

Curriculum Vitae

Name: Igor Khavkine
Qualifications: PhD (Applied Mathematics & Theoretical Physics),
Docent (Assistant Professor habilitation, Czech Republic),
Qualification (MCF 25, France), Abilitazione (II Fascia – 01/A4, MAT/07, Italy)
Current Position: Researcher in Algebra, Geometry and Mathematical Physics
Institute of Mathematics, Czech Academy of Sciences, Prague, Czech Republic
Address: Žitná 25
110 00 Praha 1, Czech Republic
Email: khavkine@math.cas.cz
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Citizenship: Canadian
Languages: English, Russian, French, Italian (advanced), Dutch (basic)

Research Interests

*mathematical physics, quantum field theory, general relativity, quantum gravity
differential geometry, supergeometry, geometry of PDEs, homological algebra*

1. Geometry and PDEs.
 - (a) Jets, variational calculus, exact and approximate conservation laws, involution and formal integrability.
 - (b) PDEs on fermionic fields, supergeometry.
 - (c) Applications of homological algebra and higher structures to the geometry of gauge theories.
2. Classical and quantum field theory in curved space-time.
 - (a) Local symplectic/Poisson structure, symmetries, conservation laws.
 - (b) Deformation quantization.
 - (c) Algebraic quantum field theory, Epstein-Glaser renormalization, BV-BRST method.
 - (d) Perturbative quantization of gauge theories and gravity.
3. Quantum gravity phenomenology.
 - (a) Definition of diffeomorphism-invariant observables.
 - (b) Relation of observables to (in principle) possible experiments.
 - (c) Causal structure and non-linearity.

Work Experience

12/2017– **Researcher** Institute of Mathematics, Czech Academy of Sciences (Prague, Czech Republic).
Mathematical aspects of classical and quantum field theory.

12/2016–11/2017 **Postdoctoral Fellow** Department of Mathematics, University of Milan Statale (Italy).
Mathematical aspects of classical and quantum field theory.

05/2016–11/2016 **Postdoctoral Fellow** Department of Mathematics, University of Rome 2 Tor Vergata (Italy).
Mathematical aspects of classical and quantum field theory.

10/2013–10/2015 **Postdoctoral Fellow** Department of Mathematics, University of Trento (Italy).
Mathematical Physics group. Mathematical aspects of classical and quantum field theory.

01/2011–10/2013 **NWO VENI Postdoctoral Fellow** ITF, Utrecht University (The Netherlands).
Quantum Gravity group. Observables in quantum gravity and causal structure of classical and quantum gravity.

01/2009–12/2010 **NSERC Postdoctoral Fellow** ITF, Utrecht University (The Netherlands).
Quantum Gravity group. Causality and observables in perturbative quantum gravity;
issues of coupling localized matter to CDT models of quantum gravity.

09/2004–12/2007 **Teaching Assistant** Department of Applied Mathematics, University of Western Ontario
(Canada).

09/2002–05/2004 **Teaching Assistant** Department of Physics, University of Toronto (Canada).

05/2001–08/2001, 05/2000–08/2000 **Research Assistant** Femtosecond Science Group, National Research Council (Canada).

Academic Background

09/2004–08/2008	PhD, Applied Mathematics and Theoretical Physics Department of Applied Mathematics, University of Western Ontario London, Ontario, Canada Thesis: Computer simulation of spin foam models of quantum gravity Advisor: Dr. J. Daniel Christensen
09/2002–08/2004	MSc, Theoretical Physics Department of Physics, University of Toronto Toronto, Ontario, Canada Thesis: Formation of electronic nematic phase in interacting systems Advisor: Dr. Hae-Young Kee
09/1999–05/2002	BSc, Physics Department of Physics, Concordia University Montreal, Quebec, Canada Graduating grade point average (GPA): 4.13/4.3

Major Scholarships and Awards

<i>Period Held</i>	<i>Name of Award</i>	<i>Type</i>	<i>Value/yr</i>	<i>Location of Tenure</i>
01/2011–10/2013	NWO Veni Postdoctoral Fellowship	national	€ 76 300	Utrecht University
01/2009–12/2010	NSERC Postdoctoral Fellowship	national	C\$ 40 000	Utrecht University
05/2008–08/2008	SHARCNET Fellowship	institutional	C\$ 8 000	University of Western Ontario
09/2007–05/2008	OGSST	provincial	C\$ 10 000	University of Western Ontario
09/2006–08/2007	Bourse de Doctorat en Recherche, FQRNT	provincial	C\$ 20 000	University of Western Ontario
09/2004–08/2006	NSERC Postgraduate Scholarship D	national	C\$ 21 000	University of Western Ontario
09/2002–08/2004	NSERC Postgraduate Scholarship A	national	C\$ 17 400	University of Toronto

NWO: The Netherlands Organization for Scientific Research

NSERC: Natural Sciences and Engineering Research Council of Canada

SHARCNET: Shared Hierarchical Academic Research Computing Network of Canada

OGSST: Ontario Graduate Scholarship in Science and Technology

FQRNT: Fonds Québécois de la Recherche sur la Nature et les Technologies

Other Academic Experience

1. Journal Referee: American Journal of Mathematics, Annales Henri Poincaré, Classical and Quantum Gravity, Communications in Mathematical Physics, General Relativity and Gravitation, International Journal of Geometric Methods in Modern Physics, Journal of Differential Geometry, Journal of Geometry and Physics, Journal of Mathematical Physics, Mathematical Physics Analysis and Geometry, Physical Review D, SIGMA.
2. (2023–) Associate editor: Advances in Theoretical and Mathematical Physics.
3. (2021–) Member of *Human Resources Strategy for Researchers* Committee, Institute of Mathematics, Czech Academy of Sciences.
4. (2018–) Co-organizer of the Prague-Hradec Králové Cohomology Seminar, Institute of Mathematics, Czech Academy of Sciences.
5. (2010–) Contributor to research mathematics Q&A site MathOverflow.net, focusing on mathematical physics (380+ answers).
6. (2014–2015) Organizer of the Mathematical Physics group’s seminars, Department of Mathematics, University of Trento.

