

### Research Interests

Modeling and constraining new physics at the intersection of high energy theory and gravity. 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, dark matter.

### 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.

### Submitted Papers

- S1. JB, Christopher D. Carone, Noah L. Donald, and Mikkie R. Musser, “Asymptotically safe dark matter with gauged baryon number,” 2209.14268 [hep-ph], submitted to Phys. Rev. D. Letters.

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## Publications

22. JB, Christopher D. Carone, Noah L. Donald, and Mikkie R. Musser, “Asymptotic safety and gauged baryon number,” *Phys. Rev. D* **106**, 035015 (2022); 2206.02686 [hep-ph].
21. JB and Christopher D. Carone, “Asymptotic non-locality in non-Abelian gauge theories,” *Phys. Rev. D* **105**, 035034 (2022); 2112.052701 [hep-ph].
20. JB and Christopher D. Carone, “Asymptotic non-locality in gauge theories,” *Phys. Rev. D* **104**, 095020 (2021); 2109.06261 [hep-th].
19. JB and Christopher D. Carone, “Asymptotic non-locality,” *Phys. Rev. D* **104**, 015028 (2021); 2104.11195 [hep-th].
18. JB and Ivan Kolář, “Non-locality and gravitoelectromagnetic duality,” *Phys. Rev. D* **104**, 024018 (2021); 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**, 105004 (2021); 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**, 136252 (2021); 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**, 045013 (2021); 2012.05347 [hep-th].
13. JB, “Angle deficit & non-local gravitoelectromagnetism around a slowly spinning cosmic string,” *Int. J. Mod. Phys. D* **29**, 2043027 (2020); 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**, 124065 (2020); 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**, 104008 (2019); 1909.01494 [hep-th].
10. JB, Valeri P. Frolov, and Andrei Zelnikov, “On thermal field fluctuations in ghost-free theories,” *Phys. Lett. B* **793**, 290 (2019); 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**, 076014 (2019); 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**, 907 (2018); 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**, 688 (2018); 1805.01875 [hep-th].
6. JB, “Gravitational Friedel oscillations in higher-derivative and infinite-derivative gravity?,” *Int. J. Mod. Phys. D* **27**, 1847022 (2018); 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**, 084021 (2018); 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**, 084015 (2018); 1801.00122 [gr-qc].

3. JB and Valeri P. Frolov, “Stationary black holes with stringy hair,” *Phys. Rev. D* **97**, 024024 (2018); 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**, 751 (2017); 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**, 1550079 (2015); 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. Review of “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*

*High Energy Theory Group, Department of Physics, William & Mary  
 Small Hall, 300 Ukrop Way, Williamsburg, VA 23187-8795, United States*

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- Springer Thesis Award (\$500)  
*Springer Nature, Switzerland*
- 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<sup>†</sup> graduates  
*Patron: prime minister of North Rhine-Westfalia, Germany*  
Manfred Lennings medal for best Abitur<sup>†</sup> grade  
*Rotary Club Oberhausen*
- <sup>†</sup>Diploma from German secondary schools qualifying for university admission or matriculation.

## Teaching Experience

- 2021 PHYS 581: Differential Geometry for Physicists  
Graduate course, William & Mary, <http://www.spintwo.net/Courses/>  
PHYS 101H: guest lecturer on black hole physics  
Undergraduate course, William & Mary
- 2020 Differential Geometry Student Meetings<sup>‡</sup>
- 2019 Black Hole Student Meetings<sup>‡</sup>  
Conformal Field Theory Student Meetings<sup>‡</sup>
- 2018 Gauge Theory Student Meetings<sup>‡</sup>  
Quantum Field Theory Student Meetings<sup>‡</sup>  
Graduate seminars, University of Alberta, <http://www.spintwo.net/Courses/>
- 2015 Geometry in Physics  
*Teaching assistant, graduate course, University of Cologne, Prof. Alexander Altland.*

*High Energy Theory Group, Department of Physics, William & Mary  
Small Hall, 300 Ukrop Way, Williamsburg, VA 23187-8795, United States*

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- 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.

## Attended Conferences and Schools

- 2022 Bad Honnef Physics School on Black Holes  
*Physikzentrum German Physical Society, Bad Honnef, Germany*
- 2021 16<sup>th</sup> 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*  
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 14<sup>th</sup> Marcel Grossmann Meeting  
*University of Rome (La Sapienza), Italy*  
DPG (German Physical Society) Spring Meeting  
*Technical University Berlin, Germany*
- 2014 569<sup>th</sup> 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

- Dec 2022 **Asymptotic safety and gauged baryon number**  
*Invited talk, Asymptotic Safety Seminars (online talk)*
- 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**  
*16<sup>th</sup> 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**  
*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 GRRR 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  
*14<sup>th</sup> 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– Physical Review D; Physics Letters B; Journal of Cosmology and Astroparticle Physics; General Relativity and Gravitation; International Journal of Modern Physics A; Symmetry; Universe
- 2021– Europhysics Letters
- 2019– European Physical Journal C
- 2018– International Journal of Modern Physics D; Zeitschrift für Naturforschung A
- 2016– Annals of Physics (Berlin)

## Memberships

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

## 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– 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](http://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](http://physik.uni-koeln.de))

*Department of Physics, University of Cologne*

## Computer Skills

algebra Mathematica, Maple, Reduce with Excalc

programming C, Java, Python, BASIC, FreeBasic

data analysis ROOT data analysis framework

media  $\LaTeX$ , GIMP, Inkscape, Adobe InDesign, Adobe Premiere Pro, DaVinci Resolve 15

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](http://www.friendlywire.com)), programming, collecting vintage vacuum “Nixie” tubes (see personal website [www.jb-electronics.de](http://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

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## Languages

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

## 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. Don N. Page (dpage@ualberta.ca)

*Ph.D. committee member, 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: November 2022