS-Quantum Technologies,
Coordinator: Institute of Physics SAS, Bratislava
Institute principal investigator: A. Dvurečenskij
Duration: 1.2009-6.2013
Sum: 15 975,00 Eur

2.3.9. National projects supported by EU Structural Funds

1. **ESF-EC-0009-10**
Title: Geometrické reprezentácie a symetrie grafov, máp a iných diskrétnych štruktúr s aplikáciami vo vede
(Geometric representations and symmetries of graphs, maps and otherdiscrete structures and applications in science) EUROGIGA
Coordinator: Commenius Univ., Bratislava
Institute principal investigator: Roman Nedela
Duration: 2011-2014

2.3.10. List of journals (published only in the Slovak language) edited/published by the institute:

2.3.10.1. WOS (IF of journals in each year of the assessment period)

2.3.10.2. SCOPUS

2.3.10.3. Other databases

2.3.10.4. Not included in databases

Institute is a co-publisher of **Obzory matematiky, fyziky a informatiky**, which is a more than 30 Years journal oriented to mathematical teaching of mathematics at elementary and secondary schools. Some articles are in English.

- **Position of individual researchers in an international context**

2.3.11. List of invited/keynote presentations at international conferences, as documented by programme or invitation letter

1. **DVUREČENSKIJ, A.**: *On the role of l-groups and po-groups for algebraic and quantum structures*, 3rd International Conference on Quantitative Logic and Soft Computing, 12-15.5.2012, Xian, China.
2. **DVUREČENSKIJ, A.**: *On the role of l-groups and po-groups for algebraic and quantum structures*, ManyVal '12 Conference in honour of Antonio Di Nola, Salerno, 4-7.7.2012, Italy.
3. **DVUREČENSKIJ, A.**: *Recent results on commutative and noncommutative effect algebras,* International Workshop Information, Uncertainty, and Imprecision, 6-8.6.2012, Olomouc, ČR.

4. **DVUREČENSKIJ, A.**: *Quantum structures I-III.,* International Summer School Information and Uncertainty, 6-8.6.2012, Olomouc, ČR.
5. **JENČOVÁ, A.**: *Generalized channels and quantum networks*, BIRS workshop: Operator Structures in Quantum Information Theory, Banff, Canada, 26.2-2.3. 2012.
6. **JENČOVÁ, A.**: *Minicourse: Basic structures of quantum information geometry*, Noncommutative Workshop, Imperial College, London, 24.-27. 1 2012.
7. **DVUREČENSKIJ, A.**: *On States on Quantum and Algebraic Structures*, 34th Linz Seminar on Fuzzy Set Theory, Non-Classical Measures and Integrals, Linz, Austria, 26. 2.-2. 3. 2013.
8. **HOLÁ, Ľ.:** *Quasicontinuity and minimal usco maps***,** XXVII International Summer Conference on Real Functions Theory, Niedzica, Poland, 1.-6. 9. 2013.
9. **JENČOVÁ, A.**: *Distinguishing quantum channels by restricted testers*, Symposium KCIK, Sopot, Poland, 23.-25. 5. 2013.
10. **KORBAŠ, J.**: *The vector field problem for Dold manifolds*, Knots, manifolds, and Group Actions, Słubice, Poland, 11.-14. 9. 2013.
11. **NEMOGA, K.**: *Alternant Codes for McEliece Cryptosystem*, Secure Implementationof Post-Quantum Cryptography workshop, Tel Aviv Univ., Israel, 8.-11. 12. 2013.
12. **NEMOGA, K**.: *NATO Science for Peace and Security Programme*, NATO Information Day & Partnership Building, Podgorica, Čierna Hora, 29. 1. 2013. (nematematický charakter)
13. **STRAUCH, O.**: *Distribution functions of sequences*, 21 Czech and Slovak International Conference on Number Theory, Ostravice, 2.-6. 9. 2013.
14. **DVUREČENSKIJ, A.**: *Algebraic structures in quantum structures*, I, II, Summer School in Gneral Algebra and Ordered Sets, Stará Lesná, 6-12.9.2014.
15. **PALMOVSKÝ, M.**: *Kleene Closure on Regular Languages, Prefix-Free and Prefix-Closed regular languages*, Automaty a optimalizace, Opava, Czech Republic, 6-7.11.2014.
16. **STRAUCH, O.—** OHKUBO, Y.: *Distribution of leading digits of numbers*, 4th International Conference on Uniform Distribution Theory, Ostravice, Czech Republic, 30.6.-4.7.2014.
17. **ZEMÁNKOVÁ, A.**: *Advances in multi-polar aggregation*, 12th International Conference on Fuzzy Set Theory and Applications (FSTA 2014), Liptovský Ján, 26-31.1.2014.
18. **BORSÍK, J.**: *Points of some generalizations of continuity*, XXIX International Summer Conference on Real Functions Theory, Niedzica, Poland, 6. - 11. 9. 2015.
19. **GRENDÁR, M.**: *Regression: experimental vs observational data*, Teorie a praxe statistického zpracování dat, Pusté Žibřidovice, 26. - 28. 11. 2015.
20. **JIRÁSKOVÁ, G.**: *On the boundary of regular languages*, Brzozowski 80; Waterloo, Canada, 24. 6. 2015.
21. **KOCHOL, M.**: *Splitting Formulas for Tutte-Grothendiek Invariants on Graphs*, Workshop on New Directions for the Tutte Polynomial: Extensions, Interrelations, and Applications, Royal Holloway University of London, UK, 11-14.7.2015.
22. **MACKO, T.**: The Borel Conjecture on aspherical manifolds, Glances at Manifolds, Krakow, July 2015.

2.3.12. List of researchers who served as members of the organising and/or programme committees

1. **Ján Borsík,**
    1. 26th Summer
    2. Conference on Real Functions (2012) (P,O), head
    3. 27th Summer Conference on Real Functions (2013) (P)
    4. 28th Summer Conference on Real Functions (2014) (P,O), head
2. **Anatolij Dvurečenskij,**
    1. FSTA 2012 (P)
    2. FSTA 2014 (P)
    3. IQSA 2014 (P,O)

4. Spomienková konferencia pri príležitosti 100. výročia narodenia Štefana Schwarza (2014) (P, O)
   (Conference - 100 anniversary of Štefan Schwarz)