7. (2009–2012) Co-organizer of the Quantum Gravity group's seminars, Institute for Theoretical Physics, Utrecht University.
8. (2002–2003) Organizer of the Graduate Student Seminar in Theoretical Physics, University of Toronto.
9. (2003–2004) Member of Graduate Curriculum Committee, Department of Physics, University of Toronto.

Supervision of Projects and Theses

1. (01/2011, 04/2011) Supervision of undergraduate students from University College Utrecht; month-long independent study in relativity (*Twin Paradox*).
2. (2011–2012) **B. P. Bonga**, MSc thesis *Quantum Gravitational Fluctuations of Time Delay Observable in Minkowski Vacuum*. Officially co-supervised with Prof. Renate Loll, Utrecht University, The Netherlands. Bonga completed a PhD in 2017 with Prof. Abhay Ashtekar at Penn State, USA.
3. (2014–2015) **F. Bussola**, MSc thesis *De Donder gauge graviton Green's function in Schwarzschild spacetime with an outlook toward the Feynman propagator*. Officially co-supervised with Prof. Valter Moretti, University of Trento, Italy.
4. (2015–2016) **G. Canepa**, MSc thesis *An ideal characterization of Friedmann-Lemaître-Robertson-Walker space-times*. Officially co-supervised with Prof. Claudio Dappiaggi, University of Pavia, Italy. Canepa is now a PhD student with Prof. Alberto Cattaneo at the University of Zurich, Switzerland.
5. (2014–2018) **A. Melati**, PhD project *Renormalization of Wick polynomials for Boson fields in locally covariant AQFT*. Joint co-supervision with Prof. Valter Moretti, University of Trento, Italy.
6. (2015–2019) **F. Bussola**, PhD project *Hadamard states and tunneling effects for a BTZ black hole*. Joint co-supervision with Prof. Claudio Dappiaggi, University of Pavia, Italy.
7. (2020–) **D. Matejov**, PhD project, Charles University, Czech Republic.

Preprints and Articles In Preparation

1. **I. Khavkine**, D. McNutt, L. Wylleman (2024) *IDEAL characterization of vacuum pp-waves* [arXiv:2407.18410]
2. B. Jacelon, **I. Khavkine** (2023) *The K-distribution of random graph C^* -algebras* [arXiv:2307.01861]
3. **I. Khavkine**, U. Schreiber (2017) *Synthetic geometry of differential equations: I. Jets and comonad structure* [arXiv:1701.06238]
4. **I. Khavkine** (2015) *A polynomial action for gravity with matter, gauge fixing and ghosts* [arXiv:1512.08460]
5. **I. Khavkine** (2012) *Characteristics, conal geometry and causality in locally covariant field theory* (108 pages) [arXiv:1211.1914]

Refereed Publications

1. A. García-Parrado, **I. Khavkine** (2022) *Closed conformal Killing-Yano initial data* Class and Quantum Grav **39** 105002 [arXiv:1912.04752]
2. M.B. Fröb, **I. Khavkine**, T. Málek, V. Pravda (2022) *On well-posedness and algebraic type of the five-dimensional charged rotating black hole with two equal-magnitude angular momenta* Eur Phys J C **82** 215 [arXiv:2112.13266]
3. **I. Khavkine** (2022) *Explicit triangular decoupling of the separated Lichnerowicz tensor wave equation on Schwarzschild into scalar Regge-Wheeler equations* SIGMA **18** 011 [arXiv:2004.09651]
4. S. Aksteiner, L. Andersson, T. Bäckdahl, **I. Khavkine**, B. Whiting (2021) *Compatibility complex for black hole spacetimes* Commun Math Phys **384** 1585–1614 [arXiv:1910.08756]
5. **I. Khavkine** (2020) *Reducing triangular systems of ODEs with rational coefficients, with applications to coupled Regge-Wheeler equations* Diff Geom Appl **70** 101632 [arXiv:1801.09800]
6. A. García-Parrado, **I. Khavkine** (2019) *Conformal Killing Initial Data* J Math Phys **60** 122502 [arXiv:1905.01231]
7. **I. Khavkine** (2019) *Compatibility complexes of overdetermined PDEs of finite type, with applications to the Killing equation* Class and Quantum Grav **36** 185012 [arXiv:1805.03751]
8. **I. Khavkine** (2019) *IDEAL characterization of higher dimensional spherically symmetric black holes* Class and Quantum Grav **36** 045001 [arXiv:1807.09699]
9. **I. Khavkine** (2019) A. Melati, V. Moretti *On Wick polynomials of boson fields in locally covariant algebraic QFT* Ann H Poincaré **20** 929–1002 [arXiv:1710.01937]
10. M. B. Fröb, T.-P. Hack, **I. Khavkine** (2018) *Approaches to linear local gauge-invariant observables in infla-*

