Institute of Mathematics CAS, v. v. i.

Identification number: 67985840
Address: 115 67 Praha 1, Žitná 609/25

Annual report on activities and economic management in 2022

English summary

The Annual report was discussed by the Supervisory Board of the Institute on June 12, 2023 and approved by the Board of the Institute on June 15, 2023.

Contents

1 The Institute

The Institute of Mathematics of the Czech Academy of Sciences, v. v. i. (“the Institute” or “IM”), is a public research institution according to the Act No. 341/2005 Coll.

The founder of the Institute is the Czech Academy of Sciences seated at Praha 1, Národní street 1009/3, ZIP code 117 20.

The Institute was founded in order to carry out scientific research in the field of mathematics, to contribute to the utilisation of its research results, and to provide the research infrastructure.

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IN: 67985840
TIN: CZ67985840

1.1 Foundation deed (unofficial translation)

Based upon Act No. 283/1992 Coll., on the Czech Academy of Sciences, as subsequently amended, and upon Act No. 341/2005 Coll., on public research institutions, as subsequently amended, and further, in accordance with the Statutes of the Czech Academy of Sciences issued on 24 May 2006, the Czech Academy of Sciences (hereinafter CAS) hereby issues the Full Text of the Foundation Deed of the Institute of Mathematics of the CAS (in Czech "Matematický ústav AV ČR, v. v. i.") dated 28 June 2006 (English version dated 20 December 2006), as subsequently amended by the resolution of the twentieth session of the Academy Council of the CAS held on 15 July 2014 which changed English translation of the name of the CAS from the Academy of Sciences of the Czech Republic to the Czech Academy of Sciences as of 1 January 2015:

I.

(1) The Institute was incorporated into the Czechoslovak Academy of Sciences (hereinafter CSAS) under the name the Mathematical Institute of the CSAS by a resolution of the third plenary meeting of the Government Commission for the Establishment of the CSAS held on 30 March 1952, which took effect on 1 January 1953. Under section 18 (2) of Act No. 283/1992 Coll., the Institute became an entity of the CAS as of 31 December 1992.

(2) Under Act No. 341/2005 Coll., the legal status of the Mathematical Institute of the CAS has been transformed from a state contributory organisation into a public research institution (abbreviated in Czech as v. v. i.) from 1 January 2007.

II.

(1) The Institute of Mathematics of the CAS (hereinafter IM) is established for an indefinite period as a legal entity with identification number 67985840, and is located in Prague 1, Žitná 609/25, Postal Code 115 67.

(2) The founder of the IM is the CAS, an organisational body of the state, identification number 60165171, headquartered in Prague 1, Národní 1009/3, Postal Code 117 20.

III.

(1) The purpose for which the IM has been established is to carry out scientific research in the field of mathematics, to contribute to the utilisation of its research results, and to provide the research infrastructure.

(2) The principal activity of the IM is scientific research in the fields of mathematics and its applications. The IM contributes to raising the level of knowledge and education and to utilising the results of scientific research in practice. It acquires, processes and disseminates scientific information, issues scientific and professional publications (monographs, journals, proceedings, etc.). It provides scientific assessments, professional opinions and recommendations, consulting and advisory services. In cooperation with universities, the IM carries out doctoral study programmes and provides training for young scientists. Within the scope of its activity, the IM promotes international cooperation, including the organisation of joint research projects with foreign partners, participation in exchange programmes for scientists and the exchange of scientific information, as well as the preparation of joint publications. The IM organises scientific meetings, conferences and seminars on the national and international levels and provides the infrastructure for research, including the provision of accommodation for its employees and guests. It pursues its aims both independently and in cooperation with universities and other research and professional institutions.

IV.

(1) The director, the Board and the Supervisory Board are the bodies of the IM. The director is the statutory body of the IM and is entitled to act on behalf of the IM.

(2) Basic organisational units of the IM are scientific departments responsible for research and development, and service departments responsible for provision of the infrastructure.

(3) The detailed organisational structure of the IM is regulated by rules of organisation issued by the director after being approved by the Board.

V.

The foundation deed in its present form took effect on 1 January 2015.

Prof. Jiří Drahoš
President of the CAS

1.2 Governing bodies (as of December 31, 2021)

Director: Doc. RNDr. Tomáš Vejchodský, Ph.D.

Deputy Director: Doc. Dr. Ing. Miroslav Rozložník, DSc.

Board of the Institute:

Chair:	RNDr. Martin Markl, DrSc.
Vice-chair:	Vojtěch Pravda, Ph.D., DSc.
Members at large:	Prof. RNDr. Zuzana Došlá, CSc., DSc. (Masaryk University)
	Prof. RNDr. Pavel Drábek, DrSc. (University of West Bohemia in Pilsen)
	Prof. RNDr. Eduard Feireisl, DrSc.
	Prof. RNDr. Michal Křížek, DrSc.
	Prof. Wieslaw Kubiś, Ph.D.
	RNDr. Šárka Nečasová, CSc., DSc.
	Doc. Mgr. Milan Pokorný, Ph.D., DSc. (Charles University)
	Ing. Jakub Šístek, Ph.D.
	Prof. RNDr. Jan Trlifaj, CSc., DSc. (Charles University)

Supervisory Board:

Chair:	Prof. Ing. Michal Haindl, DrSc. (Academy Council of the CAS)
Vice-chair:	Mgr. Alena Pravdová, Ph.D.
Members at large:	Prof. RNDr. Jan Hamhalter, CSc. (Czech Technical University in Prague)
	Prof. RNDr. Luboš Pick, CSc., DSc. (Charles University)
	prof. Ing. Miroslav Tůma, CSc. (Charles University)

The director of the Institute cooperated with the Board of the Institute and relied on an informal advisory board formed by the chair of the Board Martin Markl, deputy director Miroslav Rozložník, the scientific secretary and project manager Beata Kubiś, head of the Administration Department Jan Bíža, head of the IT Department Martin Jarník.