3. **Roman Frič,**
   1. 26th Summer Conference on Real Functions (2012) (P,O)
   2. 28th Summer Conference on Real Functions (2014) (O)
   3. 29th Summer Conference on Real Functions (2015) (P,O)
4. **Galina Jirásková,**
   1. Descriptional Complexity of Formal Systems 2012 (P)
   2. Descriptional Complexity of Formal Systems 2013 (P)
   3. Sofsem 2013 (P)
   4. Descriptional Complexity of Formal Systems 2015 (P)
   5. SOFSEM 2015 (P)
5. **Július Korbaš,**
   1. Variations on a Theme (A meeting to celebrate the 70th birthday of Demeter Krupka) (2012)(O)
   2. Glances at Manifolds. In honour of K. M. Pawalowski and A. Szücs on their 65th birthdays, as well as J. Korbaš et al. on their 60th bithdays. (2015) (O)
6. **Tibor Macko,**
   1. Seminar on Chirurgy Theory, Oberwolfachu (2012) (P,O)
   2. Summer school: Topology of high-dimensional manifolds (2013) (P,O)
7. **Karol Nemoga**
   1. 12th Central European Conference on Cryptology (2012) (P,O)
   2. 3rd International Conference on Uniform Distribution Theory (UDT2012) (P, O)
   3. 21st Czech and Slovak International Conference on Number Theory (2013) (P, O)
   4. CECC 2013 (P, O)
   5. CECC 2014 (P)
   6. Globálne exitenciálne riziká 2014
      (Global Existence risks 2014) (P)
   7. Globálne kríza a scenáre budúcnosti (2014) (P)
      (Global crisis and future scenarios)
   8. Spomienková konferencia pri príležitosti 100. výročia narodenia Štefana Schwarza (2014) (P, O)
      (Conference - 100 anniversary of Štefan Schwarz)
   9. CECC 2015 (P)
   10. 22nd Czech and Slovak International Conference on Number Theory (2015) (P, O)
8. **Matúš Palmovský,**
   1. International Miniconference “Automatons and optimization” 2013 (O)
9. **Miroslav Ploščica,**
   1. Summer School on Algebra and Ordered Sets 2014 (P,O)
10. **Gabriel Okša,**
    1. Parallel Matrix Algorithms and Applications 2012 (P)
    2. Parallel Matrix Algorithms and Applications 2013 (P)
    3. Parallel Matrix Algorithms and Applications 2014 (P)

11. **Marian Vajteršic,**
    1. 10th International Conference on Parallel Processing and Applied Mathematics (PPAM2013) (P)
    2. 19th International European Conference on Parallel and Distributed Computing (2013) (P)
    3. 27th IEEE International Parallel & Distributed Processing Symposium (IPDPS 2013) (P)
    4. The 17th Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD 2013) (P)
    5. The Fifth International Conference on Advances in Databases, Knowledge, and Data Applications (DBKDA 2013) (P)
    6. 28th IEEE International Parallel & Distributed Processing Symposium (IPDPS 2014) (P)
    7. 8th International Conference on Parallel Matrix Algorithms and Applications (PMAA 2014) (P,O)
    8. The 18th Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD 2014) (P)
    9. The International Conference on High Performance Computing & Simulation (HPCS 2014) (P,O)
    10. 11th International Conference on Parallel Processing and Applied Mathematics (PPAM 2015) (P)
    11. 2015 IEEE International Conference on Big Data (IEEE Big Data 2015) (P,O)
    12. 21th International Conference on Parallel and Distributed Computing (Euro-Par 2015) (P)
    13. Austrian HPC Meeting 2015 (AHPC15) (P)
    14. The 19th Pacific-Asia Conference on Knowlwdge Discovery and Data Mining (PAKD 2015) (P)
    15. The International Conference on High Performance Computing & Simulation (HPCS 2015) (P)
12. **Oto Strauch,**
    1. 3rd International Conference on Uniform Distribution Theory (UDT2012) (P,O), head
13. **Onderj Šuch,**
    1. MEMRISYS 2015 (P)
14. **Ľubomír Török,**
    1. Graph Embeddings and Maps on Surfaces 2013 (O)
15. **Gejza Wimmer,**
    1. MEASUREMENT 2015 (P)
    2. PROBASTAT 2015 (O)
    3. STAKAN 2015 (P)

- **Position of individual researchers in a national context**

2.3.13. List of invited/keynote presentations at national conferences, as documented by programme or invitation letter

1. **DVUREČENSKIJ, A.**: *Slávnostný príhovor k 150. výročiu zloženia Jednoty, Festive speech on the occasion of 150th anniversary of the Mathematical Union.* konferencia

Jednoty slovenských matematikov a fyzikov na UKF Nitra, 24.8.2012.

2. **FRIČ, R.**: *Medzi viac a menej*, *Sociálne posolstvo Jána Pavla II. pre dnešný svet*, Between less and more, Social message of John Paul the Second „Univerzita ako miesto dialógu“, Katolícka univerzita v Ružomberku, Poprad, 10-11.4.2014.

2.3.14. List of researchers who served as members of organising and programme committees of national conferences

A. Dvurečenskij-

- 55 years of Institute of Mathematics SAS, Oct. 2015

K. Nemoga-

- Economical theory in growing world, Nov. 2013
- Global crisis and scenario of future, Nov. 2014
- Global existence risks Nov. 2014
- Rome Club and his activities in the second decade of the 21st century, Sept. 2015
- Global crisis and scenario of future, Nov. 2015
- 55 years of Institute of Mathematics SAS, Oct. 2015

T. Žáčik-

- Fluis Dynamics Workshop, common workshop with eustream a.s. May 2012, Dec. 2012, Nov. 2013, May 2014

On the occasion of the 100th anniversary of Prof. Š. Schwarz, an outstanding Slovak mathematician and the second director of the Mathematical Institute SAS, we reveal the bust of Š. Schwarz on the faced of our Institute, Sept. 2014.

- **Supplementary information and/or comments documenting the international and national status of the Institute**

  Anatolij Dvurečenskij-

  - Member of the Mathematical Panel, ERC - European Research Council, Brussels, 2008-2012.
  - Member of prezidium of APVV- Slovak Research and Development Agency
  - Member of the Nominating Commitee of the Internation Quantum Structure Association
  - Member of the Learned Society of the Slovak Academy of Sciences
  - Member of the Europen Academy of Sciences and Arts

  Roman Nedela-

  - Member of the Mathematical Panel, ERC - European Research Council, Brussels, since 2014.

  Karol Nemoga -

  - Independent Scientific Evaluation Group, NATO, 2009-2012, 2015-17
  - Secretary of the Club of Rome – Slovak Branch

  Sylvia Pulnannová-

  - Member of the Council of the Internation Quantum Structure Association
  - Member of the Learned Society of the Slovak Academy of Science

  Imrich Vrťo-

  - Member of an APVV commision

Since 2011, **A.Dvurečenskij** and **S. Pulmannová** are recognized by an analytical project ARRA, Slovakia, Identification of top scientific teams and their members in the Slovak Academy of Sciences, as a top team from 22 teams (and of 17 above-average teams) of SAS who achieve the world parameters.

Many of our colleagues are invited to be a key speaker at important conferences, or address a talk at universities in abroad. They are referees of articles or projects or members of journal editorial boards or conference boards.

2.4. Tables of project structure, research grants and other funding resources

- **International projects and funding**

2.4.1. Major projects within the European Research Area and other important project – Framework Programmes of the EU, ERA-NET, European Science Foundation, NATO, COST, INTAS, etc. (here and in items below please specify: type of project, title, grant number, duration, total funding and funding for the institute, responsible person in the institute and his/her status in the project, e.g. coordinator "C", work package leader "W", investigator "I"),

Start	Project title	Project number	Duration - months	Funding for theOrganisation (EUR)	Role of the Organisation
2012	meta-QUTE - Centrum excelentnosti kvantových technológií (meta-QUTE Center of excellency of quantum technologies)	26240120022	03/2010 - 09/2012	21 635	I

2.4.2. Other international projects, incl. total funding and funding for the institute

1. Geometric representations and symmetries of graphs, maps and other discrete structures and applications in science (Geometrické reprezentácie a symetrie grafov, máp a iných diskrétnych štruktúr s aplikáciami vo vede), EUROGIGA, ESF-EC-0009-10, 5/2011–4/2014, Funding for the Institute 11000,-EUR, R. Nedela – investigator. A multilateral international project supported by European Science Foundation.

