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 2017

English summary

The Annual report was discussed by the Supervisory Board of the Institute on 11 May 2018 and approved by the Board of the Institute on 23 May 2018.

Contents

1 The Institute

The Institute of Mathematics of the Czech Academy of Sciences, v. v. i. (“the Institute”), 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.

Contact:
Institute of Mathematics CAS
Žitná 25
115 67 Praha 1

Tel.: +420 222 090 711
Fax: +420 222 090 701
e-mail: mathinst@math.cas.cz
URL: www.math.cas.cz

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

Director: RNDr. Jiří Rákosník, CSc.

Board of the Institute:

Chair:	RNDr. Martin Markl, DrSc.
Vice-chair:	Vojtěch Pravda, Ph.D.
Members at large:	Prof. RNDr. Zuzana Došlá, DSc. (Masaryk University in Brno)
	Prof. RNDr. Pavel Drábek, DrSc. (University of West Bohemia in Pilsen)
	Prof. RNDr. Eduard Feireisl, DrSc.
	Prof. RNDr. Stanislav Hencl, Ph.D., DSc. (Univerzita Karlova)
	Prof. RNDr. Michal Křížek, DrSc.
	Wieslaw Kubiś, Ph.D.
	RNDr. Šárka Nečasová, DSc.
	Prof. RNDr. Ivan Netuka, DrSc. (Charles University in Prague)
	Doc. RNDr. Tomáš Vejchodský, Ph.D.

Supervisory Board (until 30th April 2017):

Chair:	Prof. Ing. Michal Haindl, DrSc. (Academy Council of the CAS)
Vice-chair:	Vojtěch Pravda, Ph.D.
Members at large:	RNDr. Eva Čermáková, CSc. (Institute of Economy of the CAS)
	prof. RNDr. Miroslav Hušek, DrSc. (Charles University in Prague)
	prof. RNDr. Jiří Sgall, DrSc. (Charles University in Prague)

Supervisory Board (since 1st May 2017):

Chair:	Prof. Ing. Michal Haindl, DrSc. (Academy Council of the CAS)
Vice-chair:	Doc. Ing. Miroslav Rozložník, Dr.
Members at large:	Prof. RNDr. Jan Hamhalter, CSc. (Czech Technical University in Prague)
	Prof. RNDr. Luboš Pick, CSc., DSc. (Charles University in Prague)
	Ing. Július Štuller, CSc. (Institute of Computer Science of the CAS)

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 Tomáš Vejchodský, the scientific secretary and project manager Beata Kubiś, head of the Administration Department Radka Vrkočová and head of the IT Department Martin Jarník.