The **Board of the Institute** held seven meetings, four of them per rollam. The topics the Board discussed and approved included among others:

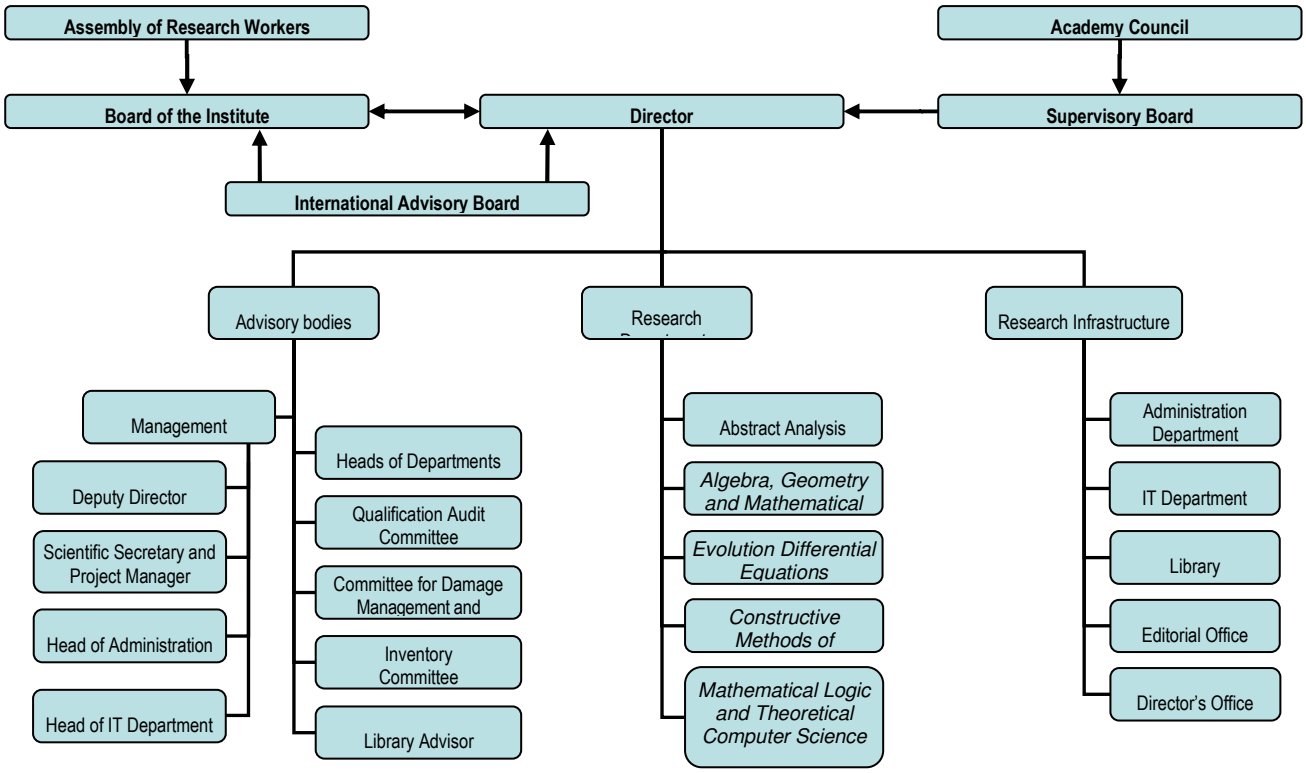
- budget of the Institute for 2022 and the medium-term financial outlook for 2023–2024,
- annual report on activities and economic management in 2021 and auditor's report on financial statements,
- selection of J. Cancino-Manríquez for the postdoctoral position in the Academy's programme supporting prospective human resources,
- proposal of P. Pudlák for the Award De scientia et humanitate optime meritis.
- recommendation to invite Prof. Y. Shibata (Waseda University, Tokyo, Japan) for the Eduard Čech Distinguished Visitor position,
- selection of I. Marquez-Albez for the postdoctoral position in the Academy's programme supporting prospective human resources,
- proposal of J. Papež for the Otto Wichterle Award to promising young scientists.

The **Supervisory Board** held four meetings, two of them per rollam. The topics they discussed and approved included among others:

- discussion about the proposal of the budget of the Institute for 2022 and the medium-term financial outlook for 2023–2024, about the annual report on activities and economic management in 2021 and about auditor's report on financial statements,
- approval of lease agreements and amendments extending lease agreements for flats in the Institute's building.

Institute of Mathematics, Czech Academy of Sciences

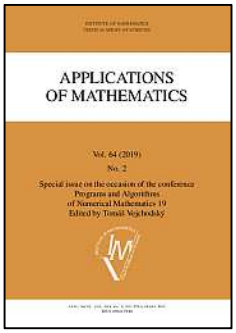
Scheme of the organizational structure



The Institute publishes three internationally recognized mathematical journals:

- Czechoslovak Mathematical Journal
- Mathematica Bohemica
- Applications of Mathematics
- Higher Structures

The director nominates the Editorial Boards and the Editors-in-Chief.