2. International Visegrad Found – the 12th Central Europena Conference on Cryptology, 2012, Funding for the Institute 2595 Eur, Coordinator K. Nemoga

2.4.3. Other important, international projects and collaborations without direct funding (max. 10 projects)

1. International Visegrad Found – the 12th Central Europena Conference on Cryptology, 2012, Funding for the Institute 2595 Eur, Coordinator K. Nemoga

2. Number Theory and Cryptology, MAD project with Institute of Informatics Academy of the Czech Republic. 2012-2014, Coordinator O. Strauch

3. Fuzzy Logics and Their Applications, MAD project with the Institute of Informatics of the Academy of the Czech Republic. 2011-2013 Coordinator M. Duchoň.

4. Fuzzy Systems and Their Applications, , MAD project with the Institute of Informatics of the Academy of the Czech Republic. Coordinator M. Duchoň.

5. Measures in Vector Spaces and Fuzzy Measures, Univ. Leuwen, Belgium, Coordinator M. Duchoň

6. Operators in Banach spaces, geometry of Banach spaces, topology, harmonic analysis of vector measures, applications, Institute of Informatics of the Academy of the Czech Republic. Coordinator M. Duchoň.

7. Intuitionistic fuzzy sets - theory and applications, MAD Project with Bulgarian Academy of Sciences, Sofia, 2012-2014, Coordinator B. Riečan

8. Dealing with uncertain and imprecise information through algebraic structures, MAD Project with Polish Academy of Sciences 2013-2015, Coordinator B. Riečan

9. Vector-valued measures and integration in polarized vector spaces, MAD project with Ukraine 2014-2016, Coordinator J. Haluška,

- **National projects and their funding**

2.4.4. Projects supported by the Slovak Research and Development Agency (APVV)

Role of the Institute e.g. coordinator "C", investigator "I".

	Project title	Typ / Project number	Duration - months	Funding for the Institute (EUR)	Role of the Institute / Responsible person
2012	Algoritmy, automaty a diskrétne dátové štruktúry (Algorithms, automatons and discrete data structures)	APVV-0035-10	05/2011 – 10/2014	4 000	I G. Jirásková
	Štatistické metódy pre analýzu neistôt v metrológii (Statistical methods for uncertainty analysis in metrology)	APVV-0096-10	05/2011 – 10/2014	10 001	I G. Wimmer
	Nelineárne javy v spojitých a diskrétnych dynamických systémoch (Nonlinear phenomena in continuous and discrete dynamical systems)	APVV-0134-10	05/2011 – 05/2014	6 308	I N. Dilna
	Neurčitosť z pohľadu pravdepodobnosti, algebry, samoadjungovaných operátorov a kvantových štruktúr (Uncertainity from point of view of probability, algebra, selfadjoint operatorov and qunatum strictures)	APVV-0178-11	07/2012 – 12/2015	20 315	C A. Dvurečenskij
	Funkcionálne priestory, bornológie, hyperpriestory a topologické štruktúry (Function spaces, bornologies, hyperspaces and topological structures)	APVV-0269-11	07/2012 – 12/2015	12 780	C Ľ. Holá
2013	Algoritmy, automaty a diskrétne dátové štruktúry (Algorithms, automatons and discrete data structures)	APVV-0035-10	05/2011 – 10/2014	4 000	I G. Jirásková
	Štatistické metódy pre analýzu neistôt v metrológii (Statistical methods for uncertainty analysis in metrology)	APVV-0096-10	05/2011 – 10/2014	7 601	I G. Wimmer
	Nelineárne javy v spojitých a diskrétnych dynamických systémoch (Nonlinear phenomena in continuous and discrete dynamical systems)	APVV-0134-10	05/2011 – 05/2014	6 518	I N. Dilna

	Neurčitosť z pohľadu pravdepodobnosti, algebry, samoadjungovaných operátorov a kvantových štruktúr (Uncertainity from point of view of probability, algebra, selfadjoint operatorov and qunatum strictures)	APVV-0178-11	07/2012 – 12/2015	49 083	C A. Dvurečenskij
	Funkcionálne priestory, bornológie, hyperpriestory a topologické štruktúry (Function spaces, bornologies, hyperspaces and topological structures)	APVV-0269-11	07/2012 – 12/2015	22 312	C Ľ. Holá
2014	Algoritmy, automaty a diskrétne dátové štruktúry (Algorithms, automatons and discrete data structures)	APVV-0035-10	05/2011 – 10/2014	3 325	I G. Jirásková
	Štatistické metódy pre analýzu neistôt v metrológii (Statistical methods for uncertainty analysis in metrology)	APVV-0096-10	05/2011 – 10/2014	5 823	I G. Wimmer
	Nelineárne javy v spojitých a diskrétnych dynamických systémoch (Nonlinear phenomena in continuous and discrete dynamical systems)	APVV-0134-10	05/2011 – 05/2014	2 257	I N. Dilna
	Neurčitosť z pohľadu pravdepodobnosti, algebry, samoadjungovaných operátorov a kvantových štruktúr (Uncertainity from point of view of probability, algebra, selfadjoint operatorov and qunatum strictures)	APVV-0178-11	07/2012 – 12/2015	23 718	C A. Dvurečenskij
	Funkcionálne priestory, bornológie, hyperpriestory a topologické štruktúry (Function spaces, bornologies, hyperspaces and topological structures)	APVV-0269-11	07/2012 – 12/2015	16 670	C Ľ. Holá
	Automatizované spravovávanie trasologických objektov (Automatic processing of traceology objects)	APVV-0219-12	10/2013- 09/2017	16 510	I O. Šuch
2015	Neurčitosť z pohľadu pravdepodobnosti, algebry, samoadjungovaných operátorov a kvantových štruktúr (Uncertainity from point of view of probability, algebra, selfadjoint operatorov and qunatum strictures)	APVV-0178-11	07/2012 – 12/2015	33 815	C A. Dvurečenskij
	Funkcionálne priestory, bornológie, hyperpriestory a topologické štruktúry (Function spaces, bornologies, hyperspaces and topological structures)	APVV-0269-11	07/2012 – 12/2015	20 797	C Ľ. Holá
	Automatizované spravovávanie trasologických objektov (Automatic processing of traceology objects)	APVV-0219-12	10/2013- 09/2017	9 106	I O. Šuch

2.4.5. Projects supported by the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA) for each year, and their funding

VEGA	2012	2013	2014	2015
Number	17	19	18	17
Funding in the year (EUR)	79170	80597	60076	75665

[1]

- **Summary of funding from external resources**

[1] Excluding projects for the popularisation of science

2.4.6. List of projects supported by EU Structural Funds

1. **meta-QUTE Center of excellency of quantum technologies** (meta-QUTE – Centrum excelentnosti kvantových technológií), IMTS 26240120022, 3/2010 – 5/2013, Role Coordinator. A. Dvurečenskij. The project financed with Structural Foundations, joint project with Institute of Physics SAS, Prof.V. Bužek is the PI.

