

Curriculum vitae

# Matěj Tušek

Email: [tusekmat@fjfi.cvut.cz](mailto:tusekmat@fjfi.cvut.cz)

Website: <http://kmlinux.fjfi.cvut.cz/~tusekmat>

Born on February 26, 1982 in Prague.

Czech Republic citizen.

## Education

2009: *Ph.D.* Mathematical Physics, Czech Technical University in Prague

2006: *Ing.* (*M.Sc.* equivalent) Mathematical Physics, Czech Technical University in Prague

## Scientific Interests

Application of functional analysis, differential geometry, and partial differential equations within the realm of Quantum Mechanics

## Professional Experience

2010–present: *Assistant Professor* at Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering, Department of Mathematics

2017–2019, 2020–present: *Research Scientist* at Department of Theoretical Physics, Nuclear Physics Institute AS CR

2012 (winter semester): *Postdoctoral Fellow* in the program *Hamiltonians in Magnetic Fields* at Institut Mittag-Leffler, The Royal Swedish Academy of Sciences

2011–2012: *Postdoctoral Fellow* in the Milenium Nucleus project *Mathematical theory of quantum and classical magnetic systems* at Pontificia Universidad Católica de Chile

2008–2010: *Teaching Assistant* at Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering, Department of Mathematics

2008–2010: *Research Assistant* at Masaryk University in Brno, Faculty of Science, Department of Theoretical Physics and Astrophysics

## Research visits

Department of Mathematics of Faculté des Sciences d'Orsay, Université Paris-Sud: 2 weeks in 2018–2019

Centre de Physique Théorique, Marseille: 5 weeks in 2007–2009

## Articles

- [1] D. Krejčířík, V. Lotoreichik, K. Pankrashkin, and M. Tušek, "Spectral analysis of the multidimensional diffusion operator with random jumps from the boundary," *JOURNAL OF EVOLUTION EQUATIONS*, vol. 21, no. 2, 1651–1675, JUN 2021.
- [2] M. Tušek, "Approximation of one-dimensional relativistic point interactions by regular potentials revised," *LETTERS IN MATHEMATICAL PHYSICS*, vol. 110, no. 10, 2585–2601, OCT 2020.

- [3] D. Krejčířík and M. Tušek, “Location of hot spots in thin curved strips,” *JOURNAL OF DIFFERENTIAL EQUATIONS*, vol. 266, no. 6, 2953–2977, MAR 2019.
- [4] M. Fialová, V. Jakubský, and M. Tušek, “Qualitative analysis of magnetic waveguides for two-dimensional Dirac fermions,” *ANNALS OF PHYSICS*, vol. 395, 219–237, AUG 2018.
- [5] P. Exner, T. Kalvoda, and M. Tušek, “A geometric Iwatsuka type effect in quantum layers,” *JOURNAL OF MATHEMATICAL PHYSICS*, vol. 59, no. 4, APR 2018.
- [6] V. Jakubský and M. Tušek, “Dispersionless wave packets in Dirac materials,” *ANNALS OF PHYSICS*, vol. 378, 171–182, MAR 2017.
- [7] M. Tušek, “On an extension of the Iwatsuka model,” *JOURNAL OF PHYSICS A-MATHEMATICAL AND THEORETICAL*, vol. 49, no. 36, SEP 2016.
- [8] D. Krejčířík, N. Raymond, and M. Tušek, “The Magnetic Laplacian in Shrinking Tubular Neighborhoods of Hypersurfaces,” *JOURNAL OF GEOMETRIC ANALYSIS*, vol. 25, no. 4, 2546–2564, OCT 2015.
- [9] D. Krejčířík and M. Tušek, “Nodal sets of thin curved layers,” *JOURNAL OF DIFFERENTIAL EQUATIONS*, vol. 258, no. 2, 281–301, JAN 2015.
- [10] M. Tušek, “Atoms confined by very thin layers,” *JOURNAL OF MATHEMATICAL PHYSICS*, vol. 55, no. 11, NOV 2014.
- [11] R. D. Benguria, P. Gallegos, and M. Tušek, “A New Estimate on the Two-Dimensional Indirect Coulomb Energy,” *ANNALES HENRI POINCARÉ*, vol. 13, no. 8, 1733–1744, DEC 2012.
- [12] R. D. Benguria and M. Tušek, “Indirect Coulomb energy for two-dimensional atoms,” *JOURNAL OF MATHEMATICAL PHYSICS*, vol. 53, no. 9, SI, SEP 2012.
- [13] P. Duclos, P. Šťovíček, and M. Tušek, “On the two-dimensional Coulomb-like potential with a central point interaction,” *JOURNAL OF PHYSICS A-MATHEMATICAL AND THEORETICAL*, vol. 43, no. 47, NOV 2010.
- [14] P. Šťovíček and M. Tušek, “On the harmonic oscillator on the Lobachevsky plane,” *RUSSIAN JOURNAL OF MATHEMATICAL PHYSICS*, vol. 14, no. 4, 493–497, DEC 2007.