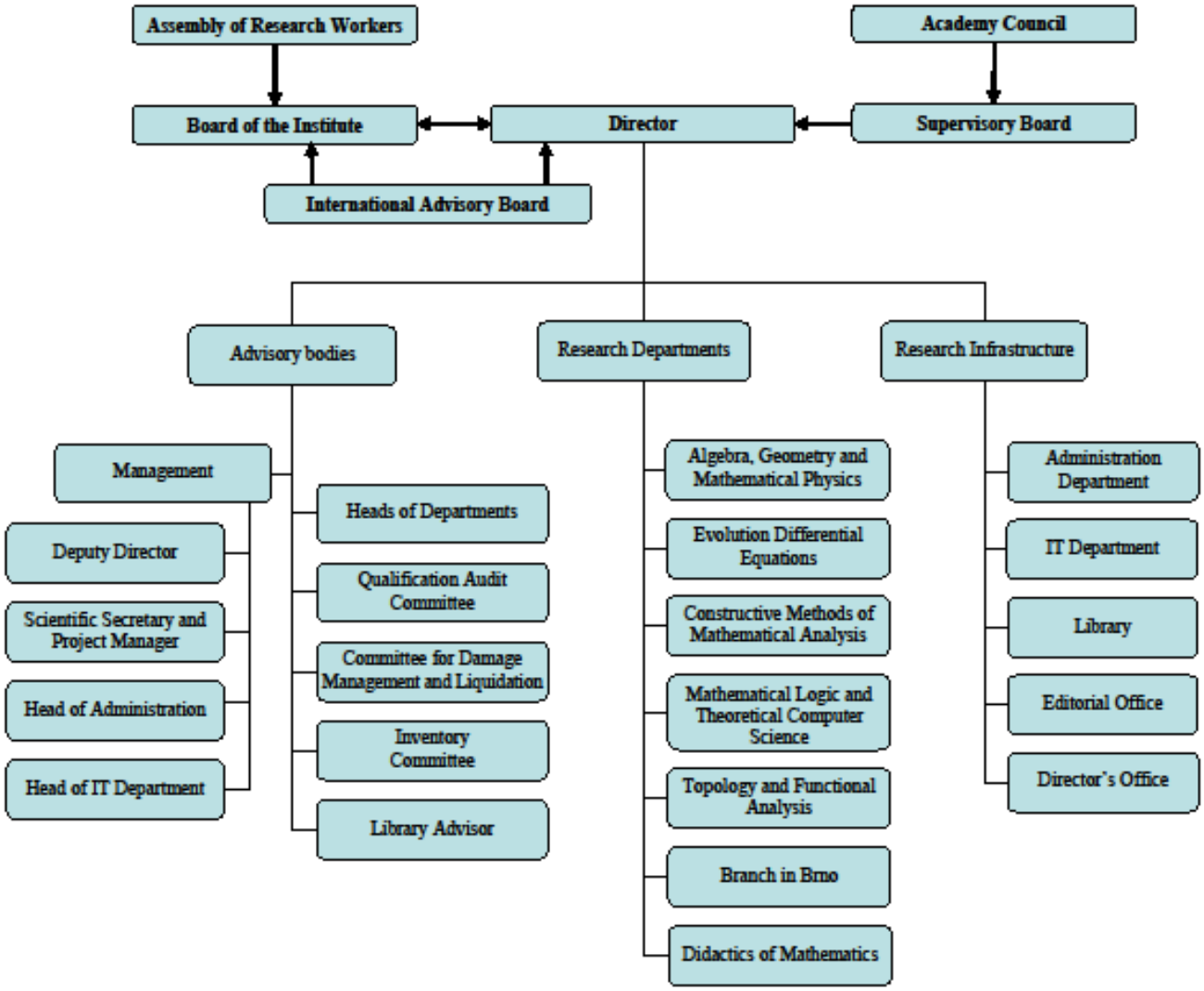
The **Board of the Institute** held four meetings, one of them remotely. The topics they discussed and approved included among others:

- election of the new chair and vice-chair at the first meeting of the newly elected Board
- budget of the Institute for 2017
- the annual report on activities and economic management in 2016 and auditor's report on financial statements
- proposal to award the Otto Wichterle Premium to Martin Doležal and Pavel Kůs (the Academy Council of the CAS approved the Premium for M. Doležal)
- selection of candidates for the postdoctoral positions in the Academy's programme supporting prospective human resources
- recommendation to invite Prof. G. P. Galdi for the Eduard Čech Distinguished Visitor position
- proposal of awarding Martin Markl the prestigious Praemium Academiae (has not been approved by the Academy Council of the CAS)

The **Supervisory Board** held three meetings, one of them remotely. The topics they discussed and approved included among others:

- discussion about the proposal of the budget of the Institute for 2017, about the annual report on activities and economic management in 2016 and about auditor's report on financial statements
- determination of the auditor for financial statements for 2017
- approval of lease agreements and amendments extending lease agreements for flats in the Institute's building
- approval of the ammedment to the lease agreement with the Institute of Physics of Materials of the CAS, allowing to locate the Otakar Borůvka Society in the spaces of the Branch in Brno

1.3 Structure

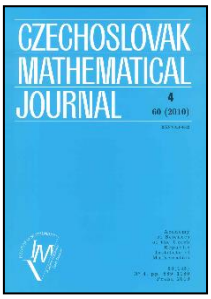


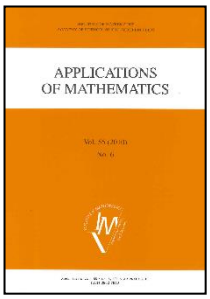
Didactics of Mathematics is a very small group (less than 1 FTE) which, however, plays an important role in providing an expert connection between the institute on the one side and institutions educating teachers of mathematics and teachers themselves on the other side.

The Institute publishes three internationally recognized mathematical journals:

- Czechoslovak Mathematical Journal
- Mathematica Bohemica
- Applications of Mathematics

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 http://dml.cz and participates in the development of the European Digital Mathematics Library EuDML accessed at http://eudml.org. The Institute operates the Prague zbMATH Editorial Group contributing to the production of the database.

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, and didactics of mathematics.