The Institute is maintaining and developing the Czech Digital Mathematics Library DML-CZ accessed at https://dml.cz and participates in the development of the European Digital Mathematics Library EuDML accessed at https://eudml.org. The Institute operates the Prague Zentralblatt Editorial Group contributing to the production of the database zbMATH.

2 Research activities

2.1 Characteristics of the principal activity

The principal activity of the IM is to support fundamental research in the fields of mathematics and its applications, and to provide necessary infrastructure for research. The IM contributes to raising the level of knowledge and education and to utilising the results of scientific research in practice. It acquires, processes and disseminates scientific information including scientific publications (journals, proceedings, monographs etc.). In cooperation with universities, the IM carries out doctoral study programmes and provides training for young scientists. The IM promotes international cooperation, including the organisation of joint research projects with foreign partners and participation in exchange programmes. The IM organises scientific meetings, conferences and seminars on the national and international levels.

Research in the Institute focuses on mathematical analysis (differential equations, numerical analysis, functional analysis, theory of function spaces), algebraic and differential geometry, mathematical physics, mathematical logic, complexity theory, combinatorics, set theory, numerical linear algebra, general and algebraic topology, optimization and control.

2.2 Departments

Abstract Analysis

Main research themes of the department members can be described as the study and classification of mathematical structures, using advanced methods of logic, set theory, and category theory, as well as modern tools of mathematical analysis and algebra. Abstract analysis refers to these areas of science where mathematical logic plays a significant role, even though it is not the main object of study. These areas include descriptive set theory, topology, Banach space theory, and the theory of C* algebras.

Algebra, Geometry and Mathematical Physics

The department consists of researchers interested in algebraic and differential geometry and in closely related areas of mathematical physics. The research is focused on mathematical aspects of modern theoretical models of physics of microcosmos and cosmology related to logical correctness of physical hypotheses and mathematical models aiming at understanding the nature of matter and space. Research topics include representation theory and its applications to algebraic geometry, homological algebra, algebraic topology, applied theory of categories, tensors classification, generalized theory of gravitation, and study of Einstein equations.

Constructive Methods of Mathematical Analysis

The department focuses on mathematical modelling of complex physical processes that involve an immense amount of data and require advanced implementations on parallel computer architectures. The main topics include theory and applications of numerical methods for partial differential equations, a posteriori error analysis, computational methods of numerical linear algebra, matrix theory, domain decomposition and multilevel methods. Another topic is presented by methods of flow-filed analysis, mostly for vortex identification. Members of the department are involved in the Jindřich Nečas Centre for Mathematical Modeling (http://ncmm.karlin.mff.cuni.cz/) and in the network for industrial mathematics EU-MATHS-IN.CZ (http://www.eu-maths-in.cz/), part of the European network EU-MATHS-IN (http://eu-maths-in.eu/).

Evolution Differential Equations

The department focuses on qualitative theory of partial differential equations in mechanics and thermodynamics of continuum, in biology, chemistry and other natural and technical sciences. The research aims at verification of correctness and other fundamental properties of mathematical models and at the possibility of providing theoretical predictions of future development of systems without the full knowledge of the initial state. The core are work equations describing motion of various kinds of

fluids, including exchange heat and interaction with solid bodies. The attention is also paid to processes in solid materials, focusing on mathematical modelling of memory in multifunctional substances, on dynamical behaviour of bodies in contact with neighbourhood, and on phase transitions. Several members investigate modern theory of integration in connection with ordinary differential equations.

Mathematical Logic and Theoretical Computer Science

The research conducted in the department concerns several loosely connected areas. The main ones are theoretical computer science and mathematical logic; other important areas are combinatorics, control theory, automata theory and differential geometry. The main topic in theoretical computer science is computational complexity, which is connected with another topic, proof complexity, an area of research on the border of theoretical computer science and mathematical logic. Other main topics of mathematical logic studied in the department are set theory and formal arithmetic.

2.3 Research centres

Jindřich Nečas Centre for Mathematical Modeling (http://ncmm.karlin.mff.cuni.cz/) is a consortium of the Institute of Mathematics, the Faculty of Mathematics and Physics of the Charles University, and the Institute of Computer Science CAS. It was established in 2013 to continue the efforts of a joint project funded by the Ministry of Education, Youth and Sports in 2005–2011. Its general goal is to establish a strong research team in the field of mathematical properties of models in continuum mechanics and thermodynamics, developed by an intensive collaboration of important research groups at participating institutions and their goal-directed collaboration with top experts from abroad. Organization of lecture courses and the everyday interaction with PhD and undergraduate students aims at upbringing new generation of competent scientists and forming a basis for a strong and stable research team.

DIMATIA – Centre for Discrete Mathematics, Theoretical Computer Science and Applications (http://dimatia.mff.cuni.cz/) is a consortium of the Faculty of Mathematics and Physics of the Charles University, the Institute of Mathematics and the Institute of Chemical Technology in Prague. It was established in 1996 with the aim to foster research in all fields of discrete mathematics and its modern applications and relationship to computer science, operations research and fields as diverse as biology, chemistry and social sciences. The centre organizes a continuing programme of workshops, conferences and research visits, postdoctoral positions announced and jointly supported by the partners and short-term visits of senior researches. DIMATIA created an extensive international network with 13 further research institutions.

2.4 Research output

In 2022, members of the Institute published the total of 175 journal and proceedings papers, including one monograph. The following 13 results were selected to illustrate the output. The detailed information about all publications is available at Institute's web site http://www.math.cas.cz/ in section Research / Publications.