- tionary cosmologies* Class and Quantum Grav **35** 115002 [arXiv:1801.02632]
11. **I. Khavkine** (2018) *Explicit triangular decoupling of the separated vector wave equation on Schwarzschild into scalar Regge-Wheeler equations* J Phys: Conf Ser **968** 012006 [arXiv:1711.00585]
 12. G. Canepa, C. Dappiaggi, **I. Khavkine** (2018) *IDEAL characterization of isometry classes of FLRW and inflationary spacetimes* Class and Quantum Grav **35** 035013 [arXiv:1704.05542]
 13. F. Bussola, C. Dappiaggi, H.R.C. Ferreira, **I. Khavkine** (2017) *Ground state for a massive scalar field in BTZ spacetime with Robin boundary conditions* Phys Rev D **96** 105016 [arXiv:1708.00271]
 14. **I. Khavkine** (2017) *The Calabi complex and Killing sheaf cohomology* J Geom Phys **113** 131–169 [arXiv:1409.7212]
 15. **I. Khavkine** (2016) *Cohomology with causally restricted supports* Ann H Poincaré **17** 3577–3603 [arXiv:1404.1932]
 16. **I. Khavkine**, V. Moretti (2016) *Analytic dependence is an unnecessary requirement in renormalization of locally covariant QFT* Commun Math Phys **344** 581–620 [arXiv:1411.1302v2]
 17. **I. Khavkine** (2015) *Local and gauge invariant observables in gravity* Class and Quantum Grav **32** 185019 [arXiv:1503.03754]
 18. **I. Khavkine**, V. Moretti (2015) *Algebraic QFT in curved spacetime and quasifree Hadamard states: an introduction* Book chapter in *Advances in Algebraic Quantum Field Theory*, R. Brunetti, C. Dappiaggi, K. Fredenhagen, J. Yngvason (eds.) (Springer, 2015) [arXiv:1412.5945]
 19. **I. Khavkine** (2015) *Topology, rigid cosymmetries and linearization instabilities in higher gauge theories* Ann H Poincaré **16** 255 [arXiv:1303.2406]
 20. **I. Khavkine** (2014) *Covariant phase space, constraints, gauge and the Peierls formula* Int J Mod Phys A **29** 1430009 [arXiv:1402.1282]
 21. B. Bonga, **I. Khavkine** (2014) *Quantum astrometric observables II: fluctuations of time delay in the quantum gravitational vacuum* Phys Rev D **89** 024039 [arXiv:1307.0256]
 22. **I. Khavkine** (2013) *Presymplectic current and the inverse problem of the calculus of variations* J Math Phys **54** 111502 [arXiv:1210.0802]
 23. **I. Khavkine** (2012) *Quantum astrometric observables: time delay in classical and quantum gravity* Phys Rev D **85** 124014 [arXiv:1111.7127]
 24. **I. Khavkine** (2010) *Comment on ‘Hawking radiation from fluctuating black holes’* Class Quantum Grav **28** 038001 [arXiv:1008.5059]
 25. **I. Khavkine**, R. Loll, P. Reska (2010) *Coupling a point-like mass to quantum gravity with causal dynamical triangulations* Class Quantum Grav **27** 185025 [arXiv:1002.4618]
 _____ PhD Work _____
 26. **I. Khavkine** (2015) *Recurrence relation for the $6j$ -symbol of $su_q(2)$ from an eigenvalue problem* Int J Geom Methods Mod Phys **12** 1550117 [arXiv:1009.2261]
 27. J. D. Christensen, **I. Khavkine**, E. R. Livine, S. Speziale (2010) *Sub-leading asymptotic behaviour of area correlations in the Barrett-Crane model* Class Quantum Grav **27** 035012 [arXiv:0908.4476]
 28. **I. Khavkine** (2009) *Evaluation of new spin foam vertex amplitudes* Class Quantum Grav **26** 125012 [arXiv:0809.3190]
 29. J. Wade Cherrington, J. D. Christensen, **I. Khavkine** (2007) *Dual Computations of Non-abelian Yang-Mills on the Lattice* Phys Rev D **76** 3271 [arXiv:0705.2629]
 30. **I. Khavkine**, J. D. Christensen (2007) *q -deformed spin foam models of Riemannian quantum gravity* Class Quantum Grav **24** 3271 [arXiv:0704.0278]
 _____ MSc Work _____
 31. **I. Khavkine**, H.-Y. Kee, K. Maki (2004) *Supercurrent in nodal superconductors* Phys Rev B **70** 184521 [arXiv:cond-mat/0405236]
 32. **I. Khavkine**, C.-H. Chung, V. Oganesyan, H.-Y. Kee (2004) *Formation of an electronic nematic phase in interacting fermion systems* Phys Rev B **70** 155110 [arXiv:cond-mat/0402565]
 _____ Undergraduate Work _____
 33. E. A. Shapiro, **I. Khavkine**, M. Spanner, and M. Yu. Ivanov (2003) *Strong-field molecular alignment for quantum logic and quantum control* Phys Rev A **67** 013406

Organized Meetings and Schools

1. (Apr 2017) *QFT Day in Milan: mathematical aspects of renormalization* workshop, University of Milan, Italy. Organized jointly with *Prof. Vieri Mastropietro*.

Attended Meetings and Schools

1. (Mar–Apr 2024) *Quantum and classical fields interacting with geometry* thematic program, Institut Henri Poincaré, Paris, France.
2. (Oct 2023) *CAS-JSPS-IBS CTPU-CGA workshop in cosmology, gravitation and particle physics*, Prague, Czech Republic.
3. (Jan 2024) *44th Winter School Geometry and Physics*, Srní, Czech Republic.
4. (Jan 2023) *The Search for Quantum Gravity: CDT & Friends* conference, Nijmegen, The Netherlands.
5. (Jan 2023) *43rd Winter School Geometry and Physics*, Srní, Czech Republic.
6. (Jul 2022) *Differential Geometry and its Applications* conference, Hradec Králové, Czechia.
7. (Jul 2022) *General Relativity and Gravitation 23* conference, Beijing, China (online).
8. (Jan 2022) *42nd Winter School Geometry and Physics*, Srní, Czech Republic.
9. (Dec 2021) *Alexandre Vinogradov Memorial Conference*, Independent University of Moscow and Moscow State University, Moscow, Russia.
10. (Sep 2021) *Geometry for Higher Spin Gravity* thematic program, Erwin Schrödinger Institute, Vienna, Austria.
11. (Aug 2021) *A finite and infinite-dimensional meeting on Lie groupoids, Poisson geometry and integrability*, Wolfgang Pauli Institute, Vienna, Austria.
12. (Dec 2020) *Black Holes Workshop XIII*, IST Lisbon, Portugal. (online)
13. (June 2020) *45th Foundations and Constructive Aspects of QFT* workshop, Paderborn, Germany. (online)
14. (May–Jun 2020) *Scattering, microlocal analysis and renormalisation* workshop, Mittag-Leffler Institute, Stockholm, Sweden. (online)
15. (Jan 2020) *40th Winter School Geometry and Physics*, Srní, Czech Republic.
16. (Dec 2019) *Supergeometry, supersymmetry and quantization* conference, University of Luxembourg, Luxembourg.
17. (Oct 2019) *Central European Seminar on Geometry* workshop, Telč, Czechia.
18. (Sep 2019) *General Relativity, Geometry and Analysis: beyond the first 100 years after Einstein* thematic program, Institut Mittag-Leffler, Stockholm, Sweden.
19. (Sep 2019) *The Semi-Classical Einstein Equation: Analytical and Numerical Challenges* workshop, Dublin City University, Dublin, Ireland.
20. (Sep 2019) *Dynamics, Geometry and Analysis: 20 years of Mathematical Institute in Opava* conference, Hradec nad Moravicí, Czechia.
21. (Sep 2019) *Differential Geometry and its Applications* conference, Hradec Králové, Czechia.
22. (Jul 2019) *General Relativity and Gravitation 22* conference, Valencia, Spain.
23. (Apr 2019) *Algebraic and geometric aspects in Quantum Field Theory* workshop, Freiburg, Germany.
24. (Jan 2019) *39th Winter School Geometry and Physics*, Srní, Czech Republic.
25. (Dec 2018) *A Century of Noether's theorem and beyond* workshop, Opava, Czechia.
26. (Oct 2018) *Local and Nonlocal Geometry of PDEs and Integrability* workshop, SISSA, Trieste, Italy.
27. (Aug 2018) *Physics and Mathematics of Quantum Field Theory* workshop, Banff, Alberta, Canada.
28. (Jul 2018) *International Congress on Mathematical Physics* conference, Montreal, Quebec, Canada.
29. (Jun 2018) *AQFT: Where operator algebra meets microlocal analysis* workshop, Cortona, Italy.
30. (May 2018) *Quantum fields, scattering and spacetime horizons* workshop, Les Houches, France.
31. (Jan 2017) *38th Winter School Geometry and Physics*, Srní, Czech Republic.
32. (Dec 2017) *Quantum Physics meets Mathematics* workshop on the occasion of Klaus Fredenhagen's 70th birthday, University of Hamburg, Germany.