2.2 Departments

Evolution Differential Equations

The scope of this department covers qualitative aspects of the theory of partial differential equations in mechanics and thermodynamics of continuum, in biology and in other sciences. The research aims at verification of correctness of mathematical models and at the possibility to provide theoretical predictions of future development of a system without the full knowledge of the initial state. The work focuses on investigation of equations describing fluid flow including heat exchange and interaction with solid bodies. Attention is paid also to processes in solid matters focusing on mathematical modelling of memory in multifunctional materials, on dynamical behaviour of bodies in a contact with an underlay, and on phase transitions. Several members cooperate with the Branch in Brno investigating the integration theory and ordinary differential equations. 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/). E. Feireisl is the principal investigator of the prestigious ERC Advanced Grant *Mathematical Thermodynamics of Flui*ds (MATHEF) devoted to the development of mathematical theory of thermodynamics of compressible viscous fluids.

Mathematical Logic and Theoretical Computer Science

The research programme of this section is connected with the questions of information processing. The main topic is the theory of computational complexity which is used for classification of algorithmic problems and plays an important role also in coding and electronic communication security. Further important research fields concern general questions of logical foundations of numbers and set theory, combinatorics and matrix theory. Members of the department are involved in the prestigious ERC Advanced Grant *Feasibility, Logic and Randomness in computational complexity* (FEALORA) devoted to study of basic open problems in computational complexity, such as the P versus NP problem. They also represent the Institute in the centre DIMATIA (http://dimatia.mff.cuni.cz/) and the research centre Institute of theoretical informatics (http://iti.mff.cuni.cz/).

Topology and Functional Analysis

Theoretical concept of infinite dimensional analysis and geometry developed in functional analysis and topology is suitable for description of systems with extremely large number of state variables. Members of this department focus on fundamental questions of the structure of mathematical objects in spaces created by abstraction of notion originally defined to describe natural processes. This enables discovering hidden connections between individual elements of the system and helps to design methods for solution of particular problems in applied mathematics. The research topics

concern operator theory, theory of Banach spaces and function spaces, harmonic analysis and thermodynamics of continuum. Members of the department participate in the international project Asymptotics of operator semigroups (AOS).

Constructive Methods of Mathematical Analysis

The department continues the long tradition of investigation and use of numerical methods established at the Institute by the world leading specialist Prof. Ivo Babuška. The importance of such methods is growing with the development of computational and experimental techniques. Mathematical modelling of complex physical processes involving immense amount of data requires new methods of communication with computers, namely for optimal employment of their ever growing capacity, and for increasing speed and controlling rigour of computation by means of superconvergence and a posteriori error estimates. The main topic concerns analysis and optimization of the finite element method for solving partial differential equations describing physical processes in solid matters and fluids. 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/).

Algebra, Geometry and Mathematical Physics

The department was formed in 2014 from 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. Members of the department are involved in two excellence centres: Eduard Čech Institute for Algebra, Geometry and Physics (http://eci.math.muni.cz/) and Albert Einstein Centre for Gravitation and Astrophysics (http://www.albert-einstein-center.cz/).

Branch in Brno

The core research performed in this section in collaboration with several members of the Department of Evolution Differential Equations concerns qualitative properties of ordinary and functional differential equations. Such equations describing development of finite dimensional systems find important applications in biology and physics. The theoretical study of their solutions helps to discover mathematical causalities in real systems including singularities in time and space variables as well as in discontinuous processes. These features are modelled by means of the Kurzweil-Henstock integral and equations on time scales. Another important topic concerns methods of optimal control of complex processes.

Didactics of Mathematics

This very small group represents a particular long-lasting research direction in the Institute, which has been gradually transferred to the Charles University. It is devoted to theoretical and practical aspects of didactics of mathematics and professionalism of teachers. The members of the department cooperate with teaqchers at primary schools and specialized groups at universities in the Czech Republic and abroad in theoretical and practical aspects of didactics of mathematics.

2.3 Research centres

The centre of excellence **Institute of Theoretical Informatics** (ITI, http://iti.mff.cuni.cz/) is a consortium which has been established for a joint project of the Faculty of Mathematics and Physics of the Charles University, the Institute of Mathematics, the Institute of Computer Science CAS, the Faculty of Applied Sciences of the University of West Bohemia in Pilsen and the Faculty of Informatics of the Masaryk University in Brno, funded by the Ministry of Education, Youth and Sports in 2005–2011. Its activity is currently supported by a joint project supported by the Czech Science Foundation in 2012–2018. The principal aim of ITI is to promote research in theoretical computer science and related fields with emphasis on the work of young researchers. ITI will also provide temporary positions for postdocs and distinguished senior researchers.