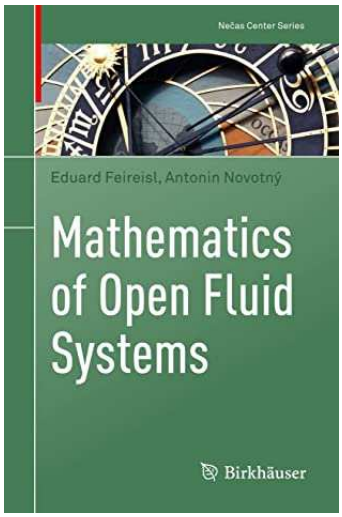
[1] **Positselski, L.**, Šťovíček, J. Topologically semisimple and topologically perfect topological rings. *Publicacions Matematiques.* 2022, **66**(2), 457-540.

This the main paper in a series of papers by Positselski and collaborators about topologically perfect right linear topological rings with applications to the Enochs conjecture on covers and direct limits. The main result of the paper is that over complete, separated right liner topological ring, all left contramodules have projective covers if and only if all flat left contramodules have projective covers if and only if all flat left contramodules are projective if and only if the ring has a topologically left T-nilpotent strongly closed two-sided ideal with a topologically semisimple quotient ring.
If the ring's topology has a countable base of neighborhoods of zero, these conditions are also equivalent to the condition that every descending chain of discrete right modules over the topological ring terminates.

Theorem 14.4. *The following implications between the properties in Theorem 14.1, in Conjecture 14.3, and the additional property (vi) hold true:*

$$
\begin{array}{ccccccc}
\text{(i)} & \Longleftrightarrow & \text{(ii)} & \Longleftrightarrow & \text{(iii)} & \Longleftrightarrow & \text{(iv)} \\
\Updownarrow & & & & \Updownarrow & & \\
\text{(i}'\text{)} & & \Longleftrightarrow & & \text{(iii}'\text{)} & & \\
\Downarrow & & & & \Downarrow & & \\
\text{(i}^\flat\text{)} & & \Longleftrightarrow & & \text{(iii}^\flat\text{)} & \Longrightarrow \text{(v)} & \Longrightarrow \text{(vi)}
\end{array}
$$

[2] **Feireisl, E.**, Novotný, A. *Mathematics of Open Fluid Systems*. 1. Cham: Birkhäuser, 2022. Nečas Center Series. ISBN 978-3-030-94792-7.



The goal of this monograph is to develop a mathematical theory of open fluid systems in the framework of continuum thermodynamics.
Part I discusses the difference between open and closed fluid systems and introduces the Navier-Stokes-Fourier system as the mathematical model of a fluid in motion. A class of generalized solutions to the Navier-Stokes-Fourier system is considered in Part II in order to show existence of global-in-time solutions for any finite energy initial data, as well as to establish the weak-strong uniqueness principle. Finally, Part III addresses questions of asymptotic compactness and global boundedness of trajectories and briefly considers the statistical theory of turbulence and the validity of the ergodic hypothesis.

[3] Bergfalk, J., Hrušák, M., **Lambie-Hanson, C**.: Simultaneously vanishing higher derived limits without large cardinals, to appear in Journal of Mathematical Logic.

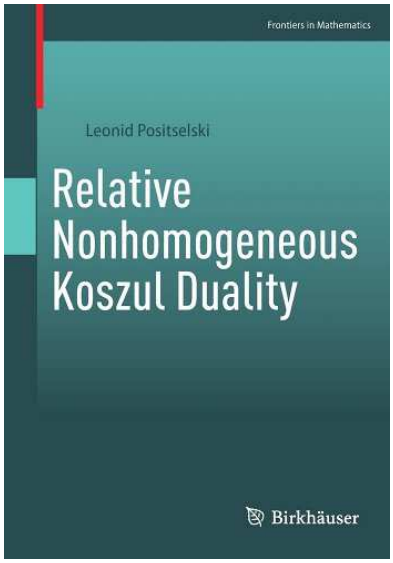
This paper addresses a question dating back to the 1980s as to whether it is consistent with the axioms of set theory that all higher derived limits of a certain inverse system of abelian groups simultaneously vanish. Since then, these derived limits have shown to be directly connected to questions in such diverse fields as homological algebra, functional analysis, descriptive set theory, and, quite recently, the work of Clausen and Scholze on condensed mathematics. The question was answered positively in a previous work of Bergfalk and Lambie-Hanson, but only under the additional assumption of a certain large cardinal axiom. In this paper, the authors substantially improve upon this work by entirely removing the large cardinal assumption, thereby providing a full positive answer to the original question.

[4] **Papež, J.**, Vohralík, M. Inexpensive guaranteed and efficient upper bounds on the algebraic error in finite element discretizations. *Numerical Algorithms.* 2022, **89**(1), 371-407.

In the paper we derived several strategies how to reduce the evaluation cost of flux-reconstruction-based error estimates for the error. The new formulas partially overcome one of the crucial disadvantage of this technique. Numerical experiments confirm that most of the favorable properties of the estimates (in particular their very tight accuracy) is preserved.

[5] **Kračmar, S.**, Kwon, Y.-S., **Nečasová, Š.**, Novotný, A. Weak solutions for a bifluid model for a mixture of two compressible noninteracting fluids with general boundary data. *SIAM Journal on Mathematical Analysis.* 2022, **54**(1), 818-871.