33. (Nov 2017) *Micro-Workshop on the Formal Theory of PDEs*, University of Salerno, Italy.
34. (Sep 2017) *Advances in Mathematical and Theoretical Physics* conference, Accademia dei Lincei, Rome, Italy.
35. (Jul 2017) *Quantum Mathematical Physics Day* workshop, University of Pavia, Italy.
36. (Jun 2017) *Non-regular spacetime geometry* workshop, University of Florence, Italy.
37. (Jun 2017) *Geometry and Algebra of PDEs* conference, University of Tromsø, Norway.
38. (Jun 2017) *Foundational and structural aspects of gauge theories* workshop, Mainz Institute for Theoretical Physics, Mainz, Germany.
39. (Jan 2017) *Microlocal analysis: a tool to explore a quantum world* workshop, Genova, Italy.
40. (Aug 2016) *Geometry and Physics XIV: Graded geometry and applications to physics* workshop, Sheffield, UK.
41. (Jun 2016) *Operator Algebras and Quantum Field Theory Dedicated to the memory of John E. Roberts* workshop, INFN Frascati, Italy.
42. (Nov 2015) *General Relativity: A celebration of the 100th anniversary* conference, Paris, France.
43. (Oct 2015) *Integrable Nonlinear Equations* workshop, Mikulov, Czech Republic.
44. (Sep 2015) *Algebraic Quantum Field Theory of Lorentzian Manifolds* minisymposium at *DMV Annual Meeting 2015*, Hamburg, Germany.
45. (Sep 2015) *Hyperbolic Equations on Spacetimes: Stability, Microlocal Analysis and Quantum Field Theory* workshop, ESI, Vienna, Austria.
46. (Aug 2015) *20th International Summer School on Global Analysis and its Applications*, Stará Lesná, Slovakia.
47. (May 2015) *36th Foundations and Constructive Aspects of QFT* workshop, Leipzig, Germany.
48. (Feb 2015) *New Trends in Algebraic Quantum Field Theory (AQFT2015)* workshop, INFN Frascati, Italy.
49. (Sep 2014) *Operator and Geometric Analysis on Quantum Theory* conference, Levico Terme, Italy.
50. (Aug 2014) *Symmetries*, 19th Summer School on Global Analysis and its Applications, Lednice, Czech Republic.
51. (Jul 2014) *Trends in Poisson Geometry* workshop, University of Toronto, Toronto, Canada.
52. (Jul 2014) *Asymptotic Analysis in General Relativity* workshop, Institut Fourier, Grenoble, France.
53. (May 2014) *Algebraic quantum field theory: its status and its future* workshop, ESI, Vienna, Austria.
54. (Feb 2014) *Philosophy of Mechanics: Mathematical Foundations* workshop, Paris, France.
55. (Aug 2013) *The Local and Global Inverse Problem of the Calculus of Variations*, 18th International Summer School on Global Analysis and its Applications, Levoca, Slovakia.
56. (Jul 2013) *General Relativity and Gravitation 20* conference, Warsaw, Poland.
57. (May 2013) *Quantum Gravity in Perspective* workshop, Munich, Germany.
58. (Aug 2012) *Geometry and Algebra of PDEs* workshop, Tromsø, Norway.
59. (Aug 2012) *International Congress on Mathematical Physics* conference, Aalborg, Denmark.
60. (Jul 2012) *Mathematical Aspects of Quantum Field Theory and Quantum Statistical Mechanics* workshop, Hamburg, Germany.
61. (Jul 2012) *Marcel Grossmann 13* conference, Stockholm, Sweden.
62. (Jun 2012) *100 years after Einstein in Prague* conference, Prague, Czech Republic.
63. (Jun 2012) *Integrable Systems and Quantum Symmetries* conference, Prague, Czech Republic.
64. (Sep 2011) *Modern Trends in Algebraic Quantum Field Theory* workshop, Pavia, Italy.
65. (Jun 2011) *Cosmological Frontiers in Fundamental Physics* workshop, Paris, France.
66. (Feb 2011) *Foundational Aspects of Cosmology* workshop, Hamburg, Germany.
67. (Nov 2010) *27th Foundations and Constructive Aspects of QFT* workshop, Leipzig, Germany.
68. (Sep 2010) *Quantum Field Theory and Gravity* conference, Regensburg University, Regensburg, Germany.
69. (Jul 2010) *Experimental Search for Quantum Gravity* workshop, NORDITA, Stockholm, Sweden.
70. (May 2008) *New Paths Toward Quantum Gravity* summer school, Holbæk, Denmark.
71. (Jun 2007) *LOOPS'07* conference, Instituto de Matemáticas Unidad Morelia, Morelia, Mexico.

72. (Oct 2005) *LOOPS'05* conference, Albert Einstein Institute, Golm, Germany.
73. (Apr 2005) *Quantum Gravity* workshop, University of New Brunswick, Fredericton, Canada.
74. (Oct 2004) *Quantum Gravity in the Americas* workshop, Perimeter Institute, Waterloo, Canada.
75. (Mar 2004) *APS March Meeting* conference, Montreal, Canada.
76. (May 2003) *Canadian Institute for Advanced Research Quantum Materials summer school*, University of British Columbia, Vancouver, Canada.