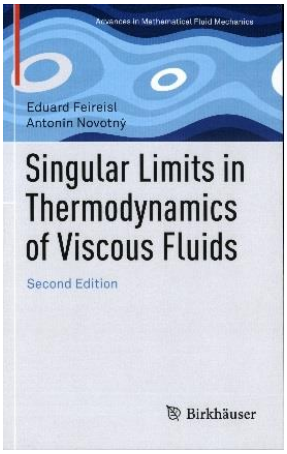
Jindřich Nečas Centre for Mathematical Modeling (http://ncmm.karlin.mff.cuni.cz/) is a joint department of the Institute of Mathematics, the Faculty of Mathematics and Physics of the Charles University, and the Institute of Computer Science CAS. It was established in 2013 to continue the efforts of a 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 both 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 scientist 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 14 further research institutions.

2.4 Research output

In 2017, members of the Institute of Mathematics published the total of 167 journal and proceedings papers, 4 monographs and 5 chapters in monographs. The following 7 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.

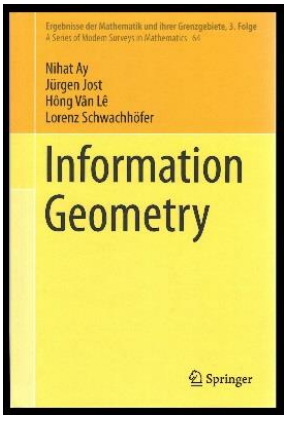
[1] **E. Feireisl**, A. Novotný: *Singular Limits in Thermodynamics of Viscous Fluids***.** Birkhäuser, Cham, 2017.



The main objective of this book is the rigorous derivation of mathematical models for the behaviour of viscous compressible fluids with thermal conductivity. Such fluids can be air in the Earth's atmosphere or clouds of particles around the stars. The air flow in the Earth's atmosphere and the corresponding heat transfer are essential for predicting the weather. Similarly, both the flow and the heat transmission are essential for behaviour of gases in the vicinity of the stars.

The book studies singular limits of the general system of compressible Naivier–Stokes–Fourier equations and derives less complex systems of simpler partial differential equations that can be used for example in meteorology or astrophysics to describe the above-mentioned processes. Thanks to a comprehensible introduction to modeling in mechanics and thermomechanics, this book can also be useful for students and researchers with a deeper interest in this issue.

[2] N. Ay, J. Jost, **H. Van Le**, L. Schwachhofer: *Information Geometry.* Springer, Cham, 2017.



The book presents a comprehensive introduction and new mathematical foundations of information geometry with complete proofs and a detailed background material on the measure theory, Riemannian geometry and theory of Banach spaces. Parametric measurement models are defined as basic geometric objects and can be both finite and infinite dimensional. Based on these models, canonical tensor fields, including Fisher metrics and the Amari-Chentsov tensor, are introduced and investigated, and embeddings of statistical manifolds are investigated.

These new foundations can be used in applications such as the generalization of the classical Chentsov result of unambiguity or the Cramér–Rao inequality. In addition, several new areas of geometric information such as hierarchical and graphical models, complexity theory, population genetics, or Markov Monte Carlo strings are mentioned.

[3] **J. Hladký**, J. Komlós, D. Piguet, M. Simonovits, M. Stein, E. Szemerédi: *The approximate Loebl-Komlos-Sos Conjecture I: The sparse decomposition.* SIAM Journal on Discrete Mathematics, 31 (2), 2017, 945–982.

J. Hladký, J. Komlós, D. Piguet, M. Simonovits, M. Stein, E. Szemerédi: *The approximate Loebl-Komlós-Sós Conjecture II: The rough structure of LKS graphs.* SIAM Journal on Discrete Mathematics 31 (2), 2017, 983–1016.

J. Hladký, J. Komlós, D. Piguet, M. Simonovits, M. Stein, E. Szemerédi: *The approximate Loebl-Komlós-Sós Conjecture III: The finer structure of LKS graphs.* SIAM Journal on Discrete Mathematics 31 (2), 2017, 1017–1071.

J. Hladký, J. Komlós, D. Piguet, M. Simonovits, M. Stein, E. Szemerédi: *The approximate Loebl-Komlós-Sós Conjecture IV: Embedding techniques and the proof of the main result.* SIAM Journal on Discrete Mathematics 31 (2), 2017, 1072–1148.

