

# Jens Boos

## Curriculum Vitae

### 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, 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

23 publications,  $h_{\text{HEP}} = 11$ , Ph.D. thesis published in Springer Theses, 2 single-authored honorable mentions in the 2020 and 2018 Gravity Research Foundation Essay Competition, 1 book review, 42 talks (11 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 and Christopher D. Carone, “Asymptotically nonlocal gravity,” 2212.00861 [hep-th], submitted to JHEP.

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

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## Publications

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

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

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*Canadian Association of Physicists, Division of Theoretical Physics  
Winnipeg Institute for Theoretical Physics, Canada*

**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/>

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- 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.

## 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*

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## 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*

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

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- 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)



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## 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.*

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## 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*

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## 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

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## 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

## 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*

Further information available upon request. Last update: February 2023