

Research Interests

Black holes and gravitational physics at the intersection of high energy physics. Modified gravity: non-Riemannian geometries, short-distance modifications of gravity, the role of (non-)locality, string-inspired infinite-derivative nonlocality. Aspects of asymptotic safety. General Relativity: exact solutions, hidden Killing-Yano symmetries of black holes and integrability. Physics beyond the standard model: Lee-Wick theories, electroweak hierarchy, kinetic mixing, Z' models.

In Brief

21 publications, $h_{\text{HEP}} = 10$, 2 single-authored honorable mentions in the 2020 and 2018 Gravity Research Foundation Essay Competition, 1 book review, 41 talks (10 invited), 15 attended conferences, taught 6 graduate courses, \$356,724 of funding in 9 awards and scholarships.

Positions

2020– **Postdoctoral Research Associate of Physics**, *High Energy Theory Group, Department of Physics, William & Mary*, Williamsburg, VA, United States

Education

2016–2020 **Doctor of Philosophy (Ph.D.) in Physics**, *University of Alberta*, Edmonton, Canada
Vanier scholar, *GPA – 3.8*, awarded Faculty of Science Dissertation Award.

2015–2016 **Master of Science in Physics**, *University of Waterloo*, Waterloo, Canada
Perimeter Scholars International, *Perimeter Institute*, Waterloo, Canada
GPA – PSI program is traditionally not graded.

2012–2015 **Master of Science in Physics**, *University of Cologne*, Cologne, Germany
GPA – 1.0 (honor's branch)*

2009–2012 **Bachelor of Science in Physics**, *RWTH Aachen University*, Aachen, Germany
GPA – 1.1 excellent*

2000–2009 **Abitur**, *Heinrich-Heine Gymnasium*, Oberhausen, Germany
*GPA – 1.0**

*German grading system: 1.0 corresponds to the highest possible grade.

Publications

22. JB, Christopher D. Carone, Noah L. Donald, and Mikkie R. Musser, “Asymptotic safety and gauged baryon number,” *Phys. Rev. D* **106** (2022) no. 3, 035015; 2206.02686 [hep-ph].

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21. JB and Christopher D. Carone, “Asymptotic non-locality in non-Abelian gauge theories,” *Phys. Rev. D* **105** (2022) no. 3, 035034; 2112.052701 [hep-ph].
20. JB and Christopher D. Carone, “Asymptotic non-locality in gauge theories,” *Phys. Rev. D* **104** (2021) no. 9, 095020; 2109.06261 [hep-th].
19. JB and Christopher D. Carone, “Asymptotic non-locality,” *Phys. Rev. D* **104** (2021) no. 1, 015028; 2104.11195 [hep-th].
18. JB and Ivan Kolář, “Non-locality and gravitoelectromagnetic duality,” *Phys. Rev. D* **104** (2021) no. 2, 024018 ; 2103.10555 [gr-qc].
17. JB, “Effects of non-locality in gravity and quantum theory,” 2009.10856 [gr-qc], Ph.D. thesis, 234 pages, University of Alberta (2020), published in Springer Theses.
16. Ivan Kolář and JB, “Retarded potential of a uniformly accelerated source in non-local scalar field theory,” *Phys. Rev. D* **103** (2021) no. 10, 105004; 2102.07843 [hep-th].
15. JB, Valeri P. Frolov, and Andrei Zelnikov, “Resonant particle creation by a time-dependent potential in a non-local theory,” *Phys. Lett. B* **816** (2021) 136252; 2011.12929 [hep-th].
14. JB, Valeri P. Frolov, and Jose Pinedo Soto, “Ultrarelativistic charged and magnetized objects in non-local ghost-free electrodynamics,” *Phys. Rev. D* **103** (2021) no. 4, 045013; 2012.05347 [hep-th].
13. JB, “Angle deficit & non-local gravitoelectromagnetism around a slowly spinning cosmic string,” *Int. J. Mod. Phys. D* (2020) no. 14, 2043027; 2003.13847 [gr-qc], honorable mention in the Gravity Research Foundation Essay Competition 2020.
12. JB, Jose Pinedo Soto, and Valeri P. Frolov, “Ultrarelativistic spinning objects in non-local ghost-free gravity,” *Phys. Rev. D* **101** (2020) no. 12, 124065; 2004.07420 [gr-qc].
11. JB, Valeri P. Frolov, and Andrei Zelnikov, “Ghost-free modification of the Polyakov action and Hawking radiation,” *Phys. Rev. D* **100** (2019) no. 10, 104008; 1909.01494 [hep-th].
10. JB, Valeri P. Frolov, and Andrei Zelnikov, “On thermal field fluctuations in ghost-free theories,” *Phys. Lett. B* **793** (2019) 290; 1904.07917 [hep-th].
9. JB, Valeri P. Frolov, and Andrei Zelnikov, “Probing the vacuum fluctuations in scalar ghost-free theories,” *Phys. Rev. D* **99** (2019) no. 7, 076014; 1901.07096 [hep-th].
8. Yakov Itin, Yuri N. Obukhov, JB, and Friedrich W. Hehl, “Premetric teleparallel theory of gravity and its local and linear constitutive law,” *Eur. Phys. J. C* **78** (2018) 907; 1808.08048 [gr-qc].
7. JB, Valeri P. Frolov, and Andrei Zelnikov, “Quantum scattering on a delta potential in ghost-free theory,” *Phys. Lett. B* **782** (2018) 688; 1805.01875 [hep-th].
6. JB, “Gravitational Friedel oscillations in higher-derivative and infinite-derivative gravity?,” *Int. J. Mod. Phys. D* **27** (2018) 1847022; 1804.00225 [gr-qc], honorable mention in the Gravity Research Foundation Essay Competition 2018.
5. JB, Valeri P. Frolov, and Andrei Zelnikov, “The gravitational field of p -branes in linearized ghost-free gravity,” *Phys. Rev. D* **97** (2018) no. 8, 084021; 1802.09573 [gr-qc].
4. JB and Valeri P. Frolov, “Principal Killing strings in higher-dimensional Kerr–NUT–(A)dS spacetimes,” *Phys. Rev. D* **97** (2018) no. 8, 084015; 1801.00122 [gr-qc].
3. JB and Valeri P. Frolov, “Stationary black holes with stringy hair,” *Phys. Rev. D* **97** (2018) no. 2, 024024; 1711.06357 [gr-qc].