Mini Courses

1. *Hyperbolic PDEs* 6-hour minicourse (26 Jan–1 Feb 2019) University of Pavia, Italy.
2. *Topics in the formal theory of PDEs* 6-hour minicourse (6–10 Nov 2017) *Micro-Workshop on the Formal Theory of PDEs*, University of Salerno, Italy.
3. *Reductions, deformations and resolutions in the service of physics* (Jun 2011) Five part lecture reviewing mathematical aspects of classical gauge theory and BV-BRST cohomology. Derived Differential Geometry Seminar, Department of Mathematics, Utrecht University, Utrecht, The Netherlands.

Invited Talks

1. *A glimpse at Type Theory and a glance at the Lean Proof Assistant* (29 Oct 2024) *Algebra Colloquium*, Charles University, Prague, Czechia.
2. *Renormalization of Wick polynomials of locally covariant bosonic vector valued fields* (12 Sep 2019) *The Semi-Classical Einstein Equation: Analytical and Numerical Challenges* workshop, Dublin City University, Dublin, Ireland.
3. *Renormalization of Wick polynomials of locally covariant bosonic vector valued fields* (7 Jun 2018) *AQFT: Where operator algebra meets microlocal analysis* workshop, Cortona, Italy.
4. *Local gauge invariant observables on spacetimes of sub-maximal symmetry* (5 Jul 2017) *Quantum Mathematical Physics Day* workshop, University of Pavia, Italy.
5. *Spectral theory of vector and tensor fields on Schwarzschild spacetime* (22 Jun 2017) *Non-regular spacetime geometry* workshop, University of Florence, Florence, Italy.
6. *An IDEAL characterization of FLRW spacetimes* (29 May 2017) *Foundational and structural aspects of gauge theories* workshop, Mainz Institute for Theoretical Physics, Mainz, Germany.
7. *Spectral theory of vector and tensor fields on Schwarzschild spacetime*, (12 Jan 2017) *Microlocal analysis: a tool to explore a quantum world* workshop, Genova, Italy.
8. *Applications of compatibility complexes and their cohomology in relativity and gauge theories*, (20 Oct 2015) *Integrable Nonlinear Equations* workshop, Mikulov, Czech Republic.
9. *Supergeometry in classical field theory*, (24 Sep 2015) *Algebraic Quantum Field Theory of Lorentzian Manifolds* minisymposium at *DMV Annual Meeting 2015*, Hamburg, Germany.
10. *Graviton propagator on Schwarzschild spacetime*, (9 Sep 2015) *Hyperbolic Equations on Spacetimes: Stability, Microlocal Analysis and Quantum Field Theory* workshop, ESI, Vienna, Austria.
11. *Local and gauge invariant observables in gravity*, (17 Sep 2014) *Operator and Geometric Analysis on Quantum Theory* conference, Levico Terme, Italy.
12. *Covariant phase space symplectic form and Peierls inversion formula in the presence of constraints and gauge*, (23 Jul 2014) *Trends in Poisson Geometry* workshop, University of Toronto, Toronto, Canada.
13. *The Calabi complex: a case study in linear dynamical obstructions to isotony*, (23 May 2014) *Algebraic quantum field theory: its status and its future* workshop, ESI, Vienna, Austria.
14. *Topology, rigid cosymmetries and linearization instability in higher gauge theories* (21 Jun 2013) Quarterly seminar on Topology and Geometry, Utrecht University, Utrecht, The Netherlands.

Contributed Talks

1. *Simplifying harmonic gauge perturbations around black holes* (02 Apr 2024) *Quantum and classical fields interacting with geometry* thematic program, Institut Henri Poincaré, Paris, France.
2. *Update on IDEAL characterization of pp-wave spacetimes* (15 Jan 2024) *44th Winter School Geometry and Physics*, Srní, Czech Republic.
3. *IDEAL characterizations of spacetimes in cosmology and beyond* (12 Oct 2023) *CAS-JSPS-IBS CTPU-CGA workshop in cosmology, gravitation and particle physics*, Prague, Czech Republic.
4. *Linear local gauge invariant observables: construction and applications* (27 Jan 2023) *The Search for Quantum Gravity: CDT & Friends* conference, Nijmegen, The Netherlands.
5. *IDEAL characterization of pp-wave spacetimes* (20 Jan 2023) *43rd Winter School Geometry and Physics*, Srní, Czech Republic.
6. *An IDEAL characterization of pp-wave spacetimes* (19 Jul 2022) *Differential Geometry and its Applications* conference, Hradec Králové, Czechia.
7. *Triangular decoupling of harmonic gauge linearized gravity around a Schwarzschild black hole* (05 Jul 2022) *General Relativity and Gravitation 23* conference, Beijing, China (online).
8. *Recursive formulas for L_∞ homotopy transfer to non-minimal models* (19 Jan 2022) *42nd Winter School Geometry and Physics*, Srní, Czech Republic.
9. *Applications of complexes of differential operators in gauge theories* (14 Dec 2021) *Alexandre Vinogradov Memorial Conference*, Independent University of Moscow and Moscow State University, Moscow, Russia.
10. *Homotopy transfer for conserved currents and rigid symmetries in gauge theories* (07 Sep 2021) *Geometry for Higher Spin Gravity* thematic program, Erwin Schrödinger Institute, Vienna, Austria.
11. *The geometry of analytic structures* (17 Aug 2021) *A finite and infinite-dimensional meeting on Lie groupoids, Poisson geometry and integrability*, Wolfgang Pauli Institute, Vienna, Austria.
12. *Harmonic gauge linear fields around a Schwarzschild black hole*, (22 Dec 2020) *Black Holes Workshop XIII*, IST Lisbon, Portugal. (online)
13. *Initial data for closed conformal Killing-Yano 2-forms* (17 Jan 2020) *40th Winter School Geometry and Physics*, Srní, Czech Republic.
14. *Initial data for closed conformal Killing-Yano 2-forms* (25 Oct 2019) *Central European Seminar on Geometry* workshop, Telč, Czechia.
15. *Conformal Killing initial data* (24 Sep 2019) *General Relativity, Geometry and Analysis: beyond the first 100 years after Einstein* thematic program, Institut Mittag-Leffler, Stockholm, Sweden.
16. *Conformal Killing initial data* (8 Sep 2019) *Dynamics, Geometry and Analysis: 20 years of Mathematical Institute in Opava* conference, Hradec nad Moravicí, Czechia. <http://conferences.math.slu.cz/dga20/index.php>
17. *Conformal Killing initial data* (3 Sep 2019) *Differential Geometry and its Applications* conference, Hradec Králové, Czechia.
18. *Completeness of local gauge invariant observables on cosmological and black hole spacetimes* (09 Jul 2019) *General Relativity and Gravitation 22* conference, Valencia, Spain.
19. *IDEAL characterization of cosmological and black hole spacetimes* (08 Jul 2019) *General Relativity and Gravitation 22* conference, Valencia, Spain.
20. *Local gauge invariant observables in linear gauge theories*, (18 Apr 2019) *Algebraic and geometric aspects in Quantum Field Theory* workshop, Freiburg, Germany.
21. *Compatibility complexes of overdetermined PDEs of finite type, with applications to the Killing equation*, (17 Jan 2019) *39th Winter School Geometry and Physics*, Srní, Czech Republic.
22. *Explicit triangular decoupling of vector and tensor mode equation on Schwarzschild* (1 Dec 2018) *A Century of Noether's theorem and beyond* workshop, Opava, Czechia.
23. *Compatibility complexes for the Killing equation*, (11 Oct 2018) *Local and Nonlocal Geometry of PDEs and Integrability* workshop, SISSA, Trieste, Italy.
24. *Linear local gauge-invariant observables on spacetimes of sub-maximal symmetry*, (27 Jul 2018) *International Congress on Mathematical Physics* conference, Montreal, Quebec.
25. *Explicit triangular decoupling of vector and tensor mode equation on Schwarzschild*, (14 Jan 2018) *38th Winter School Geometry and Physics*, Srní, Czech Republic.