2.4.7. Summary of external resources of the EU Structural Funds (ERDF/ESF)

Role of the Institute in the project, e.g. coordinator "C", work package leader "W", investigator "I".

Year	Project title	Project number	Duration - months	Funding for the Organisation (EUR)	Role of the Organisation
2012	Geometrické reprezentácie a symetrie grafov, máp a iných diskrétnych štruktúr s aplikáciami vo vede (Geometric representations and symmetries of graphs, maps and other discrete structures and applications in science)	ESF-EC-0009-10	05/2011-04/2014	0	I
2013	Geometrické reprezentácie a symetrie grafov, máp a iných diskrétnych štruktúr s aplikáciami vo vede (Geometric representations and symmetries of graphs, maps and other discrete structures and applications in science)	ESF-EC-0009-10	05/2011-04/2014	6000	I
2014	Geometrické reprezentácie a symetrie grafov, máp a iných diskrétnych štruktúr s aplikáciami vo vede (Geometric representations and symmetries of graphs, maps and other discrete structures and applications in science)	ESF-EC-0009-10	05/2011-04/2014	2000	I
2015					

External resources	2012	2013	2014	2015	total	average
External resources (milions of EUR)	0,205	0,143	0,203	0,101	**0,652**	**0,163**
External resources transfered to coooperating research organisations (milions of EUR)	0,000	0,000	0,000	0,000	**0,000**	**0,000**

- **Supplementary information and/or comments on research projects and funding sources**

2.5. PhD studies and educational activities

2.5.1. List of accredited programmes of doctoral studies, period of validity

9-1-9 Applied Mathematics (Aplikovaná matematika) – cooperation with Faculty of Mathematics, Physics and Informatics, Commenius University, Bratislava, since 2006 under Act 131/2002. The internal form of the PhD study is 4 eyars and the external one is 5 years.

2.5.2. Summary table on doctoral studies (number of internal/external PhD students; number of foreign PhD students, number of students who successfully completed their theses, number of PhD students who quit the programme*)*

PhD study	31.12.2012			31.12.2013			31.12.2014			31.12.2015		
Number of potential PhD supervisors	16			16			17			17		
PhD students	number	defended thesis	students quitted	number	defended thesis	students quitted	number	defended thesis	students quitted	number	defended thesis	students quitted
Internal	11,0	1,0	0,0	9,0	2,0	0,0	9,0	1,0	0,0	8,0	1,0	2,0
External	1,0	0,0	0,0	1,0	0,0	0,0	1,0	0,0	0,0	2,0	0,0	0,0
Other supervised by the research employees of the institute	7,0	1,0	0,0	8,0	0,0	0,0	10,0	0,0	0,0	11,0	2,0	0,0

Several PhD. students from abroad spent part of their doctoral studies at the Mathematical Institute SAS:

- 2012 Mgr. Jan Krňavek, 3 months,
- 2013 Mgr. Miroslav Kolařík 2 weeks,
- 2014 Mgr. Miroslav Kolařík, 1 month,
  Mgr. Hana Machu, 3 months,
  Mgr. Marie Dvorská 2 months,
  Mgr. Zdeněk Svoboda 3 months,

all PhD. students from the Faculty of Science, Palcký University Olomouc, Czech Republic.

2.5.3. Summary table on educational activities

Teaching	2012	2013	2014	2015
Lectures (hours/year)[3]	827	982	811	772
Practicum courses (hours/year)[3]	567	648	658	681
Supervised bachelor thesis (in total)	22	42	35	42
Supervised diploma thesis (in total)	0	0	0	0
Supervised PhD thesis (in total)	18	19	17	12
Members in PhD committees (in total)	9	8	10	11
Members in DrSc. committees (in total)	4	2	2	2
Members in university/faculty councils (in total)	9	9	8	8
Members in habilitation/inauguration committees (in total)	14	6	9	3

2

2.5.4. List of published university textbooks

1. KORBAŠ, Július - GYÜRKI, Š. Prednášky z lineárnej algebry a geometrie. 1. Vydanie. Bratislava : Polygrafické stredisko UK v Bratislave, 2013. 132 s. ISBN 978-80-223-3408-2.

2.5.5. Number of published academic course books

2.5.6. List of joint research laboratories/facilities with universities

Institute of Mathematics and Informatics, joint research institute of the Mathematical Institute and Faculty of Natural Sciences of Matej Bel University, Banská Bystrica, founded in 2001.

- **Supplementary information and/or comments on doctoral studies and educational activities**

According to the old system of PhD-study, our Institute had rights for 6 programs in mathematics. In a new system which is performed with a strong connection with universities, we have only one, because, we could have a program if only some Slovak university has it. For examples, algebra and number theory or computer science were nowhere at our universities because they haven't any specialist in the program, therefore, it is not at our Institutes, however we have specialists. Hence, of study covers practically all areas of the previous programs under the common roof of applied mathematics.

Nevertheless that scholarships for PhD-studies in our country are very low, every year we have applicants for the doctorial study. On the other hand, the number of interesting students in PhD-study is not so high as before, the same is for all Slovak universities. Due to regulations by Slovak Academy of Sciences, we could accept at most three students at our Institute. The level of our PhD-study is traditionally very high confirmed also by a fact that in the last years three young mathematicians of EU (Italy, Germany, Malta) obtained their PhD-degree at our Institute. Unfortunately, according to EU rules, we cannot take any non-EU citizen as a PhD-student in Academy under the same conditions as Slovak one.

Unfortunately, the new system of PhD-study as the third grade of university study is not optimal thanks to the rule that the candidate has to finish his study including the defense within the standard length of study. This caused that the level of theses is not very high as before, but we are still paying attention to high quality. Therefore, now there is a serious problem to attract PhD-students to study at the Institute.

Since 2013 we have started to organize a summer praxis at Mathematical Institute for students of mathematical faculties of higher years. Students under patronage of renowned experts solve interesting tasks, so they became familiar with the Institute and we can test for future PhD-students.

Besides of leading our own PhD-students in both forms internal and external, plenty of our colleagues are PhD-tutors of students on many Slovak universities. In addition, A. Dvurečenskij collaborates on the Ph program at Univ. of Cagliari, Cagliari, Italy.

For us the best applications of our research is the dissemination of our research among students at universities. Therefore, we have relatively many colleagues who are involved into pedagogical process at universities in all forms of university studies including the PhD-study.