2. JB and Friedrich W. Hehl, “Gravity-induced four-fermion contact interaction implies gravitational intermediate W and Z type gauge bosons,” *Int. J. Theor. Phys.* **56** (2017) 751; 1606.09273 [gr-qc].
1. JB, “Plebański–Demiański solution of general relativity and its expressions quadratic and cubic in curvature: analogies to electromagnetism,” *Int. J. Mod. Phys. D* **24** (2015) 1550079; 1412.1958 [gr-qc].

Working Papers

- W2. JB, “Non-singular ‘Gauss’ black hole from non-locality: a simple model with a de Sitter core, mass gap, and no inner horizon,” 2104.00555 [gr-qc].
- W1. JB and Alberto Favaro, “Kerr principal null directions from Bel–Robinson and Kummer surfaces,” 1703.10791 [gr-qc].

Book Reviews

- R1. “On Gravity: A Brief Tour of a Weighty Subject,” (Princeton University Press, 2018), *Physics in Canada*, Canadian Association of Physicists, 2019.

Awards and Scholarships ($n = 9$, $\Sigma = \$356,724$)

- 2017–2020 Vanier Canada Graduate Scholarship (\$166,667)
Natural Sciences and Engineering Research Council of Canada
 Golden Bell Jar Graduate Scholarship in Physics (\$90,000)
University of Alberta
- 2019 Andrew Stewart Memorial Graduate Prize (\$5,000)
 Graduate Student Travel Award (\$457.78)
University of Alberta
- 2017 President’s Doctoral Prize of Distinction (\$21,600)
University of Alberta
- 2016–2017 Dean’s Excellence Recruitment Scholarship Award (\$5,000)
 University of Alberta Doctoral Recruitment Scholarship (\$20,000)
University of Alberta
- 2015–2016 Perimeter Scholars International Award (\$30,000)
Perimeter Institute for Theoretical Physics
- 2013–2015 Member of Bonn–Cologne Graduate School Honor’s Branch (\$18,000)
University of Cologne

Honors and Distinctions

- 2021 P. R. Wallace Thesis Prize (\$500)
Canadian Association of Physicists, Division of Theoretical Physics
Winnipeg Institute for Theoretical Physics, Canada
 Springer Thesis Award (\$500)
Springer Nature, Switzerland