26. *A synthetic approach to the formal theory of PDEs*, (09 Jun 2017) *Geometry and Algebra of PDEs* conference, University of Tromsø, Norway.
27. *Feynman Propagators and spectral theory of vector and tensor fields on Schwarzschild spacetime*, (07 Jul 2016) *Mathematics and Physics at the Crossroads* trimester program at Laboratori Nazionali di Frascati INFN, Italy.
28. *A polynomial action for gravity with matter, gauge fixing and ghosts*, (18 Aug 2015) *20th International Summer School on Global Analysis and its Applications*, Stará Lesná, Slovakia.
29. *Local and gauge invariant observables in gravity*, (30 May 2015) *36th Foundations and Constructive Aspects of QFT* workshop, Leipzig, Germany.
30. *Analyticity is an unnecessary hypothesis in the renormalization of locally covariant QFT on curved spacetime*, (11 Feb 2015) *New Trends in Algebraic Quantum Field Theory (AQFT2015)* workshop, INFN Frascati, Italy.
31. *Topology, rigid cosymmetries and linearization instability in higher gauge theories*, (25 Aug 2014) *19th Summer School on Global Analysis and its Applications*, Lednice, Czech Republic.
32. *Covariant phase space symplectic form and Peierls inversion formula in the presence of constraints and gauge* (15 Nov 2013) *33rd Foundations and Constructive Aspects of QFT* workshop, Mathematics Institute, University of Göttingen, Göttingen, Germany.
33. *Presymplectic current and the inverse problem of the calculus of variations* (13 Aug 2013) *18th International Summer School on Global Analysis and its Applications*, Levoca, Slovakia.
34. *Gravity: an exercise in quantization* (31 May 2013) *Quantum Gravity in Perspective* workshop, Munich Center for Mathematical Philosophy, Munich, Germany.
35. *Time delay observable in classical and quantum geometries* (3 Jul 2012) *Marcel Grossmann 13* conference, Stockholm, Sweden.
36. *Time delay observable in classical and quantum geometries* (25 Jun 2012) *100 years after Einstein in Prague* conference, Prague, Čech Republic.
37. *Recurrence relation for the $6j$ -symbol of $su_q(2)$ from an eigenvalue problem* (18 Jun 2012) *Integrable Systems and Quantum Symmetries* conference, Prague, Čech Republic.
38. *Characteristic geometry and causality in locally covariant field theory* (14 Sep 2011) *Modern Trends in Algebraic Quantum Field Theory* workshop, University of Pavia, Pavia, Italy.
39. *Time delay observable in classical and quantum geometries* (19 Nov 2010) *27th Foundations and Constructive Aspects of QFT* workshop, Leipzig University, Leipzig, Germany.
40. *q -deformed spin foams for Riemannian quantum gravity* (26 Jun 2007) *LOOPS'07* conference, Instituto de Matemáticas Unidad Morelia, Morelia, Mexico.
41. (22 Mar 2004) *Formation of an electronic nematic phase in interacting systems* *APS March Meeting* conference, Montreal, Canada.

Contributed Posters

1. (poster) *Topology, rigid cosymmetries and linearization instability in higher gauge theories* (Jul 2013) *General Relativity and Gravitation 20* conference, Warsaw, Poland.
2. (poster) *Covariant phase space symplectic form and Peierls inversion formula in the presence of constraints and gauge* (Jul 2013) *General Relativity and Gravitation 20* conference, Warsaw, Poland.
3. (poster) *Characteristic geometry and causality in locally covariant field theory* (Aug 2012) *International Congress on Mathematical Physics* conference, Aalborg, Denmark.
4. (poster) *Supergeometry and classical field theory with fermions* (Jul 2012) *Mathematical Aspects of Quantum Field Theory and Quantum Statistical Mechanics* workshop, DESY, Hamburg, Germany.
5. (poster) *Efficient Evaluation of q -deformed Riemannian $10j$ -symbols*. (Oct 2005) *LOOPS'05* conference, Albert Einstein Institute, Golm, Germany.

Seminars

1. *Introduction to using the Lean proof assistant* (26 Mar 2024) Set Theory Seminar, Institute of Mathematics, Czech Academy of Sciences, Prague, Czechia.
2. *Introduction to the Lean Proof Assistant* (15 Aug 2024) Emmy-Noether Seminar, Institute of Theoretical Physics, Leipzig University, Leipzig, Germany.