## Proceedings papers

- [15] P. Šťovíček and M. Tušek, “On the Spectrum of a Quantum Dot with Impurity in the Lobachevsky Plane,” in *RECENT ADVANCES IN OPERATOR THEORY IN HILBERT AND KREIN SPACES*, ser. Operator Theory Advances and Applications, 7th Workshop on Operator Theory in Krein Spaces and Spectral Analysis, Techn Univ Berlin, Berlin, GERMANY, DEC 13-16, 2007, vol. 198, 2010, 291–304.
- [16] V. Geyler, P. Šťovíček, and M. Tušek, “A Quantum Dot with Impurity in the Lobachevsky Plane,” in *SPECTRAL THEORY IN INNER PRODUCT SPACES AND APPLICATIONS*, ser. Operator Theory Advances and Applications, 6th Workshop on Operator Theory in Krein Spaces and Operator Polynomials, Tech Univ Berlin, Berlin, GERMANY, DEC 14-17, 2006-2007, vol. 188, 2009, pp. 135+.

## Preprints

- [17] B. Cassano, V. Lotoreichik, A. Mas, and M. Tušek, *Spectral transition for Dirac operators with electrostatic  $\delta$ -shell potentials supported on the straight line*, <https://arxiv.org/abs/2107.01156>, 2021.
- [18] J. Behrndt, M. Holzmann, and M. Tušek, *General  $\delta$ -shell interactions for the two-dimensional Dirac operator: self-adjointness and approximation*, <https://arxiv.org/abs/2102.09988>, 2021.

## Invited talks

Approximation of one-dimensional relativistic point interactions by regular potentials, *Asymptotic Analysis & Spectral Theory*, Paris, September 30-October 4, 2019.

Nodal Sets of Eigenfunctions of the Laplacian in Thin Curved Layers, *Spectral Theory and Mathematical Physics*, Santiago de Chile, November 24-28, 2014.

## Contributed talks

Spectral analysis of the multi-dimensional diffusion operator with random jumps from the boundary, *Mathematical aspects of the physics with non-self-adjoint operators: 10 years after*, Marseille/online, February 1-5, 2021.

Approximation of One-Dimensional Relativistic Point Interactions by Regular Potentials, *The 6th Najman Conference on Spectral Theory and Differential Equations*, Sveti Martin na Muri, September 8-13, 2019.

Location of Hot spots in Thin Curved Strips, *XIX International Congress in Mathematical Physics*, Montreal, July 23-28, 2018.

A Geometric Iwatsuka Type Effect in Quantum Layers, *The 5th Najman Conference on Spectral Theory and Differential Equations*, Opatija, September 10-15, 2017.

Estimates on the Two-Dimensional Indirect Coulomb Energy, *XVIII Internatinal Congress in Mathematical Physics*, Santiago de Chile, July 27-August 1, 2015.