The goal is to show the global existence of weak solutions for a version of the one velocity Baer--Nunziato system with dissipation describing a mixture of two noninteracting viscous compressible fluids in a piecewise regular Lipschitz domain with general inflow/outflow boundary conditions. The geometrical setting is general enough to comply with most current domains important for applications, such as (curved) pipes of piecewise regular and axis-dependent cross-sections.For the existence proof, we extend the classical Lions--Feireisl approach to the compressible Navier--Stokes equations with mixture and combined with a generalization of the theory of renormalized solutions to the transport equations in the spirit of Vasseur et al. We develop the generalized the theory of renormalized solutions (introduced by Lions-DiPerna) to families of transport equations with nonhomogeneous boundary data, which is one of the building blocks of the proofs. These results are new and of independent interest.



[6] **Positselski, L.** *Relative Nonhomogeneous Koszul Duality*. 1. Cham: Birkhäuser, 2021. Frontiers in Mathematics. ISBN 978-3-030-89539-6.

This book develops a new direction in the theory of Koszul algebras and derived Koszul duality which was generally neglected in the numerous recent publication on the topic, namely, relative Koszul duality over an (arbitrary, noncommutative, nonsemisimple) base ring. In fact, this is the first publication in which a version of Koszul duality including the duality between the rings of differential operators and the (curved) DG-rings of differential forms is worked out in a natural generality.The main results include the Poincaré-Birkhoff-Witt theorem for nonhomogeneous Koszul rings over a base ring and the triangulated equivalences of derived Koszul duality worked out in this context, including the comodule-contramodule correspondence and various Koszul triality and Koszul quadrality diagrams.

[7] **Jeřábek, E.** Iterated multiplication in VTC0. *Archive for Mathematical Logic.* 2022, **61**(5-6), 705-767.

We have shown that VTC^0, the basic theory of bounded arithmetic corresponding to the complexity class TC^0, proves the totality of iterated multiplication satisfying the common recursive definition. Consequently, it also proves the totality of integer division, and induction and minimization for (translations of) sharply bounded formulas.

[8] Li, Y., **She, B.** On convergence of numerical solutions for the compressible MHD system with exactly divergence-free magnetic field. *SIAM Journal on Numerical Analysis.* 2022, **60**(4), 2182-2202.

Numerical approximation of MHD problems are important due to their wide applications in physics. We present a very general convergence theory in the sense of the Lax equivalence theorem, which helps the design of numerical schemes that obeys the natural mechanism of the problem.

[9] Fröb, M. B., **Khavkine, I.**, **Málek, T.**, **Pravda, V.** On well-posedness and algebraic type of the five-dimensional charged rotating black hole with two equal-magnitude angular momenta. *European Physical Journal C.* 2022, **82**(3), 215.

The paper studies various mathematical aspects of the charged rotating black hole with two equal-magnitude angular momenta in five dimensions. We introduce a coordinate system that is regular on the horizon and in which Einstein-Maxwell equations reduce to an autonomous system of ODEs. Employing Bondi and Kruskal-like coordinates, we analyze the geometric regularity of the black hole metric at infinity and the horizon, respectively, and the well-posedness of the corresponding boundary value problem. The authors also study the algebraic types of the electromagnetic and curvature tensors. While outside the horizon the electromagnetic and Ricci tensors are of type D, the Weyl tensor is algebraically general. The Weyl tensor simplifies to type II on the horizon and type D on the bifurcation sphere. These results imply inconsistency of the metric with the Kerr-Schild form with a geodesic Kerr-Schild vector.

[10] Ando, H., **Doucha, M.**, Matsuzawa, Y. Large scale geometry of Banach-Lie groups. *American Mathematical Society. Transactions.* 2022, **375**(4), 2827-2881.

The authors initiate the large scale geometric study of Banach-Lie groups, especially of linear Banach-Lie groups. We show that the exponential length, originally introduced by Ringrose for unitary groups of -algebras, defines the quasi-isometry type of any connected Banach-Lie group. As an illustrative example, they consider unitary groups of separable abelian unital -algebras with spectrum having finitely many components, which we classify up to topological isomorphism and up to quasi-isometry, in order to highlight the difference. The main results then concern the Haagerup property, and Properties (T) and (FH). We present the first non-trivial non-abelian and non-locally compact groups having the Haagerup property, most of them being non-amenable. These are the groups , where is a semifinite von Neumann algebra with a normal faithful semifinite trace . Finally, they investigate the groups , which are closed subgroups of generated by elementary matrices, where is a unital Banach algebra. We show that for, all these groups have Property (T) and they are unbounded, so they have Property (FH) non-trivially. On the other hand, if is an infinite-dimensional unital -algebra, then does not have the Haagerup property. If is moreover abelian and separable, then does not have the Haagerup property.

[11] **Kolář, V.**, **Šístek, J.** Disappearing vortex problem in vortex identification: Non-existence for selected criteria. *Physics of Fluids.* 2022, **34**(7)), 071704.

A discontinuous outcome of vortex-identification methods called the disappearing vortex problem (DVP) has been already found for the swirling strength criterion and the Rortex (later renamed as Liutex) method. Here, the opposite property reflecting the situation that the DVP cannot be found for any input data, that is, the non-existence of the DVP, is examined and proved valid for selected criteria based on the velocity-gradient tensor, including Q, lambda-2, and the triple decomposition method. For the Q-criterion and the triple decomposition method, it is done directly, whereas for lambda-2, it is shown using a proof by contradiction.

[12] Krejčí, P., **Monteiro, G. A.**, Recupero, V. Non-convex sweeping processes in the space of regulated functions. *Communications on Pure and Applied Analysis.* 2022, **21**(9), 2999-3029

The aim of this paper is to study a wide class of non-convex sweeping processes with moving constraint whose translation and deformation are represented by regulated functions, i.e., functions of not necessarily bounded variation admitting one-sided limits at every point. Assuming that the time-dependent constraint is uniformly prox-regular and has uniformly non-empty interior, we prove existence and uniqueness of solutions, as well as continuous data dependence with respect to the sup-norm.