3. *Initial data for closed conformal Killing vectors and Killing-Yano 2-forms* (18 Nov 2022) Seminar, Institute of Theoretical Physics, University of Warsaw, Warsaw, Poland.
4. *Triangular decoupling of harmonic gauge linearized gravity around a Schwarzschild black hole* (18 Nov 2022) Seminar, Institute of Theoretical Physics, University of Warsaw, Warsaw, Poland.
5. *Homotopy transfer for conserved currents and rigid symmetries in gauge theories* (19 May 2022) Geometry Seminar, Mathematics Institute, University of Göttingen, Göttingen, Germany.
6. *A look at the geometry of the 5-dimensional charged rotating black hole* (05 Apr 2022) Relativity Seminar, Charles University, Prague, Czechia.
7. *Harmonic gauge linearized gravity around a Schwarzschild black hole* (25 Nov 2021) General Relativity Seminar, University of Stavanger, Stavanger, Norway.
8. *Triangular decoupling of systems of differential equations, with application to separation of variables on Schwarzschild spacetime* (20 Oct 2021) Geometry of Differential Equations Seminar, Independent University of Moscow, Moscow, Russia. (online)
9. *Killing compatibility complex on Kerr spacetime*, (16 Dec 2020) Geometry of Differential Equations Seminar, Independent University of Moscow, Moscow, Russia. (online)
10. *Harmonic gauge linear fields around a Schwarzschild black hole*, (12 Oct 2020) HEP – GR Seminar, University of Leipzig, Leipzig, Germany. (online)
11. *Harmonic gauge classical and quantum fields around a Schwarzschild black hole*, (03 Jul 2020) Quantum Gravity Seminar, Radboud University, Nijmegen, The Netherlands. (online)
12. *Initial data for closed conformal Killing-Yano 2-forms*, (26 May 2020) Relativity Seminar, Charles University, Prague, Czechia.
13. *Triangular decoupling of systems of differential equations, with application to separation of variables on Schwarzschild spacetime*, (29 Apr 2020) Prague-Hradec Králové Cohomology Seminar. (online)
14. *Initial data for closed conformal Killing-Yano 2-forms* (12 Dec 2019) Geometry Seminar, University of Opava, Opava, Czechia.
15. *IDEAL Characterization of Cosmological and Black Hole Spacetimes* (28 Nov 2019) Analysis + Geometry Seminar, Friedrich Schiller University, Jena, Germany.
16. *Conformal Killing Initial Data* (08 Nov 2019) Geometry Seminar, University of Granada, Granada, Spain.
17. *Conformal Killing Initial Data* (07 Jun 2019) Relativity Seminar, University of Vienna, Vienna, Austria.
18. *IDEAL Characterization of Cosmological and Black Hole Spacetimes* (20 Mar 2019) Mathematical Physics Seminar, University of Ostrava, Ostrava, Czechia.
19. *Hyperbolic Partial Differential Equations, I–III* (28,30 Jan, 01 Feb 2019) PhD Minicourse, University of Pavia, Pavia, Italy.
20. *Linear local gauge-invariant observables on spacetimes of sub-maximal symmetry* (22 Nov 2018) Relativity Seminar, University of Vienna, Vienna, Austria.
21. *Linear local gauge-invariant observables on spacetimes of sub-maximal symmetry* (12 Jun 2018) Relativity Seminar, Charles University, Prague, Czechia.
22. *Topics in the formal theory of PDEs, I–IV* (23 Feb, 2 Mar, 20 Apr, 18 May 2018) Differential Geometry Seminar, Charles University, Prague, Czechia.
23. *Renormalization of Wick polynomials of locally covariant bosonic vector valued fields* (13 Mar 2018) University of Regensburg, Regensburg, Germany.
24. *Local gauge invariant observables on spacetimes of sub-maximal symmetry* (15 Dec 2017) Middle European seminar on geometry, Masaryk University, Brno, Czech Republic.
25. *An IDEAL characterization of FLRW spacetimes* (11 Dec 2017) GR Seminar, Czech Academy of Sciences, Prague, Czech Republic.
26. *Local gauge invariant observables on spacetimes of sub-maximal symmetry* (26 Nov 2017) Geometry and Relativity Seminar, Albert Einstein Institute for Gravitational Physics, Golm, Germany.
27. *Applications of PDE compatibility complexes in relativity* (14 Jun 2017) Geometry and Relativity Seminar, Albert Einstein Institute for Gravitational Physics, Golm, Germany.
28. *Applications of PDE compatibility complexes in relativity* (16 May 2017) Algorithmic Algebra and Discrete Mathematics Seminar, University of Kassel, Germany.