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- 2020 Faculty of Science Doctoral Dissertation Award
Faculty of Science, University of Alberta
Honorable Mention, Essay Competition 2020
Gravity Research Foundation
Semi-finalist prize, Images of Research Competition 2020
University of Alberta
- 2019 Finalist, three-minute thesis (3MT) competition
Faculty of Graduate Studies and Research, University of Alberta
- 2018 Honorable Mention, Essay Competition 2018
Gravity Research Foundation
First prize, Annual Symposium for Graduate Physics Research (\$250)
Graduate Physics Student Association, University of Alberta
Semi-finalist prize, Images of Research Competition 2018
University of Alberta
- 2013 Selected for Dean's List 2013
RWTH Aachen University
- 2012 becoMINT graduate prize
Robert Bosch corporation
- 2009 State distinction for best Abitur[†] graduates
Patron: prime minister of North Rhine-Westfalia, Germany
Manfred Lennings medal for best Abitur[†] grade
Rotary Club Oberhausen
- [†]Diploma from German secondary schools qualifying for university admission or matriculation.

Attended Conferences and Schools

- 2022 Bad Honnef Physics School on Black Holes
Physikzentrum German Physical Society, Bad Honnef, Germany
- 2021 16th Marcel Grossmann Meeting
University of Rome (La Sapienza), Italy (online conference)
Quantum Gravity, Higher Derivatives, and Nonlocality
Tokyo Institute of Technology, Japan (online conference)
- 2020 Nobel Laureate Discussion Panel on “The Greatest Physics Discoveries of the 20th Century”
Online seminar hosted by the HAPP Centre at the University of Oxford, UK
- 2019 25th Saalburg Summer School – Foundations and New Methods in Theoretical Physics
Heigenbrücken, Germany
- 2018 Hundred Years of Gauge Theory
Physikzentrum German Physical Society, Bad Honnef, Germany
Prospects in Theoretical Physics – From Qubits to Spacetime
Institute for Advanced Study, Princeton, USA

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- Joint Canada-Asia Pacific Conf. on General Relativity and Relativistic Astrophysics
University of Alberta, Edmonton, Canada
- 2017 Geometric Foundations of Gravity
University of Tartu, Estonia
Mathematical Physics and General Relativity Symposium in Honor of Professor Ivor Robinson
University of Texas at Dallas, USA
- 2016 Time in Cosmology
Perimeter Institute for Theoretical Physics, Waterloo, Canada
Black Holes' New Horizons
Casa Matemática Oaxaca, Mexico
- 2015 14th Marcel Grossmann Meeting
University of Rome (La Sapienza), Italy
DPG (German Physical Society) Spring Meeting
Technical University Berlin, Germany
- 2014 569th Wilhelm and Else Heraeus Seminar on Quantum Cosmology
Physikzentrum German Physical Society, Bad Honnef, Germany
Graduate School "From Classical to Quantum GR: Applications to Cosmology"
University of Sussex, United Kingdom
- 2013 Second Erlangen Fall School on Quantum Geometry
University of Erlangen–Nuremberg, Germany
Jürgen Ehlers Spring School "Gravitational Physics"
Max Planck Institute for Gravitational Physics, Potsdam, Germany

Talks and Invited Seminars

- Jan 2022 Asymptotic nonlocality
Invited talk, Van Swinderen Institute, University of Groningen, Netherlands
- Oct 2021 So black holes exist. Now what?
Invited symposium, Department of Physics, William & Mary, United States
- Jul 2021 Ultrarelativistic spinning objects in non-local ghost-free gravity
16th Marcel Grossmann Meeting, University of Rome (La Sapienza), Italy (online talk)
- Jun 2021 Effects of non-locality in gravity and quantum theory
Invited talk, Canadian Association of Physicists (online talk)
- Mar 2021 Regular solutions in weak-field infinite-derivative theories: Green function approach
Invited talk, Tokyo Institute of Technology, Japan (online conference)
Unexpected features of non-locality: resonant particle production
William & Mary, United States
- Sep 2020 Effects of non-locality in gravity and quantum theory
Ph.D. Defense, University of Alberta, Canada
- Jun 2020 Ultrarelativistic objects in non-local infinite-derivative gravity