[13] Bartl, D., **Fabian, M.**, Kolář, J. Clarke Jacobians, Bouligand Jacobians, and compact connected sets of matrices. *Journal of Mathematical Analysis and Applications.* 2022, **516**(1)), 126491.

The authors prove that every non-empty compact connected set of matrices can be expressed as the Bouligand Jacobian at the origin of a suitable Lipschitzian mapping which is moreover either countably piecewise affine or C∞-smooth off the origin. Given proofs are simpler and different from the previous ones.

2.5 Projects

2 projects Praemium Academiae funded by the Czech Academy of Sciences

- Operadic categories and their applications (2019–2024, M. Markl)
- Fluid-structure interaction problems: mathematical analysis and applications (2022–2027, Š. Nečasová).

2 grant projects for the support of excellence in basic research EXPRO funded by the Czech Science Foundation:

- 20-31529X Abstract convergence schemes and their complexities (2020–2024, W. Kubiś)
- 19-27871X Efficient approximation algorithms and circuit complexity (2019–2023, P. Hrubeš)

8 standard grant projects funded by the Czech Science Foundation:

- GA22-01591S Mathematical theory and numerical analysis for equations of viscous newtonian compressible fluids (2022–2024, Š. Nečasová)
- 21-02411S Solving ill posed problems in the dynamics of compressible fluids (2021–2023, E. Feireisl)
- 20-14736S Hysteresis modeling in mathematical engineering (2020–2022, G. Monteiro)
- 20-13778S Symmetries, dualities and approximations in derived algebraic geometry and representation theory (2020–2022, L. Positselski)
- 20-01074S Adaptive methods for the numerical solution of partial differential equations: analysis, error estimates and iterative solvers (2020–2022, T. Vejchodský)
- 19-09659S Exact solutions of gravity theories: black holes, radiative spacetimes and electromagnetic fields (2019–2021, extended to 30.6. 2022, V. Pravda)
- 19-04243S Partial differential equations in mechanics and thermodynamics of fluids (2019–2021, extended to 30.6. 2022, Š. Nečasová)
- 19-05497S Complexity of mathematical proofs and structures (2019–2021, extended to 30.6. 2022, E. Jeřábek)

3 junior grant projects funded by the Czech Science Foundation:

- 20-17488Y Applications of C*-algebra classification: dynamics, geometry, and their quantum analogues (2020–2022, K. Strung)
- 19-05271Y Groups and their actions, operator algebras, and descriptive set theory (2019–2021, extended to 30.6. 2022, M. Doucha)
- 19-07129Y Linear-analysis techniques in operator algebras and vice versa (2019–2021, extended to 30.6. 2022, T. Kania)

3 international grant projects funded by the Czech Science Foundation

- GF22-07833K Homogeneity and Genericity of Metric Structures - Groups, Dynamical Systems, Banach Spaces and C*-Algebras (2022-2024, Bice)
- GC22-08633J Qualitative Theory of the MHD and Related Equations (2022-2024, J. Neustupa)
- 19-06175J Compositional Methods for the Control of Concurrent Timed Discrete-Event Systems (2019–2021, extended to 30.6. 2022, J. Komenda)

1 international grant project evaluated on the basis of the LEAD Agency principle funded by the Czech Science Foundation

- 20-22230L Banach spaces of continuous and Lipschitz functions (2020–2022, W. Kubiś)

2 projects in the Structural Funds Operational Programme Research, Development and Education, funded by the European Commission, operated by the Ministry of Education, Youth and Sports

- CZ.02.2.69/0.0/0.0/18_054/0014664 Institute of Mathematics CAS goes for HR Award
- implementation of the professional HR management (2020–2022, team: L. Bauerová, B. Kubiś, M. Rozložník, K. Strung, T. Vejchodský)
- CZ.02.2.69/0.0/0.0/16_018/0002713 Doctoral School for Education in Mathematical Methods and Tools in HPC (2017–2022, T. Vejchodský)

1 MOBILITY project funded by the Ministry of Education, Youth and Sports:

- 8J20AT022 Hysteresis in hypo-plastic models (2020–2021, extended to 31.12. 2022, G. Monteiro)

1 INTER-EXCELLENCE project funded by the Ministry of Education, Youth and Sports:

- LTAUSA19098 Verification and Control of Networked Discrete-Event-Systems (2020–2022, J. Komenda)

A detailed information on the projects is available at the Institute's web site http://www.math.cas.cz/ in the section Research / Grants.

2.6 International conferences and workshops organized by the Institute

Winter School in Abstract Analysis, section Set Theory & Topology, Klášter Hejnice, 29.1. - 5. 2. 2022
https://www.winterschool.eu/2022

Applications of Mathematics, Praha, 31.3.- 1.4. 2022
http://am2022.math.cas.cz/

PANM 21 Programy a algoritmy numerické matematiky 21, Hotel Merkur, Jablonec nad Nisou, 19.-24. 6. 2022,
http://panm21.math.cas.cz/

Complexity Theory with a Human Face, Špindlerův Mlýn, 27.6. - 1.7. 2022
https://workshop.math.cas.cz/HumanFace/2022/

27th International Domain Decomposition Conference, Praha, 25.-29.7. 2022,
https://www.dd27.cz/