In the series of four articles, the asymptotic version of Loebl, Komlós and Sós conjecture is proved. This classical, more than 20 year old problem of extremal graph theory, claims that every graph with a median degree at least $\boldsymbol{k}$ contains every tree on $\boldsymbol{k}+\mathbf{1}$ vertices as a subgraph. The solution is based on a technique that significantly extends the famous Szemerédi lemma on regularity.

[4] **M. Markl**, A. Voronov: *The MV formalism for IBL∞- and BV∞-algebras*. Letters in Mathematical Physics 107 (8), 2017, 1515–1543.

IBL∞-algebras are homotopic versions of the involutive Lie bialgebras – hence the name. Inside, they describe the composition of operators in the field string theory. This article greatly simplifies the work with these structures by placing them in the wider context of the category of MV-algebras (abbreviation for Markl-Voronov). In this context, it also interprets the appropriate quantum parent equation.

[5] E. Chiodaroli, **E. Feireisl**, **O. Kreml**, E. Wiedemann: *A-free rigidity and applications to the compressible Euler system*. Annali di Matematica Pura ed Applicata 196 (4), 2017, 1557–1572.

The authors prove that there exists a measure-valued solution to the compressible Euler system that cannot be approximated by a sequence of weak solutions to the same problem. This result proves that there is a significant difference between measure-valued solutions to the incompressible Euler system and to its compressible version because in the case of an incompressible system, it has been proved that each measure-valued solution can be approximated by a sequence of weak solutions, indicating that between weak solutions and the measure-valued solutions is not a big difference. The same, however, as the authors demonstrate in this paper, does not apply to a compressible system. To prove this assertion, the authors work in an abstract formulation where the compressible Euler system is formulated using the abstract linear differential operator $\boldsymbol{A}$ and the Euler system can be written simply as $\boldsymbol{Az}=\mathbf{0}$. For this general system, the authors prove a "firmness" result. In particular, if the sequence of solutions to the equation $\boldsymbol{Az}=\mathbf{0}$ generates a Young measure supported on a segment that does not belong to the wave cone associated with the operator $\boldsymbol{A}$, then this Young measure is actually the Dirac measure supported on a constant function. Applying this general result it can be shown that a measure-valued solution to the Euler compressible system that is supported on a segment that does not belong to the wave cone and is not just a Dirac measure cannot be approximated by a sequence of weak solutions. In addition, the authors also prove that each measure-valued solution generated by a sequence of weak solutions must satisfy a certain form of Jensen's inequality. The article as a whole is valuable particularly because it connects until then fundamentally different parts of mathematical analysis, namely the theory of linear differential operators, solution of the equations $\boldsymbol{Az}=\mathbf{0}$, and the theory of fluid mechanics.

[6] S. Hervik, **V. Pravda**, **A. Pravdová**: *Universal spacetimes in four dimensions*. Journal of High Energy Physics 2017 (10), 2017: 28. https://doi.org/10.1007/JHEP10(2017)028

Universal metrics are metrics that, in addition to Einstein's equations, simultaneously address (almost) all the equations of the field of modified gravity theories. For example, they can coexist as prototypes of exact solutions even in theories whose field equations are too complicated to be solved by standard methods. The authors found the necessary and sufficient conditions for the universality of the four-dimensional Lorentzian metrics for all Petrov's types except type II, leading to a range of universal metrics.

[7] B. Yaacov, **M. Doucha**, A. Nies, T. Tsankov: *Metric Scott analysis.* Advances in Mathematics 318, 2017, 46–87.

The authors develop an analogue of the classical Scott analysis for metric structures and infinitary continuous logic. The main result is the existence of Scott sentences for metric structures and a version of López–Escobar theorem. Various descriptive set theoretic consequences are also derived: especially, that isomorphism on a class of separable structures is a Borell equivalence relation if and only if their Scott rank is uniformly bounded below $\boldsymbol{\omega_1}$. Finally, the developed methods are used to study the Gromov–Hausdorff distance between metric spaces and the Kadets distance between Banach spaces. It is shown that the set of spaces with a distance 0 to a fixed space is a Borel set.