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- Invited talk, William & Mary, United States*
- Dec 2019 What is a black hole?
Invited talk, Rotary Club Oberhausen, Germany
- Sep 2019 Black holes and mathematical sandpaper
Graduate research symposium, University of Alberta, Canada
- Aug 2019 Black holes, strings, and hidden symmetries
Invited talk, Department of Applied Mathematics and Theoretical Physics, University of Cambridge, UK
- Towards surface charges in spacetimes with curvature and torsion
Invited talk, Université Libre de Bruxelles, Belgium
- Non-local “ghost-free” gravity
University of Cologne, Germany
- Apr 2019 An exact Kerr–(A)dS black hole solution with torsion and curvature
Gravity seminar, University of Alberta, Canada
- Black holes and Einstein’s end of eternity
3MT Finals 2019, University of Alberta, Canada
- Nov 2018 Quantum-mechanical scattering on a delta potential in ghost-free theory
Gravity seminar, University of Alberta, Canada
- Oct 2018 An exact stationary string configuration attached to a rotating black hole
Graduate research symposium, University of Alberta, Canada
- Jun 2018 Principal Killing strings in higher-dimensional Kerr–NUT–(A)dS spacetimes
JCAPC GRRRA 2018, University of Alberta, Canada
- Mar 2018 Linearized short-distance modifications of Einstein’s General Relativity
Graduate weekend, University of Alberta, Canada
- Jan 2018 Cosmic strings in stationary BH geometries: stringy matter, principal Killing strings
Invited talk, University of Cologne, Germany
- Aug 2017 Curvature tensors in a 4D Riemann–Cartan space: decompositions and superenergy
Geometric Foundations of Gravity, University of Tartu, Estonia
- May 2017 The Bel–Robinson tensor as an irreducible piece of the Bel tensor
Mathematical Physics and General Relativity Symposium in Honor of Professor Ivor Robinson, University of Texas at Dallas, USA
- Sep 2016 Quasi-normal modes: what can ringing black holes tell us about quantum gravity?
Symposium for Graduate Physics Research, University of Alberta, Canada
- May 2016 Quasi-normal modes of the BTZ black hole and (2+1)D Poincaré gauge theory of gravity
Invited talk, Black Holes’ New Horizons, Casa Matemática Oaxaca, Mexico
- Mar 2016 Gauge structures in gravity
Gravity seminar, University of Alberta, Canada
- Dec 2015 Poincaré gauge theory and its deformed Lie algebra – mass-spin classification of elementary particles

- PSI seminar, Perimeter Institute for Theoretical Physics, Canada*
- Nov 2015 Classical aspects of Poincaré gauge theory of gravity
Quantum gravity seminar, Perimeter Institute for Theoretical Physics, Canada
- Sep 2015 Differential forms: from classical force to the Wilson loop
PSI seminar, Perimeter Institute for Theoretical Physics, Canada
- Jul 2015 Plebański–Demiański solution of general relativity and its expressions quadratic and cubic in curvature: analogies to electromagnetism
14th Marcel Grossmann Meeting, University of Rome (La Sapienza), Italy
- Mar 2015 Plebański–Demiański solution of general relativity and its expressions quadratic and cubic in curvature: analogies to electromagnetism
DPG (German Physical Society) Spring Meeting, Berlin, Germany
- Apr 2015 Poincaré gauge theory of gravity — an introduction
Invited talk, BCGS seminar, Physikzentrum German Physical Society, Bad Honnef, Germany
- Feb 2015 Quasi-normal modes of the BTZ black hole with torsion
Gravitation and Relativity seminar, University of Cologne, Germany
- Nov 2014 Second order curvature invariants for the Plebański–Demiański solution
Gravitation and Relativity seminar, University of Cologne, Germany
- Jun 2014 Poincaré gauge theory of gravity
Gravitation and Relativity seminar, University of Cologne, Germany
- Jun 2014 Exterior calculus and Einstein–Cartan theory
Gravitation and Relativity seminar, University of Cologne, Germany
- Aug 2012 Physics inside the Schwarzschild radius
Department for Theoretical Particle Physics, RWTH Aachen University, Germany

Master's Theses

- Title *Symplectic boundary degrees of freedom in Poincaré gauge theory of gravity*
- Supervisors Prof. Lee Smolin & Prof. Laurent Freidel
- Title *Quasi-normal modes of the the BTZ black hole solution of (2 + 1)-dimensional Poincaré gauge theory of gravity*
- Supervisors Prof. Friedrich W. Hehl & Prof. Claus Kiefer

Bachelor's Thesis

- Title *Physics inside the Schwarzschild radius*
- Supervisor Prof. Yvonne Y. Wong

Refereeing

- 2022–present Physical Review D; Physics Letters B; Journal of Cosmology and Astroparticle Physics; General Relativity and Gravitation; Symmetry; Universe
- 2021–present Europhysics Letters

- 2019–present European Physical Journal C
2018–present International Journal of Modern Physics D; Zeitschrift für Naturforschung A
2016–present Annals of Physics (Berlin)