Nodal sets of Eigenfunctions of the Laplacian in Thin Curved Layers, *Operator Theory, Analysis, and Mathematical Physics*, Stockholm, July 7-11, 2014.

Effective Hamiltonian for a Thin Curved Quantum Layer in a Magnetic Field, *QMATH 12, Mathematical Results in Quantum Mechanics*, Berlin, September 10-13, 2013.

The Magnetic Laplacian in Shrinking Tubular Neighbourhoods of Hypersurfaces, *Equadiff 13*, Praha, August 26-30, 2013.

On Thin Quantum Layers, *QGRAPH Network meeting*, Stockholm, December 10-12, 2012.

A New Estimate on the Two-Dimensional Indirect Coulomb Energy, *LXXX Encuentro Anual Sociedad de Matemática de Chile*, Los Andes, July 29-August 5, 2011.

On the Two-Dimensional Coulomb-Like Potential with a Central Point Interaction, *QMATH 11, Mathematical Results in Quantum Mechanics*, Hradec Králové, September 6-10, 2010.

Atoms in a Thin Layer, *21th International Workshop on Operator Theory and its Applications*, Berlin, July 12-16, 2010.

Quantum Dot in the Lobachevsky Plane, *XXVII Workshop on Geometric Methods in Physics*, Białowieża, June 29-July 7, 2008.

On the Spectrum of a Quantum Dot with Impurity in the Lobachevsky Plane, *7th Workshop on Operator Theory in Krein Spaces and Spectral Analysis*, Berlin, December 13-16, 2007.

A Quantum Dot with Impurity in the Lobachevsky Plane, *6th Workshop on Operator Theory in Krein Spaces and Spectral Analysis*, Berlin, December 14-17, 2006.

## Projects

Team member of **research grants**:

New Effects from Time-Reversal Non-Invariance (GA CR), 2021–present.

Centre of Advanced Applied Sciences (CZ.02.1.01/0.0/0.0/16\_019/0000778, European Regional Development Fund), 2018–present.

New Challenges for Extension Theory of Linear Operators in Modern Physics (Czech/French bilateral project Mobility-Barrande no. 8J18FR033), 2018–2019.

Matematicko-fyzikální modely nových materiálů (GA CR 17-01706S), 2017–2019.

Spectral Analysis of Linear Operators and its Applications in Quantum Mechanics (GA CR No. 13-11058S), 2013–2015.

Spectral Analysis and Dynamical Properties of Quantum Systems (GA CR No. P201/09/0811), 2009–2011.

Mathematical Structures in Quantum Physics (GA CR No. GD202/08/H072), 2008–2010.

Team member/coordinator of **pedagogy grants**:

Novel research-oriented doctoral program Quantum Technologies (CZ.02.2.69/0.0/0.0/16\_018/0002354, European Social Fund), 2017–present.

Institucionální podpora Českého vysokého učení technického v Praze (CZ.02.2.69/0.0/0.0/16\_015/0002382, European Social Fund), 2017–2019.

## Organized conferences

2021: Analytic and Algebraic Methods in Physics XVIII, member of organizing committee

2020: VA<sup>2</sup>MP (Virtual Analytic and Algebraic Methods in Physics), member of organizing committee

2019: Analytic and Algebraic Methods in Physics XVI, member of organizing committee

2018: Analytic and Algebraic Methods in Physics XV, member of organizing committee

2017: Analytic and Algebraic Methods in Physics XIV, member of organizing committee

2013–present: organizer of annual *student conferences on mathematical physics*

## Students

### PhD student:

Michal Kozák: *consultant* of PhD thesis *Stability of Reaction-Diffusion-Advection Equations*, defended in 2021.

### MSc students:

Lukáš Vácha: research project *Klein's paradox* under preparation.

Lukáš Heriban: research project *Approximations of Relativistic Point Interaction and Delta-Shell Interaction by Non-Local Potentials* finished in 2021, MSc thesis *Non-local approximations of general relativistic delta interactions* under preparation.