2.5 Projects

2 ERC Advanced Grants, 7th Framework Programme, SP2–Ideas
- 320078 MATHEF (2013–2018, E. Feireisl)
- 339691 FEALORA (2014–2018, P. Pudlák)

9 standard grant projects funded by the Czech Science Foundation
- 16-03230S Thermodynamically consistent models for fluid flows: mathematical theory and numerical solution (2016–2018, Š. Nečasová)
- 16-07378S Nonlinear analysis in Banach spaces (2016–2018, P. Hájek)
- 15-02532S Modular and decentralized control of discrete-event and hybrid systems with communication (2015–2017, J. Komenda)
- 15-12227S Analysis of mathematical models of multifunctional materials with hysteresis (2015–2017, P. Krejčí)
- 13-14743S Function spaces, weighted inequalities and interpolation II (2013–2017, A. Gogatishvili)
- 13-10042S Higher dimensional gravity (2013–2017, V. Pravda)
- P201 17-00941S Topological and geometrical properties of Banach spaces and operator algebras II (2017–2019, M. Fabian)
- 17-27844S Generic objects (2017–2019, W. Kubiś)
- 17-01747S Theory and numerical analysis of coupled problems in fluid dynamics (2017–2019, J. Neustupa)

1 junior grant project funded by the Czech Science Foundation
- 17-01694Y Mathematical analysis of partial differential equations describing inviscid flows (2017–2019, O. Kreml)

3 international projects evaluated on the basis of the LEAD Agency principle funded by the Czech Science Foundation
- GF16-34860L/I 2374-N35 Logic and Topology in Banach spaces (2016–2018, W. Kubiś)
- GF1534700L/I 1921-N25 The continuum, forcing and large cardinals (2015–2017, D. Chodounský)
- GF17-33849L/I 3081-N35 Filters, Ultrafilters and Connections with Forcing (2017–2019, D. Chodounský)

2 projects for support of excellence funded by the Czech Science Foundation
- 14-37086G Albert Einstein Center for Gravitation and Astrophysics (2014–2018, V. Pravda)
- 12/G061 Centre of Excellence – Institute for Theoretical Computer Science (CE-ITI) (2012–2018, P. Pudlák)

3 projects in the MOBILITY programme of the Ministry of Education, Youth and Sports
- 7AMB16AT035 Performance and thermodynamic aspects of incrementally non-linear constitutive equations of the rate type (2016–2017, P. Krejčí)
- 7AMB17FR053 Dynamics of mutli-component fluids (2017–2018, E. Feireisl)
- 7AMB16PL060 Flow of viscous fluid in time dependent domain (2017–2018, Š. Nečasová)

1 project 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.02.2.69/0.0/0.0/16_018/0002713 Doctoral School for Education in Mathematical Methods and Tools in HPC (2017–2022, T. Vejchodský)

2 Neuron Impuls Junior grants funded by the Neuron Fund for Support of Science
- Mathematical analysis of hyperbolic conservation laws (2017–2018, O. Kreml)
- Guaranteed bounds of eigenvalues and eigenfunctions of differential operators (2017–2019, T. Vejchodský)

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

2.6 International conferences and workshops organized by the Institute

Prague Compressible Meeting, Praha, Czech Republic, 18.–20. 12. 2017. http://workshop.math.cas.cz/PragueCompressibleMeeting/

Implicitly constituted materials: Modeling, Analysis and Computing, Roztoky, Czech Republic, 31. 7. – 4. 8. 2017. http://www.karlin.mff.cuni.cz/more2017/

Winter School in Abstract Analysis 2017, section Set Theory & Topology, Liberec, Czech Republic, 28. 1. – 4. 2. 2017. http://www.winterschool.eu/2017/

Czech-Israeli Workshop on Functional Differential Equations, Brno, Czech Republic, 19.–25. 6. 2017. http://czil.math.cas.cz/

Czech-Georgian Workshop on Boundary Value Problems 2017, Brno, Czech Republic, 10.–13. 1. 2017. http://users.math.cas.cz/~sremr/wbvp2017/main.php

Differential Equations and Applications, Brno, Czech Republic, 4.–7. 9. 2017. http://diffeqapp.fme.vutbr.cz/main.php

Functional Differential Equations and Applications, Ariel, Israel, 21.–26. 8. 2017. http://www.ariel.ac.il/projects/math/2017/

Prague Workshop on Bounded Arithmetic, Praha, Czech Republic, 2.–3. 11. 2017. http://workshop.math.cas.cz/BoundedArithmetic/ba-workshop_2017.html

2.7 International collaboration

An extensive international collaboration in 2017 is documented by the following facts:
- 45 visitors to the Institute
- 221 working trips abroad
- 10 international conferences and meetings organized or co-organized by the Institute
- 60 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 6 undergraduate students and 31 PhD students. The Institute is accredited for 10 PhD programmes jointly with the Charles University and the University of West Bohemia.