Memberships

- 2018–present CAP (Canadian Association of Physicists), Division of Theoretical Physics
2018–present APS (American Physical Society), Division of Gravitation, Division of Astrophysics
2014–present DPG (German Physical Society), Division of Gravitation and Relativity
2014–present WWF (World Wide Fund for Nature)
2014–present Welthungerhilfe Germany (NGO for development cooperation and emergency aid)

Teaching Experience

- 2021 PHYS 581: Differential Geometry for Physicists
Graduate course, William & Mary, <http://www.spintwo.net/Courses/>
PHYS 101H: guest lecture on black hole physics
Undergraduate course, William & Mary
- 2020 Differential Geometry Student Meetings[‡]
- 2019 Black Hole Student Meetings[‡]
Conformal Field Theory Student Meetings[‡]
- 2018 Gauge Theory Student Meetings[‡]
Quantum Field Theory Student Meetings[‡]
Graduate seminars, University of Alberta, <http://www.spintwo.net/Courses/>
- 2015 Geometry in Physics
Teaching assistant, graduate course, University of Cologne, Prof. Alexander Altland.
- 2014 Advanced Seminar on General Relativity & Cosmology
General Relativity & Cosmology II
Teaching assistant, graduate course, University of Cologne, Prof. Claus Kiefer.
- [‡]Independently organized events outside the department's regular curriculum.

Organized Conferences

- 2021 PhD/Early Postdoc Symposium on Non-locality
Main organizer, recurring online symposium, <http://www.spintwo.net/Symposium/>
2021 Meeting of the Division of Particles and Fields of the American Physical Society (DPF21)
Parallel Session Chair
- 2018 Joint Canada-Asia Pacific Conference on General Relativity and Relativistic Astrophysics, University of Alberta, Edmonton, Canada
Member of local organizing committee, chairperson in afternoon session.
- 2014 569th Wilhelm and Else Heraeus Seminar on Quantum Cosmology, German Physical Society, Bad Honnef, Germany

Development of conference website and database backend for participant management.

Work Experience

- 2009–present freelance web developer
- 2014–2015 teaching assistant for various graduate-level courses
Institute for Theoretical Physics, University of Cologne
- 2014 Development and implementation of registration interface for the conference “569th Wilhelm and Else Heraeus Seminar on Quantum Cosmology” (see above)
Institute for Theoretical Physics, University of Cologne, Prof. Claus Kiefer
- 2013–2014 Development of website content management system (www.loosdrecht.net)
II. Physical Institute, University of Cologne, Prof. Paul van Loosdrecht
- 2013–2014 Graphic design and poster supervision for the Physical Colloquium
Department of Physics, University of Cologne
- 2013 Supervision of physics department website (physik.uni-koeln.de)
Department of Physics, University of Cologne

Computer Skills

- algebra Reduce with Excalc, Maple, Mathematica
- data analysis ROOT data analysis framework
- media \LaTeX , GIMP, Inkscape, Adobe InDesign, Adobe Premiere Pro, DaVinci Resolve 15
- programming BASIC, C, Java, Python
- office LibreOffice Writer, Calc, Impress; Microsoft Word, Excel, Powerpoint
- web HTML, CSS, PHP, JavaScript, Ajax, MySQL, jQuery, Typo3, webdesign

Other Interests

digital microcontroller electronics (see educational blog www.friendlywire.com), programming, collecting vintage vacuum “Nixie” tubes (see personal website www.jb-electronics.de), webdesign, piano (Boogie Woogie, Rock’n’Roll), ballroom dancing, running

Other Projects

- 2012 Development of data analysis software optoScale, RWTH Aachen University
- 2011–2012 Undergraduate Fund Project (\$5,000), RWTH Aachen University
Study and construction of gas discharge tubes at the I. Physical Institute B, Prof. Lutz Feld

Languages

English (fluent), German (native), French (basic), Latin (basic), Turkish (beginner)

References

Prof. Christopher D. Carone (cdcaro@wm.edu)

Postdoc advisor, William & Mary, Virginia, United States

Prof. Valeri P. Frolov (vfrolov@ualberta.ca)

Ph.D. supervisor, University of Alberta, Canada

Prof. David Kubiznak (dkubiznak@perimeterinstitute.ca)

M.Sc. mentor, Perimeter Institute for Theoretical Physics, Canada

Prof. Friedrich W. Hehl (hehl@thp.uni-koeln.de)

M.Sc. supervisor, Institute for Theoretical Physics, University of Cologne, Germany

Further information available upon request. Last update: September 2022