[2] Do not include time spent with bachelor, diploma or PhD students during their supervising

2.6. Social impact

2.6.1. List of the most important results of applied research projects. Max. 10 items

1. Flow imbalance problem in Slovak gas transmission network, authors: I. Mračka, A. Sedliak, M. Spál, G. Wimmer, T. Žáčik
2. Evolutionary optimization calculations for gas transmission networks, authors: M. Bayer, R. Hajossy, I. Mračka, K. Nemoga, P. Somora, A. Sedliak, T. Sedláková, M. Spál, P. Vadovič, T. Žáčik (head)
3. The simulation of high-dynamic turbulent gas flow in pipelines, authors: M. Bayer, R. Hajossy, I. Mračka, K. Nemoga, P. Somora, A. Sedliak, T. Sedláková, M. Spál, P. Vadovič, T. Žáčik
4. Depressurization of a gas reservoir by a pipe of arbitrary length, authors: M. Bayer, R. Hajossy, I. Mračka, K. Nemoga, P. Somora, A. Sedliak, T. Sedláková, T. Žáčik (head)
5. Development of modules of gas leaks for Great Britain and Yemen.
6. Cryptographic methods in public administration. Collaboration with National security bureau., K. Nemoga, Since the research is secrete, there are no public publications.
7. IT security – collaboration with Defense Ministry SR. K. Nemoga. Since the research is secrete, there are no public publications.
8. Mathematical methods of diagnostic systems in the primary circuit of nuclear power plants. We design and implement the algorithms for digital signal processing which are used in the diagnostic systems installed in the nuclear power plants (Slovak Republic, Czech Republic, China).

2.6.2. List of the most important studies commissioned for the decision-making authorities, the government and NGOs, international and foreign institutes

1. Cryptographic methods in public administration. Collaboration with National security bureau., K. Nemoga, Since the research is secrete, there are no public publications.
2. IT security – collaboration with Defense Ministry SR. K. Nemoga. Since the research is secrete, there are no public publications.

2.6.3. List of contracts and research projects with industrial and other commercial partners, incl. revenues

1. Contract No. 183/12/EUS between Mathematical Institute of the Slovak Academy of Sciences and eustream, a.s., 2012 almost 20 years of collaboration. 213926 Eur
2. Development, computer-aided implementation and placing in praxis of algorithms for pipe gas leaks, contract with CSE-Control, Nitra. 0 Eur
3. Cryptographic methods in public administration. Collaboration with National Security Bureau of SR. 0 Eur
4. IT security – collaboration with Defense Ministry of SR. 0 Eur

2.6.4. List of licences sold abroad and in Slovakia, incl. Revenues

none

2.6.5. List of most important social discourses under the leadership or with significant participation of the institute (max. 10 items)

1. 40 years of growth limits - 40 years of the first report of the Rome Club, Malé kongresové centrum SAV, Bratislava, 13.03.-13.03.2012
2. Economical theory in growing world, Slovak Association of the Club of Rome, Nov. 2013
3. Global crisis and scenario of future, Slovak Association of the Club of Rome, Nov. 2014
4. Global existence risks, Slovak Association of the Club of Rome Nov. 2014
5. Rome Club and his activities in the second decade of the 21st century, Slovak Association of the Club of Rome, Sept. 2015
6. Global crisis and scenario of future, Slovak Association of the Club of Rome, Nov. 2015
7. Dvurečenskij, Nov. 2012, had a lecture Grace of Mathematics for 360 pupils of Petržalka schools, age 13
8. K. Nemoga, June 2013, had a lecture for 250 pupils of Petržalka.

2.6.6. Summary of relevant activities, max. 300 words

2.7. Popularisation of Science (outreach activities)

2.7.1. List of the most important popularisation activities, max. 20 items

1. Within the Week of Science and Technology, we have organized the Day of Open Door 2012, 2013, 2014, 2015. Students of Bratislava and Košice high schools are visiting our Institute in Bratislava and its branch in Košice.
2. A. Dvurečenskij Nov. 2012, had a lecture Grace of Mathematics for 360 pupils of Petržalka schools, age 13.
3. A. Dvurečenskij, Keď matematik odchádza na dôchodok, Aktuality SAV, 2012, (When a mathematician is leaving to pension).
4. K. Nemoga, June 2013, had a lecture for 250 pupils of Petržalka.
5. A. Dvurečenskij since 2008 is in a commission for Talents of New Europe.
6. A. Dvurečenskij, Nov. 2012 lecture at the High school in Tornala.
7. A. Dvurečenskij, Jan. 2012, discussion at radion Devin.
8. K. Nemoga, Feb. 2012, Mathematics and Music, Radio Regina.
9. A. Dvurečenskij, Prof. Ján Jakubík nonagenarian, Aktuality SAV.
10. E. Halušková, How did Egyptians calculated? High School in L. Mikuláš, Nov. 2013.
11. G. Jirásková, Poincaré hypothesis or how to be a millionaire? Opava, April 2013.
12. K. Nemoga, Talk for Slovak Radio, 2013.
13. K. Čevorová, 2014, had 3 lectures for pupils in Petržalka.
14. A. Dvurečenskij, 2015, had a lecture for pupils in a Pezinok school.
15. Within the Week of Science and Technology, we have organized the Day of Open Door 2012, 2013, 2014, 2015. Students of Bratislava and Košice high schools are visiting our Institute in Bratislava and its branch in Košice.
16. A. Dvurečenskij, Prof. Andrej Pázman and Golden Medal SAS, Aktualitry SAV. Apr. 2014.
17. K. Nemoga, Apro. 2014, Contemporary Cryptology. Slovak Radio.
18. A. Dvurečenskij, Prof. J. Jakubík – nestor of Slovak mathematicians passed away, Nov. 2015.
19. B. Riečan, Flourishing witness of the Slovak Matehmatics, Newspaper of B. Bystrica, Nov. 2015.
20. G. Okša, How mathematics increases the security of nuclear powerplants, Nov. 12015.

2.7.2. Table of outreach activities according to institute annual reports

Outreach activities	2012	2013	2014	2015	total
Articles in press media/internet popularising results of science, in particular those achieved by the Organization	27	15	5	12	59
Appearances in telecommunication media popularising results of science, in particular those achieved by the Organization	5	2	4	1	12
Public popularisation lectures	10	10	13	14	47

- **Supplementary information and/or comments on popularisation activities, max. 300 words**

Within frames of the Week of Science, we are traditionally organizing the Day of Open Door in our Institute which is visited by students of Bratislava's high schools. The interest of Bratislava's high schools is enormous, so in the last years we have to organize parallel sections. Also our branch in Košice is organizing lectures for students. In addition, within the joint program between Slovak Academy of Sciences and Petržalka, the biggest region of Bratislava, our colleagues organized lectures for 13-year-old pupils. These lectures are very popular, with 250-350 participants at each lecture. We are popularizing mathematics, our research, and personalities of mathematics in journals Správy SAV, Obzory matematiky, fyziky a informatiky, web, radio, TV, etc.

Our mathematics showed that it is not a jackstraw but an important part of our science. We hope to be active in popularization of Math also in future because this is a unique way how to show for our politicians, government and people the importance of the basic research, in particular of mathematics, for Slovakia.