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

Matteo Caggio, University of West Bohemia, supervisor Š. Nečasová

Matěj Dolník, Technical University Brno, supervisor A. Lomtatidze

Miroslav Dzimko, Masaryk University, supervisor B. Půža

Martin Fencl, University of West Bohemia, supervisor M. Kučera

Jan Grebík, Charles University, supervisor D. Chodounský

Martin Hanek, Czech Technical University, supervisor J. Šístek

Umi Mahnuna Hanung, University of Amsterdam, supervisor M. Tvrdý

Anna Horská, Charles University, supervisor P. Pudlák
Radim Hošek, University of West Bohemia, supervisor E. Feireisl
Rahele Jalali Keshavarz, Charles University, supervisor P. Pudlák
Jan Kubíček, Charles University, supervisor A. Pravdová
Martin Kuchynka, Charles University, supervisor A. Pravdová
Miroslava Maračková, Masaryk University, supervisor B. Půža
Martin Michálek, Charles University, supervisor E. Feireisl
Josef Navrátil, Czech Technical University, supervisor M. Kučera
Matěj Novotný, Czech Technical University, supervisor P. Hájek
Václav Olešovský, Technical University in Brno, supervisor B. Půža
Vita Pylypenko, Masaryk University, supervisor A. Rontó
Jan Reiss, Masaryk University, supervisor B. Půža
Tomasso Russo, Università degli Studi di Milano, supervisor P. Hájek
Vojtěch Růžička, Masaryk University, supervisor P. Řehák
Vojtěch Rybář, Charles University, supervisor T. Vejchodský
Nino Samashvili, I. Javakhishvili Tbilisi State University, supervisor A. Gogatishvili
Vincent Schlegel, Universität Zürich, supervisor U. Schreiber
Lenka Siváková, Czech Technical University, supervisor P. Krejčí
Amirhossein Akbar Tabatabai, Charles University, supervisor P. Pudlák
Tomáš Tintěra, Charles University, supervisor V. Pravda
Jana Varha, Uzhhorod State University, supervisor A. Rontó
Claudia Viscardi, Università degli Studi di Milano, supervisor W. Kubiś
Marta Walczynska, Uniwersytet Śląski w Katowicach, supervisor W. Kubiś
Felix Wellen, Universität Karlsruhe, supervisor U. Schreiber

2.9 Awards

Martin Doležal: Otto Wichterle Premium for Young Researchers, awarded by the Czech Academy of Sciences

Marián Fabian: Emeritus Scientist, awarded by the Czech Academy of Sciences

Eduard Feireisl: Bernard Bolzano Honorary Medal for Merit in Mathematical Siences, awarded by the Czech Academy of Sciences

Eduard Feireisl: Gold Honorary Medal of the Charles University, awarded by the Charles University

Michal Křížek: Certificate of Merit. Awarded by the Czech Astronomical Society on the occasion of its 100 anniversary

Tomáš Masopust: Outstanding reviewer. Awarded by the Editor-in-Chief of the Journal of Discrete Event Dynamic Systems

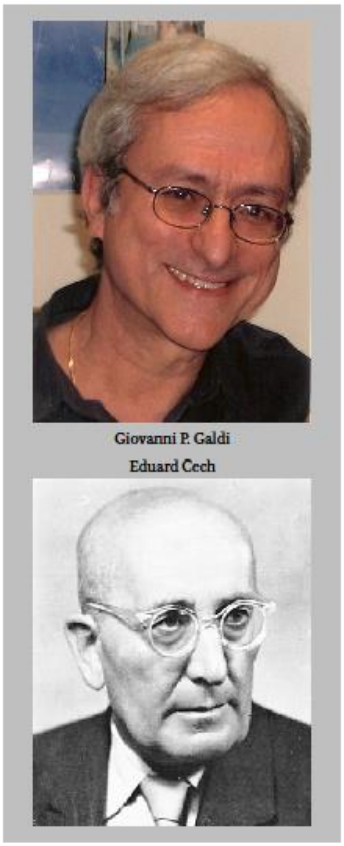
Vladimír Müller: Emeritus Scientist, awarded by the Czech Academy of Sciences

Pavel Pudlák: The Neuron Award for Contribution to World Science, awarded by the Neuron Fund for Support of Science

2.10 Further activities

In September 2016, in frames of the joint research programme *Prospects and dangers of the digital age* in the **Strategy AV21** of the Czech Academy of Sciences, the Institute organized an international interdisciplinary workshop *Two Applications of Mathematics in Practice*.