Toposym, Prague Symposia on General Topology and its Relations to Modern Analysis and Algebra, Praha, 25.7. - 29.7. 2022,
http://toposym.cz/index.php

Mathematical Fluid Mechanics In 2022, Praha, 22.- 26. 8. 2022,
https://mfm-in.com/

16th IFAC Workshop on Discrete Event Systems WODES2022, Praha, 7.- 8. 9. 2022,
https://wodes2022.ciirc.cvut.cz/

Higher Structures in Prague, Praha, 12.- 16. 9. 2022,
https://workshop.math.cas.cz/higher-structures-in-prague/

Cosmology on Small Scales 2022, Prague, 21.-24. 9. 2022,
https://css2022.math.cas.cz/

Mathematics in Industry 2022, Praha, 5. 12. 2022,
http://workshop.math.cas.cz/MathInIndustry2022/

Problems in Acoustics, Praha, 6.12. 2022,
https://www.math.cas.cz/documents/Bobcat_Program_06_12_2022.pdf

2.7 International collaboration

An extensive international collaboration in 2018 is documented by the following facts:

- 29 visitors to the Institute

- 421 research visits abroad
- 8 international conferences and meetings organized or co-organized by the Institute
- 56 memberships in editorial boards of international scholarly journals

The Institute is a corporate member of the following organizations:

- The Union of Czech Mathematicians and Physicists
- The European Mathematical Society
- ERCOM (European Research Centres on Mathematics)
- European Digital Mathematics Library Initiative
- EU-MATHS-IN (European Service Network of Mathematics For Industry and Innovation) – through the national network EU-MATHS-IN.CZ

2.8 Cooperation with universities in education

Members of the Institute held a number of courses for students at Czech and foreign universities, supervised 28 PhD students. The Institute is accredited for 16 PhD programmes jointly with the Charles University and the University of West Bohemia.

PhD students trained in the Institute in cooperation with the universities:

Azhar Abek, L. U. Gumilov Eurasian National University, consultant A. Gogatishvili
Jiří Balun, Palacký University Olomouc, supervisor T. Masopust
José Andrés Oyarce Boggioni, Universidad del Bío-Bío, Chile, cosupervisor R. Hakl
Jaroslav Bradík, Silesian university in Opava, supervisor M. Engliš
Zadira Ermiashova, L. U. Gumilov Eurasian National University, consultant A. Gogatishvili
Lukáš Folwarczný, Charles University, supervisor P. Pudlák
Martin Hanek, Czech Technical University Prague, supervisor specialist J. Šístek
Aaron Kettner, Charles University, consultan K. Strung
Erfan Khaniki, Charles University, supervisor P. Pudlák
David Kokoška, Charles University, supervisor M. Ortaggio
Anna Lancmanová, Czech Technical University, supervisor T. Bodnár
Tereza Lehečková, Czech Technical University, supervisor M. Ortaggio
Natalia Maślany, Uniwersytet Jagielloński, Krakow, supervisor T. Kania
David Matejov, Charles University, supervisor I. Khavkine
Ruben Medina, Universidad de Granada, supervisor P. Hájek
Ani Ozbetelashvili, I. Javakhishvili Tbilisi State University, supervisor A. Gogatishvili
Andres Quiles, Universidad Politècnica de València, supervisor P. Hájek
Paulina Radecka, Uniwersytet S. Wyszynskiego, Warszawa, supervisor W. Kubiś
Ana Radošević, University of Zagreb, supervisor Š. Nečasová
Jan Scherz, Charles University and Universität Würzburg, consultant Š. Nečasová
Michal Schmid, University of Pardubice, consultant V. Mácha
Aravindhan Srinivasan, Charles University, supervisor M. Ortaggio
Tomáš Tintěra, Charles University, supervisor V. Pravda
Dominik Trnka, Masaryk University in Brno, Přírodovědecká fakulta, supervisor M. Markl
George Turner, Charles University, supervisor V. Pravda
Dávid Uhrik, Charles University, supervisor D. Chodounský
Karel Vacek, Czech Technical University, supervisor P. Sváček
Xingchen Yu, Nanjing University of Information Science and Technology, cosupervisor R. Hakl

2.9 Awards

Šárka Nečasová, Praemium Academiae awarded by the Czech Academy of Sciences.

Tomasz Kania, Otto Wichterle Award, Czech Academy of Sciences. Award given to young scientists under 35 years for achievement of excellent results in their disciplines.

Martin Doubek, Branislav Jurčo, Martin Markl a **Ivo Sachs,** Prize of the Dean of the Faculty of Mathematics and Physics, Charles University for the best book publication in 2020 in the category Monographs for the book *Algebraic Structure of String Field Theory.* Lecture Notes in Physics, 973. Cham: Springer, 2020.

Jan Papež, Prize of the Dean of the Faculty of Mathematics and Physics, Charles University for the best evaluated teachers in the academic year 2020/21, for teaching the courses Analysis of matrix computations 1 a Linear algebra 1.

Pavel Pudlák, honorary medal *De scientia et humanitate optime meritis* for his tireless service to science and remarkable contributions to logic and foundations of computer science.

Martin Markl, the Bernard Bolzano Honorary Medal for Merit in the Mathematical Sciences.

Michal Křížek, honorary membership of the Union of Czech Mathematicians and Physicists.

Michal Křížek, Medal of the Faculty of Information Technology of the University of Jyväskylä, Finland.

Michal Hrbek, Czech Mathematical Society Prize for Young Researchers for the set of papers in algebra.

Jan Papež , Otto Wichterle Award, Czech Academy of Sciences. Award given to young scientists under 35 years for achievement of excellent results in their disciplines.