2.8. Background and management. Human resources and implementation of recommendations from previous assessment

2.8.1. Summary table of personnel

Personnel	2012	2013	2014	2015
All personnel	90,0	81,0	78,0	74,0
Research employees from Tab. Research staff	55,0	57,0	54,0	53,0
FTE from Tab. Research staff	31,600	29,470	29,710	30,880
Average age of research employees with university degree	52,4	52,5	52,1	52,1

2.8.1.1. Professional qualification structure (as of 31.12. 2015) FEMALE

FEMALE	AGE								
Number of	< 30	31 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64	> 65
DrSc. / prof.							1		1
II.a / Assoc. prof.			1	1		1			
Other researchers PhD./CSc.		1	1		1		1		
doc. / Assoc. prof.							1		

2.8.1.2. Professional qualification structure (as of 31.12. 2015) MALE

MALE	AGE								
Number of	< 30	31 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	60 - 64	> 65
DrSc. / prof.							3	3	6
II.a / Assoc. prof.					3	3	2	3	
Other researchers PhD./CSc.	2	2	5	2	2	1	2	1	1
doc. / Assoc. prof.							1	1	1

2.8.2. Postdoctoral and mobility scheme

2.8.2.1. Postdoctoral positions supported by national and international resources

2.8.2.2. Postdoctoral positions supported by external funding

2.8.2.3. SAS stipends and SASPRO stipends

SAS

Mgr. Andrea Zemánková, PhD. SAS stipend since 2013 – stipend for young researchers who returned from the abroad long-term stay.

SASPRO

Dr. Giselle Antunes Monteiro, Brasil, she gained in 2015 a one-year fellowship at Mathematical Institute, start April 2016.

2.8.2.4. Internal funding - the Slovak Academy of Sciences Supporting Fund of Stefan Schwarz

Mgr. N. Dilna, PhD. since 2009, in the present she is at her maternal leave.

Mgr. Ľ. Torok, PhD. 2010-2013.

2.8.3. Important research infrastructure *(max. 2 pages)*

A particularity of our Institute is a high qualified structure of our colleagues. In the evaluated period, three colleagues became a senior researcher, IIa, and many PhD's were gained. We plan to continue in this important activity in human sources also for the next period. In Nov. 2015, prof. RNDr. Ján Jakubík, DrSc. passed away in high age, 91. He was scientifically active till end of his very productive life.

The research activity of the Mathematical Institute of SAS needs fortunately only a few material and technological equipments. Due to grants and application activities, our computer pool is equipped with sufficiently many PCs with the latest PC versions and programs. Of course, during the time it will be necessary to up date them with new and modern computer tools.

The library of the Mathematical Institute is one of the best mathematical libraries in Slovakia. Each our branch has also own small library in Košice, Department of Computer Sciences, as well as in B. Bystrica. The library contains over 26 612 items of books and journals, which presents increase 665 units. In view of economical problems, the growth of library is not so intensive as in the past. However, thanks to grants, we can every year buy new books, we have electronic access to many important mathematical journals. We are unique in Slovakia who has printed versions of Mathematical Reviews, and thanks to collaboration as Slovak unit of Zentralblatt MATH, we are also unique who has printed versions of Zentralblatt MATH and also electronic access to this database. We have electronic access journals distributed by greatest publishing houses like Springer-Verlag, Birkhauser, and Elsevier.

2.8.4. Description of how the results and suggestions of the previous assessment were taken into account

Our Institute was accredited in 2012 according to its activity in the period 2007-2011 with the highest grade A. Also in the all the previous accreditations, Mathematical Institute SAS was accredited in the highest category.

The Accreditation report very highly estimated the level of the mathematical research at our Institute comparable with world trends, with a very active collaboration with domestic and foreign important mathematical centers, with grants and economical activities, with outstanding Phd studies. In particular the publication activity in CC journal was very high. We have continued also in the present assessed period in these trends. The number of CC publications in the previous five year period was 156 and the average number per year was 31,2. Now it is 152 for the four year period which means the average number per year 38,4 and the year increase is to 123 %.

We had three researchers whose H-index was at least 10, in the present period we have seven such scholars.

In the previous assessed five year period 2007-2011, the number of SCI citations was 1822 and the average number per year was 364,4. In the present assessed four year period 2012-2015 the number of SCI citations is 2170 and the average number of citations per year is 542,8 which is an 119 % increase, and the average year increase is even 149%. In addition, the number of SCOPUS citations was 188, the average number per year was 37,5. Now, the number of SCOPUS citations is 464, which is 116 citations per year, and the year increase is to 309%. These numbers on publication activities and of citations show that recommendations of the previous assessment were taken into account.

According to the evaluation report, it was recommended to participate in multidisciplinary projects where is a bigger chance to be successful than in pure mathematics. We were a partner of one grant within frames of the Structural Funds EU together with Institute of Physics SAS (Prof. Bužek PI), meta QUTE, as well as we have a joint project with Institute of Physics: Center of Excellence of the Slovak Academy of Sciences: Physics of Information and Center Excellence of the Slovak Academy of Sciences: Quantum technologies.

The age structure of the Institutes is stabilized at 52,1 in 2015, whereas in 2011 it was 51,6 nevertheless we are elder for four years. We have to look for new possibilities to have the average age more smaller. We have accepted young colleagues from our former PhD students and others, also this year we will accept a very perspective our young PhD student who will finish his study this

year. The strong middle generation in the previous assessment period moved to a higher age. Very old colleagues have now only a partial time job in the Institute, but in the calculation of average age they are counted as a full time.

Unfortunately, the constrains of EU against Russian Federation caused that the projects with optimization of gas transport are not so financially interesting as it was couple years ago, which caused that some young talented colleagues working on these optimization problems left the institute the last year.
Some project leaders of VEGA grants moved to younger colleagues. Also a very young colleague is a member of the Institute Research Council. The publication activity is a main criterion at annual financial rewards.

We note that one of our young colleague had obtain a fellowship of the Slovak Academy of Sciences for returnee from abroad, and one colleague from Brazil had obtain last year a SASPRO fellowship with the beginning this April.

For high school students we are organizing the Days of Open Door to present research activities for potential student of mathematics, and for university students of the fourth or fifth year of their study we are giving a possibility to do one month research stay at our Institute, and among them we are looking for perspective new PhD students. Unfortunately, among the graduated students of mathematics there is only a few ones wishing to do the PhD study at our Institute or at universities.

- **Supplementary information and/or comments on management, research infrastructure, and trends in personnel development**

  RNDr. J. Pócs, PhD. gained in 2104 the first place at the Contest of the Young Researcher of SAS.

  Mgr. A. Jenčová, PhD. gained in 2014 the Birkhoff-von Neumann Prize of International Quantum Structure Association.

  Mgr. A. Zemánková, PhD. Young Research Award 2014, Prague, in the area of the Applied Mathematics, award of Visegrad Group Academies.

3. Research strategy and future development of the institute for the next five years (2016-2020) **(**Recommended 3 pages, max. 5 pages)

3.1. Present state of the art in both the national and the international contexts

The aim of our Institute for the next four years is to continue in basic mathematical research in all areas in which we already gained important results. For this aims we will try to apply projects within the programs of 7RP and H2020, however we are aware that in pure mathematics it is not easy to be successful in these programs.

We will concentrate to the following fields:

1. Number theory and cryptography

Number theory belongs to the oldest mathematical fields and it has its origin already in antic Greece. Nevertheless it is one of the most important mathematical subjects which also today in time of informatics boom lives over its great development and it is its integral part. Extension and advanced technology of modern computers brought also a new and unexpected development of number theory. Nowadays security of information, banking or cryptography – so called cyber security – is staying also on many results from number theory.