29. *A synthetic approach to the formal theory of PDEs* (17 Feb 2017) Differential Geometry Seminar, Charles University, Prague, Czech Republic.
30. *Applications of compatibility complexes and their cohomology in relativity and gauge theories* (17 Jan 2017) Mathematical Physics Seminar, Université d'Angers, Angers, France.
31. *Spectral theory of vector and tensor fields on Schwarzschild spacetime* (14 Dec 2016) Geometry and Relativity Seminar, Albert Einstein Institute for Gravitational Physics, Golm, Germany.
32. *Spectral theory of vector and tensor fields on Schwarzschild spacetime* (08 Dec 2016) Mathematical Physics Seminar, Zürich, Switzerland.
33. *Applications of compatibility complexes and their cohomology in relativity and gauge theories* (10 Oct 2016) Department of Mathematics, University of Luxembourg, Luxembourg.
34. *The Noether map as an L^∞ -algebra central extension of variational symmetries by higher topological conserved currents* (05 Oct 2016) Higher Differential Geometry Seminar, Max Planck Institute for Mathematics, Bonn, Germany.
35. *Local and gauge-invariant observables in gravity* (30 Sep 2016) Quantum Gravity Seminar, Institute for Mathematics, Astrophysics and Particle Physics, Radboud University, Nijmegen, The Netherlands.
36. *Spectral theory of vector and tensor fields on Schwarzschild spacetime* (21 Sep 2016) Mathematical Physics Seminar, Mathematics Institute, University of Göttingen, Göttingen, Germany.
37. *Spectral theory of vector and tensor fields on Schwarzschild spacetime* (21 Jun 2016) Department of Mathematics, University of Trento, Trento, Italy.
38. *Graviton propagator on Schwarzschild spacetime* (09 Mar 2016) Analysis seminar, Princeton University, Princeton, USA.
39. *Graviton propagator on Schwarzschild spacetime* (05 Feb 2016) Department of Physics, Bishop's University, Sherbrooke, Canada.
40. *Topology, rigid cosymmetries and linearization instability in higher gauge theories* (29 Jan 2016) Analysis seminar, McGill University, Montreal, Canada.
41. *Graviton propagator on Schwarzschild spacetime* (22 Jan 2016) Department of Physics, McGill University, Montreal, Canada.
42. *Local and gauge invariant observables in gravity* (19 Jan 2016) Department of Physics, UC Santa Barbara, Santa Barbara, USA.
43. *Local and gauge invariant observables in gravity* (1 Dec 2015) Department of Mathematics, University of Salerno, Salerno, Italy.
44. *Local and gauge invariant observables in gravity* (20 Nov 2015) Séminaire de géométrie et physique mathématique, Université Paris 7, Paris, France.
45. *Covariant phase space, constraints, gauge and the Peierls formula* (13 May 2015) Mathematical Physics seminar, Department of Mathematics, University of Genova, Genova, Italy.
46. *Supergeometry in classical field theory* (2 Apr 2015) Geometry seminar, Department of Mathematics, University of Potsdam, Potsdam, Germany.
47. *Supergeometry in classical field theory* (26 Feb 2015) Mathematical Physics seminar, Department of Mathematics, University of York, York, UK.
48. *Analyticity is an unnecessary hypothesis in the renormalization of locally covariant QFT on curved spacetime* (22 Jan 2015) Graduate Colloquium, Mathematics Institute, University of Göttingen, Göttingen, Germany.
49. *Analyticity is an unnecessary hypothesis in the renormalization of locally covariant QFT on curved spacetime* (12 Jan 2015) High Energy Physics seminar, Department of Physics, McGill University, Montreal, Canada.
50. *Topology, rigid cosymmetries and linearization instability in higher gauge theories* (13 Aug 2014) Seminar, Albert Einstein Institute for Gravitational Physics, Golm, Germany.
51. *Lagrangian field theory from the jet bundle point of view* (1 Apr 2014) Mathematical Physics seminar, University of Pavia, Pavia, Italy.
52. *Locality and Causality in Classical Field Theory* (16 Jan 2014) Quantum Gravity seminar, Perimeter Institute for Theoretical Physics, Waterloo, Canada.
53. *Locality and Causality in Classical Field Theory* (13 Jan 2014) Relativity seminar, University of Chicago, Chicago, USA.
54. *Presymplectic current and the inverse problem of the calculus of variations* (10 Jan 2014) Analysis seminar,

McGill University, Montreal, Canada.

55. *Topology, rigid cosymmetries and linearization instability in higher gauge theories* (16 Apr 2013) Seminar, Max Planck Institute for Mathematics, Bonn, Germany.
56. *Characteristics, conal geometry and causality in locally covariant field theory* (11 Apr 2013) Graduate Colloquium, Mathematics Institute, University of Göttingen, Göttingen, Germany.
57. *Covariant phase space symplectic form and Peierls inversion formula in the presence of constraints and gauge* (19 Feb 2013) Seminar, Mathematical Physics group, Université Libre de Bruxelles, Brussels, Belgium.
58. *Covariant phase space symplectic form and Peierls inversion formula in the presence of constraints and gauge* (22 Jan 2013) Seminar, II. Institute for Theoretical Physics, Hamburg University, Hamburg, Germany.
59. *Time delay in classical and quantum gravity* (14 Jan 2013) Joint Theory Seminar, Department of Physics, UC Davis, Davis, USA.
60. *Characteristics, conal geometry and causality in locally covariant field theory* (22 Nov 2012) Seminar, Department of Mathematics, University of York, York, UK.
61. *Time delay observable in classical and quantum geometries* (16 Nov 2012) Seminar, Institute of Theoretical Physics, University of Warsaw, Warsaw, Poland.
62. *Quantum gravity: an exercise in quantization* (16 Nov 2012) Seminar, Institute of Theoretical Physics, University of Warsaw, Warsaw, Poland.
63. *Characteristic geometry and causality in locally covariant field theory* (28 Apr 2012) II. Institute for Theoretical Physics, Hamburg University, Hamburg, Germany.
64. *Time delay observable in classical and quantum geometries* (5 Dec 2011) *Quist* seminar, Institute for Theoretical Physics, Utrecht University, Utrecht, The Netherlands.
65. *Time delay observable in classical and quantum geometries* (1 Dec 2011) Seminar, Department of Fundamental Physics, University of Barcelona, Barcelona, Spain.
66. *Characteristic geometry and causality in locally covariant field theory* (8 Sep 2011) *Quist* seminar, Institute for Theoretical Physics, Utrecht University, Utrecht, The Netherlands.
67. *Time delay observable in classical and quantum geometries* (16 May 2011) Seminar, Albert Einstein Institute for Gravitational Physics, Golm, Germany.
68. *Time delay observable in classical and quantum geometries* (29 Oct 2010) Seminar, II. Institute for Theoretical Physics, Hamburg University, Hamburg, Germany.
69. *Comment on 'Hawking radiation from fluctuating black holes'* (19 Oct 2010) *Quist* seminar, Institute for Theoretical Physics, Utrecht University, Utrecht, The Netherlands.
70. *Time delay in quantum and fluctuating geometries* (29 Jan 2009) *Quist* seminar, Institute for Theoretical Physics, Utrecht University, Utrecht, The Netherlands.
71. *Computation with spin foam models of quantum gravity* (19 May 2008) *Quist* seminar, Institute for Theoretical Physics, Utrecht University, Utrecht, The Netherlands.
72. *Numerical algorithms for new spin foam vertices* (30 Jul 2008) *Young Loops and Foams* workshop, Perimeter Institute, Waterloo, Canada.
73. *First Numerical Results on the New Spin Foam Vertices* (27 Sep 2007) *Quantum Gravity* seminar, Perimeter Institute, Waterloo, Canada.