Václav Růžek: research project *Approximation of General One-Dimensional Relativistic Point Interaction by Regular Potentials* finished in 2020, MSc thesis *One-Dimensional Relativistic Point Interactions - Approximations by Regular Potentials, Application to Models of the Dirac Materials* defended in 2021.

Marie Fialová: research project *Spectral Analysis of the Dirac Operator as a Tool for Studying Graphene* finished in 2017, MSc thesis *Two-Dimensional Dirac Operator with Translationally Invariant Electromagnetic Field* defended in 2018.

### BSc students:

Jiří Kolář: *Quantum system of mixed dimensionality*, under preparation.

Lukáš Vácha: *Variations on the Harmonic Theme*, defended in 2021.

Lukáš Heriban: *Approximations of One-Dimensional Relativistic Point Interactions by Non-Local Potentials*, defended in 2020.

Václav Růžek: *Exactly Solvable Models for the Graphene*, defended in 2019.

Marie Fialová: *Nodal Lines on Two-Dimensional Domains*, defended in 2015.

Eva Lorencová: *The Mathematics 4 course in Wolfram Mathematica*, defended in 2014.

## Lectures

Moderní teorie parciálních diferenciálních rovnic / Modern Theory of Partial Differential Equations: *designed* in 2016, taught in the summer terms 2016–present.

Diferenciální počet na varietách / Differential Calculus on Manifolds: *designed* in 2010, taught in the summer terms 2011 and 2013–present.

Matematika 4 / Mathematics 4: summer terms 2010–2011 and 2013–present.

Vybrané partie funkcionální analýzy / Selected Topics in Functional Analysis: *designed* in 2013, taught in the summer terms 2013–2016.

Matematická analýza 1 / Calculus 1: winter term 2014.

Základy matematické analýzy / Introduction to Calculus: taught at Faculty of Information Technology of CTU in Prague in the winter term 2010.

## Tutorials

Rovnice matematické fyziky / Equations of Mathematical Physics: winter terms 2008, 2010, 2013, and 2016–present.

Matematická analýza 3 / Calculus 3: winter terms 2019–present.

Seminář současné matematiky / Seminar of Contemporary Mathematics: winter terms 2014–present.

Matematická analýza (1) / Calculus (1): winter terms 2014–2018.

Kvantová fyzika / Quantum Physics: summer terms 2013–2018.

Matematika 3 / Mathematics 3: winter term 2017.

Vybrané partie funkcionální analýzy / Selected Topics in Functional Analysis: summer terms 2013–2016.

Diferenciální rovnice / Differential Equations: summer term 2016.

Funkcionální analýza 3 / Functional Analysis 3: winter terms 2013–2015.

Funkcionální analýza 1 / Functional Analysis 1: winter terms 2010 and 2013–2015.

Matematika 4 / Mathematics 4: summer terms 2018 and 2013–2015.

Vybrané partie matematické analýzy / Selected Topics in Calculus: summer terms 2008–2010.

Matematická analýza B4 / Calculus B4: summer term 2009–2010.

Základy matematické analýzy / Introduction to Calculus: conducted at Faculty of Information Technology of CTU in Prague in the winter term 2009.

Matematická analýza B3 / Calculus B3: winter terms 2007–2009.

## Other

Number of citations according to WoS (without auto-citations): 49.

*The Josef Hlávka Award* to the best students and graduates from Prague public universities, Brno technical institute, and young talented researchers from the Academy of Sciences of the Czech Republic, 2006.

Organizer of the *MAFIA seminar series* on applications of functional analysis and algebra at Faculty of Nuclear Sciences and Physical Engineering, 2010–present.

Referee in *Journal of Mathematical Physics*, *Reports on Mathematical Physics*, *Journal of Physics A: Mathematical and Theoretical*, *Journal of Mathematical Analysis and Applications*, *Acta Polytechnica*.

Member of *International Association of Mathematical Physics*, member of *Union of Czech Mathematicians and Physicists*.