Jan Papež, Prize of the Dean of the Faculty of Mathematics and Physics, Charles University for the best evaluated teachers in the academic year 2021/22, for teaching the courses Analysis of matrix computations 1 a Linear algebra 1.

Tomasz Kania, 3. place in the competition Teaching Slam – forum wymiany dobrych praktyk w dydaktyce akademickiej in Jagelonian university in Krakow.

2.10 Further activities

The prestigious annual **Eduard Čech Lecture** devoted to the memory of the eminent Czech mathematician and founder of the Institute was created to attract excellent foreign mathematicians and to further stimulate creative environment at the Institute. The eighteen Eduard Čech Distinguished Visitor of the Institute of Mathematics was R. Paturi (University of California, San Diego La Jolla, USA).

The Institute organized traditional Open Houses as a part of the scientific festival Week of Czech Academy of Sciences. According to our statistics from October 31 to November 4, 2022, in total 1482 high-school students and other visitors watched 39 lectures and attended 15 excursions of the Institute.

The Institute continued in providing professional and financial support to the Mathematical Olympiad, particularly in preparation of the national representatives to the International Mathematical Olympiad.

3 Economic management

3.1 Assets

The Institute owns the estate, parcel no. 2120, and the building, house no. 609/25, on that land. Total area of residential and non-residential premises is 3,341 square metres. Part of the ground floor in the front building of 64 square metres is leased for commercial purpose; further two rooms and one storeroom are leased for non-commercial purpose to the Union of Czech Mathematicians and Physicists. In the rear building there are five flats leased mostly to employees of the Institute. All other spaces in both buildings (2,836 square metres in total) are used for the purpose of the Institute.

The book value of the compound to the day of 31 December 2022 was 43 673 thousand CZK, its remaining book value was 19 041 thousand CZK.

Further tangible fixed assets is formed mostly by devices and IT equipment with the book value 8 825 thousand CZK to the date 31 December 2022, remaining book value was 535 thousand CZK.

3.2 Expenses and revenues

Principal entries (in thousands of CZK)

Total expenses	**119,281**
Purchases of materials, electricity, gas	3,011
Maintenance and reconstructions	588
Travel expenses	4,568
Other services	7,122
Personal expenses	99,906
Other expenses	2,531
Depreciation	1,336
Total revenues	**119,281**
Sales of periodicals	2,952
Other revenues	5,015
Institutional subsidies (from the budget of the Czech Academy of Sciences)	78,935
Grants	39,379
Earnings before taxes	**0**

The total revenues compared to the year 2021, increased by 8.3%. This was mainly due to the increase of the institutional subsidies provided by the Czech Academy of Sciences whereas there was a decrease of grant sources provided mainly by the Czech Science Foundation and Ministry of Education, Youth, and Sports.

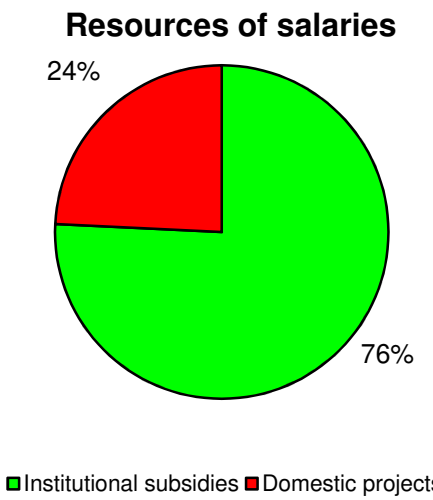
3.3 Personnel and salaries

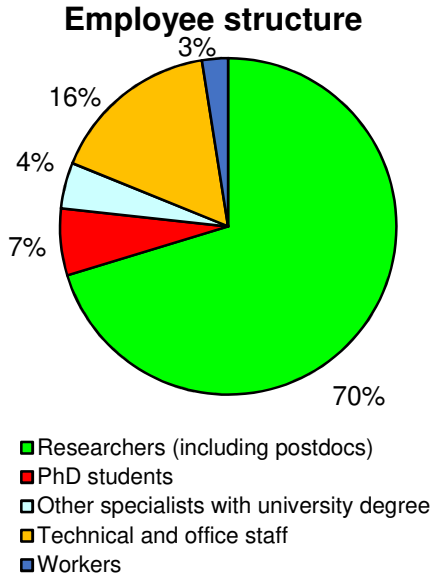
The average number of employees amounted to 98.02 FTE (96.20 FTE in previous year).

The personnel expenses of 99,906 thousand CZK represented 84,0% of total operating expenses.

The average monthly salary from all resources – institutional, project and commercial – was 60,794 CZK. This represents a negligible increase compared to the previous year on the level of one percent.

During 2022, 24 vacancies (4 research fellows, 14 postdocs, 5 Ph.D. students, 1 administration) were filled, with exception of research fellow and administration positions mostly for two-year contracts. Five researchers, 10 postdocs, 2 Ph.D. students and 2 administration workers terminated employment in 2022.





In line with the general approach of the Czech Academy of Sciences, research staff in the Institute is employed on fixed-term contracts and recruited in open competitions advertised at the Institute's web site and at the job server of the European Mathematical Society. Applicants are directed to the web site with detailed information and to the specialised web system for submitting applications and reference letters (https://application.math.cas.cz/Positions.html). The system enables a preliminary remote discussion of the heads of departments and of the selection committee members and facilitates the subsequent assessment of applications.

Doc. RNDr. Tomáš Vejchodský, Ph.D.
Director