Mathematical Institute SAS traditionally belongs among top Slovak mathematical centers of number theory, and its results belong among important world recognized results. Number theory will belong among basic trends of the mathematical research with the following directions:

- Analytical number theory and probabilistic number theory
- Algebraic and elementary number theory, diophantic equations
- Criteria of pseudo randomness and distribution of sequences
- Cryptography

2. Uncertainty modeling by statistical methods, quantum structures, and fuzzy sets

Uncertainty modeling is one of the basic problems of measurement in many scientific and technological areas having practical applications in every-day life, or in quantum mechanics or economy. The notion of uncertainty is developed into width and deepness of our knowledge. Modeling is based on deep theoretical results, mainly mathematical statistics, algebraic structures, functional analysis, Hilbert space and operators, fuzzy and many-valued logic, and topological and categorical views. Mathematical Institute SAS succeeds top results comparable with the highest world results namely in applications of statistical methods for example in medicine, metrology and linguistic. Measurement of observables in quantum mechanics is based on results of quantum structures, here MI SAS plays a leading role in worldwide scale. Results of our protagonists were published already in three monographs. Today fuzzy theory is a base of many modern fuzzy technologies. The results of our colleagues showed that there is an intimate connection between many-valued logic and algebraic structures, like MV-algebras, pseudo MV-algebras, pseudo effect algebras, and lattice ordered groups. Our colleagues achieved excellent results in those directions and MI SAS is collaborating with many domestic and foreign centers.

Envisaged directions for this area are:

- Statistical methods in measurement, linguistic, medicine, econometrics, insurance and finance
- Quantum structures as a mathematical base for quantum mechanics, quantum computing, quantum information, and soft computing
- Quantum mechanical observables and measurements
- Fuzzy sets as a mathematical base for modern fuzzy technologies
- Development of calibration theory of the sensors and transducers, uncertainty determination in calibration of sensor under the normally distributed measurement errors

3. Ordered algebraic structures and discrete structures

In the area of ordered algebraic, discrete structures and graph theory, Mathematical Institute SAS has a long-year and successful tradition which goes back the beginning of our Institute. Ordered structures like partially ordered sets and ordered groups are studying on many important mathematical centers. The problem nowadays is related with computational complexity, optimizing dissimilation and combining of many substructures. This is characteristic for microchip construction or for description of very complicate molecules or graphs coloring problems.

Envisaged planes for this research are:

- Congruence lattices and monounary algebras
- Topological properties of Hamiltonian circuits of graphs cellularly embedded into surfaces
- Branched coverings of graphs and holomorphic graph mappings
- Discrete actions of groups on Riemann surfaces
- Coherent configurations and problem of recognition of Cayley graphs
- Structural properties of snarks and algorithms for computing snark invariants

4. Dynamical systems, real and functional analysis, and topology

Very complex processes in technological branches, dynamical systems, as well as in biological milieu need description via nonlinear differential systems. A chaotic behavior of these systems requests qualitative study between a discretization and original differential equations understood from dynamical theory point of view. Study of modern trends of both analytical and topological methods to boundary problems has at MI SAS a long tradition. Developed methods of convergence processes are basic for use of temporary computer facilities. For calculating and optimizing compound systems we are developing algorithms that are used with a great success in gas pipeline transport systems, as well as in tone systems. Applications of these methods have a very large variety of applications in technology, national economy, environment protection, and make a large base of knowledge for practical use.

We are planning concentrate to the following directions:

- Periodic and chaotic solutions of nonlinear systems
- Geometric and topological properties of smooth manifolds and fibre bundles by methods and tools of algebraic and differential topology
- Existence of chaos in nonlinear wave partial differential equations
- Integration in vector, topological and ordered spaces
- Topological methods Ascoli type theorems for quasicontinuous functions
- Complete metrizability of the Hausdorff metric topology

5. Computer science and data processing

Computer science and data processing is a new paradigm in the area of data processing using Internet or WWW. In this conception we suppose access to globally distributive computational means as well as to information and knowledge. It is important that Slovakia will participate at this research.

Envisaged planes of the research:

- The design, implementation and testing of efficient parallel block algorithms for canonical decompositions of matrices and tensors
- Theoretical problems with accent to linear network decomposition
- Complexity of regular operations on languages represented by self-verifying automata
- Theoretical analysis of the asymptotic convergence of block Jacobi EVD/SVD algorithms for different orderings of sub-problems (serial and parallel case)

6. Applications of mathematical research in praxis

Mathematical Institute SAS understands very well that *nothing is more practical than a good theory.* We are planning to continue with a successful collaboration with important Slovak enterprises and institutions.
It will deal mainly with application in the following areas:

- Cryptographic methods in state administration and for Ministry of Defense of the SR

- Applications in optimizing methods to Slovak Gas Company
- Leak detection and localization in gas pipeline system
- Mathematical models for the help of health care (statistical models, big data methods, security of health data)
- Mathematical methods for Nuclear Power Plant Research Institute

The scientific activity in the above outlined directions is important not only to implement our Institute in a strategic area of development in IT, but the achieved results will represent also our concrete contribution to the knowledge society and the knowledge economy in Slovakia.

7. Participation at PhD studies and pedagogical activities

To achieve the envisaged plans is possible only in a collaboration with all generations in our Institute. The main task will be dedicated big attention to the preparation of young colleagues for their mathematical career, and the best way is to incorporate them into research teams. This is possible in a close cooperation with Slovak and foreign universities. Many of our colleagues has a long-year experience with teaching activities, because according to us, the best applications of mathematical methods is to learn students the newest mathematical results at our Universities. We are also interesting in an active propagation of mathematical results through planned monographs as well as in public media (newspaper, journal, TV, radio, internet), in organization of the Weeks of Science for students from high schools and in organizing research stays at our Institute for university students of mathematics.

Research strategy of the institute

The project of the mathematical research at the Mathematical Institute of the Slovak Academy of Sciences for the next four years presents a very courageous but realistic project which rises up from the best mathematical traditions of the Institute, and the newest trends and needs in mathematics. To perform this project we will collaborate with all mathematical centers at Slovak Academy of Sciences and at universities in Slovakia. We have some active scientific contracts with universities, as well our industry, and we have to continue in this direction. Here it is necessary to mention Institute of Measurement SAS, Faculty of Math., Phys., Infor. Comenius Univ. Bratislava, Faculty of Natural Sciences of P.J. Šafárik Univ. Košice, Slovak University of Technology Bratislava, Matej Bel Univ. B. Bystrica, Žilina Univ., Technical Univ. Košice, etc.

The development of the knowledge economy of Slovakia will depend also on fact how it will be possible to implement mathematical research also into new companies in Slovakia (Peugeot, Volkswagen, Kia) and in domestic strategic enterprises. Therefore, it will grow also the number of students of mathematics at universities, it is necessary to profound their mathematical education and to found mathematical teams there.

The economical power of USA depends also in their ability how they are able to incorporate mathematics into needs of technology and praxis. The mathematical level of USA increased also due to immigration of famous mathematicians from the former Soviet Union. Therefore, we need technical and economical conditions for mathematicians, as well as for any young researcher, to reverse brain storm back to Slovakia. We are glad that at also in our Institute, we have a perspective and young researcher from Ukraine, and in 2016 will start to collaborate a young colleague from Brazil with the program SASPRO. We will also establish a new position in algebraic topology in August 2016. We agreed with young Slovak mathematician to take this position after more than 10 years at universities in Germany.