The fourteenth prestigious annual **Eduard Čech Lecture** devoted to the memory of the eminent Czech mathematician and founder of the Institute was delivered on 14 December 2017 by Giovanni P. Galdi (University of Pittsburgh) on *Recent Findings and Open Problems in Some Fundamental Aspects of Mathematical Theory of Liquid-Solid Interaction*. Prof. Galdi was also the first Eduard Čech Distinguished Visitor of the Institute of Mathematics.



Giovanni P. Galdi

Eduard Čech

Matematický ústav AV ČR
zve všechny zájemce
na přednášku

Recent Findings and Open Problems in Some Fundamental Aspects of Mathematical Theory of Liquid-Solid Interaction

kterou prosloví

profesor Giovanni P. Galdi
University of Pittsburgh

ve čtvrtek 14. prosince 2017
v 10:30 hod.
ve velké posluchárně
Matematického ústavu AV ČR,
Žitná 25, Praha 1.

Jde o čtrnáctou přednášku konanou
v rámci cyklu reprezentačních přednášek
organizovaných na počest

prof. Eduarda Čecha,

jednoho z nejvýznamnějších českých
matematiků novodobé historie
a zakladatele
Matematického ústavu AV ČR.

Jiří Rákosník, ředitel

Recent Findings and Open Problems in Some Fundamental Aspects of Mathematical Theory of Liquid-Solid Interaction

Even though problems of liquid-solid interaction are more or less ubiquitous in many branches of applied science – ranging from small to large scale – a systematic mathematical treatment of some of their relevant and basic aspects has begun only about two decades ago. This late start is probably due to the intrinsic difficulty of the relevant equations. In fact, the presence of the solid (rigid or elastic) affects the flow of the liquid, and this, in turn, affects the motion of the solid, so that the problem of determining the flow characteristics is highly linked, typically, through a non-local coupling. It is just this latter feature that makes any fundamental mathematical problem related to fluid-solid interaction a particularly challenging one.

Objective of this lecture is to provide an account of a number of significant problems in the mathematical theory of liquid-solid interaction, as well as to present some new results and open questions, when the solid may be either rigid or elastic.

The Institute organized traditional Open Houses as part of the scientific festival Week of Science and Technology. During four days in November, 1360 high-school students and other interested people visited 34 lectures and workshops in 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, and 3 rooms and 1 storeroom are leased for non-commercial purpose to the Union of Czech Mathematicians and Physicists. In the rear building there are 5 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 2017 was 43,673 thousand CZK, its remaining book value was 23,013 thousand CZK.

Further tangible fixed assets is formed mostly by devices and IT equipment with the book value 9 264 thousand CZK to the date 31 December 2017, remaining book value was 1,332 thousand CZK.

3.2 Expenses and revenues

Principal entries (in thousands of CZK)

Total expenses	**84,859**
Purchases of materials, electricity, gas	1,689
Maintenance and reconstructions	2,522
Travel expenses	3,700
Other services	4,528
Personal expenses	63,868
Other expenses (including grant overheads)	7,473
Depreciation	1,079
Total revenues	**84,859**
Sales of periodicals	2,035
Other revenues	2,092
Institutional subsidies (from the budget of the Czech Academy of Sciences)	54,752
Grants	25,980
Earnings before taxes	**0**

The total revenues compared to the previous year, increased by 6.5%. This was due to the raised institutional subsidy from the Czech Academy of Sciences reflecting the excellent result of the evaluation of Institute's performance in the period 2010–2014, and a subsidy for a reconstruction of the library. The funding of research projects decreased by 3% because one mobility project in the Marie Skłodowska-Curie programme funded by the European Commission finished in 2016.

3.3 Personnel and salaries

The average number of employees amounted to 78 FTE (annual increase of 3%).

The personnel expenses made 63,868 thousand CZK, representing 75% of total operating expenses.

The average monthly salary from all resources – institutional, project and commercial – was 51,182 CZK (annual increase of 5.7%).

In line with the general approach of the Czech Academy of Sciences, research staff in the Institute is employed on fixed-term contracts. The research staff is 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. During 2017, 12 vacancies (4 researchers and 8 postdocs) were filled in this way, mostly for two-year contracts.