This is possible to do only in a very narrow collaboration with famous mathematical centers in Europe, and in the whole world. The mathematics cannot be divided to Slovak, German, or Russian one, only to good mathematics and to other one. Mathematical Institute SAS is collaborating with many foreign mathematical centers in abroad. We have many signed collaborations but also many informal but very active ones, and we will continue in looking for a new possibilities to be involved in projects in H2020, Framework Programs, COST, ESF, APVV,

VEGA, etc. and in applications of mathematical methods in society and economy. The crucial key will be in our possibility in involving young mathematicians, Slovak and foreign ones, into research teams via doctoral and post-doctoral studies.

In number theory and cryptology we are planning to collaborate with Prof. Pierre Liardet, Marseille, CMI, Prof. S. Porubský, Inst. Inform. Czech. Acad. Sci, Prague, prof. Georges Grekos, Univ. Saint-Etienne, France, Prof. F. Marko, Univ. Pennsylvania, USA, Prof. K. Györy, Debrecen Univ., Hungary, V. Fischer, Univ. Saint Etienne, France, E. Tromer, Tel-Aviv Univ., Israel, S. Magliveras, Florida St. Univ., USA, T. Helleseth, Bergen Univ., Norway, etc.
Topological methods will be studied in an active collaboration with Prof. R.A. McCoy, USA, Prof. U. Marconi, R. Moresco, G. Artico, Padova, R. Ceppitteli, S. Caterino, Perugia, Italy, L. Zsilinszky, USA, D. Holy, Univ. Trnava, etc.

Graph theoretical research will be performed in a collaboration with Pohang Uni. of Science and Technologies, Korea, Univ. Ljubljana, Univ. Koper, Slovenia, Auckland University, New Zeeland, Sobolev Inst. of the Russian Acad. Sci., Charles Univ. Prague, Univ. Southampton, U.K.

Many-valued logic, quantum structures will be studied with Profs. C. Holland, Bowling Green Univ. C. Tsinakis, Univ. Vanderbilt, D. Foulis Univ. Mass. USA, Univ. Boston (Prof. Ruskai, M. Guta), Prof. A. Di Nola, Univ. Salerno, Prof. P. De Lucia, Prof. A. Lettieri, Univ. Naples, Prof. T. Kowalski, Univ. Melbourne, Prof. R. Giuntini, Univ. Cagliari, Dr. R. Carbone, Univ. Pavia, Italy, Dr. R.P. Kostecki, Perimeter Inst, Waterloo, Canada, Prof. P. Klement, Univ. Linz, Prof. D. Buhagiar, Dr. E. Chetcuti, Univ. Malta, Dr. Xie Y., China, Prof. R.A. Borzooei, Dr. O. Zahiri, Univ. Appl. Sci. Techn., Tehran, Iran, Italy, Palacky Univ. Olomouc (Profs. J. Rachunek, I. Chajda, Halaš, J. Kuhr, M. Botur), Masaryk Univ. Brno (Dr. J. Paseka), etc.

Statistical and numerical methods will be studied in collaboration with Charles University in Prague, Czech Republic (Prof. J. Antoch, Prof. M. Hušková, Doc. D. Hlubinka, Doc. P. Lachout, Dr. M. Pešta), Institute of Breath Research, Medical University Innsbruck, Austria (Dr. V. Ruszanyi, Dr. W. Filipiak), Univeristy Trier, Germany (Prof. R. Koehler), University of Vienna, Austria (Dr. E. Kelih), DI Mendeleyev Institute for Metrology (VNIIM), St. Petersburg, Russia (Dr. A. Chunovkina), Profs. F. Batteli, M. Franco, A. Calamaiom, Univ. Ancona, Prof. V. Rothos, Greece, Prof. P. Zwengrovski, Univ. Calgary, Dr. A. Ronto, Brno, and others.

For example, in area of computer science we are intended to collaborate with such important experts as Prof. L.A. Szekely, Univ. South Carolina, USA, Prof. D. Bokal, Univ. Ljubljana, Slovenia, Prof. A. Raspaud, Univ. and others. Bordeaux, France, Prof. Z. Strakos, Inst. Informatics AV CR, Prague, Prof. V. Hari, Univ. Zagreb, Croatia, Prof. L. Grigori, Univ. d'Orsay, France, Prof. T. Sorevik, Univ. Bergen, Norway, Univ. Salzburg, Austria, Prof. V. Geffert, UPJŠ Košice, Dr. Baiyu Li (David R. Cheriton School of Computer Science, University of Waterloo, Waterloo, Canada), Prof. W.B. Moors, Univ. Auckland, New Zealand etc.

The envisaged development plan of activity for Mathematical Institute in 2012-2015 is a typical example of an interdisciplinary project where problems of different areas of mathematics, as well as physics and logics are met. We will use mainly methods of algebras, probability theory, theory of l-groups and partially ordered groups, Hilbert spaces, functional analysis, many-valued logic, methods of fuzzy set theory, methods of quantum logics, t-norms, aggregation operators, graph theory and discrete mathematics, number theory and algebra, computer science, mathematical analysis, mathematical statistics, etc. The envisaged methodology will outgoing from the interdisciplinarity of the plans where we use the newest methods known in the literature, respectively obtained by the investigators in the previous activities of the Institute and we suppose continuous solving the envisaged plans.

Progress of the given plans will follow the basic approaches of the mathematical research: that is, determination of hypotheses, formulation of the main assertions and their proofs, and founding the conditions when the assertions hold or not. Presentations of the obtained results on seminars and conferences and the publications in prestigious journals are assumed. We have already a very good publication activity in the best journals with very interesting citation impact. But we have to

increase this activity. We have to follow also the newest trends. We are planning to organize international conferences, and to participate at the most important scientific events to present the results of our own research, to publish the achieved results in the best scientific journals, and in monographs. A very important role is also a propagation of mathematical results in public media (newspaper, journal, TV, radio, internet) and in organization of the Week of Sciences for students.

As physics of the 20th century was the biggest inspiration source for mathematics, 21st century mathematics will gain inspiration in biological models, and we have to be ready to follows these trends.

We are sure that also a small Slovakia could contribute to the world mathematical treasury with their own contributions in a narrow collaboration with colleagues from the whole world.
Slovak Academy of Sciences is actively discussing the last six years about new organization of the research and institutes of SAS. Namely, the passage from the present status of the budgetary and allowance institutes to the public research institutes, like in the Czech republic. Unfortunately, the years 2013-2015 were very turbulent, it was planned the passage to 9-12 big centers, which was in 2015 rejected, and also today it is not clear when the Transformation Act on the Slovak Academy of Sciences will be presented by the government at the Slovak parliament. It is necessary to finish this unstable situation in Institutes which is not good for soft scientific work. However, one of the main organizing tasks of all institutes, in particular of the Mathematical Institute, is to be ready for this transformation of the Slovak Academy of Sciences.

3.2. Research strategy of the institute in the national and the international contexts, objectives and methods

Project proposals submited to 7RP or H2020	2012	2013	2014	2015
Institute as coordinator				
Institute as participant			1	

4. Other information relevant for the assessment