# Michael P. Grehan

Canadian Inst	titute fo	r Theoretical	Astro-		
physics				Phone:	1(437) 422-4124
University of Toronto		Email:	michael.grehan@mail.utoronto.ca		
60 St. George S	Street, Ro	5000 1403			
Toronto, ON.					
M5S 3H8					
Canada					

# Education

2017-2022: Cumulative GPA: Major GPA:	B.S.c. Honours in Physics, Mathematical Specialization, University of Winnipeg 4.4813/4.5 4.5/4.5
2022 - 2023	MSc in Physics at the University of Toronto. Under the supervision of Spyros Alexakis.
GPA:	4.0/4.0
2023 - Present	PhD in Physics at the University of Toronto and the Canadian Institute for The- oretical Astrophysics (CITA). Under the supervision of Chris Thompson and Bart Ripperda.

\* Please note that the standard ordering of authors in THEP is alphabetical and that the ordering does not indicate the contributions of an author.

## Publications

\* A. R. Frey, M. P. Grehan and M. Srivastava, "Complexity of Scalar Collapse in Anti-de Sitter Spacetime," [arXiv:2110.09630 [hep-th]], published in the Journal of High Energy Physics

# Preprints

\* A. R. Frey, M. P. Grehan and P. Singh, "Holographic complexity of the Klebanov-Strassler background," [arXiv:2311.18804 [hep-th]]

## **Research Experience**

2024 Further developed a semi-analytical model for the tearing instability in the strong guide field regime which was extended to the case of a charged plasma. Numerical analysis of the instability in this regime is on going. Also began analysis of the tearing instability in the strong guide field regime via the GPU accelerated general-relativistic particle-in-cell (GRPIC) code entity.

- 2023 I developed a simple test for numerical resistivity in numerical ideal magnetohydrodynamics, by analysing the decay of a thin current sheet in a local box I showed that numerical resistivity does **not** act the same as an explicit resistivity as in resistive magnetohydrodynamics. Numerical diffusion due to finite resolution was found to be subdiffuse.
- 2023 Began my PhD under the supervision of Dr. Chris Thompson and Dr. Bart Ripperda. Explored interactions between current sheets in a local box with hopes to extend the results to a kinking flux tube originating from a magnetar. This work makes use of high precision relativistic resistive magnetohydrodynamic simulations using the black hole accretion code (BHAC) and an analytical model of the sheets which is being developed via linear perturbation theory in the strong guide field regime.
- 2023 For my masters thesis under the supervision of Dr. Spyros Alexakis I focused on the calculation of holographic entropy in specific spacetimes and recent proposals for calculating holographic entropy. I studied the entropy of various CFT configurations, and produced an original calculation for the CFT dual to a rotating three dimensional black hole. As well, I investigated a recent proposal for holographic entropy which claims to be equivalent to a long standing proposal and raised concerns about crucial flaws in significant proofs and definitions.
- 2022 My honour's thesis, under the supervision of Dr. Andrew Frey, focused on the calculation of holographic complexity in the Klebanov-Strassler solution. Our motivation was twofold: first the KS solution is a 10-dimensional spacetime allowing us to make use of the full dimensionality of string theory, and second the KS solution is dual to a confining field theory. For further details please see the resulting paper (arXiv:2311.18804).
- 2021 Accepted into the IPP Summer Student Program: Undergraduate Research Experience at CERN & in Canada. Through this program I was able to work with Dr. Ben Page and Dr. Samuel Abreu at CERN. Calculated the integration by parts relations (IBPs) for a given process, the master integrals of the process, and form a pure basis of master integrals which would allow us to solve the differential equations of the Feynman integral. (see here)
- 2021 Worked under Dr. Andrew Frey, now with the goal of further generalizing the holographic complexity calculation. Existing literature on the subject does not generally include the higher dimensions needed for a complete description of string theory. The summer was spent largely preparing for my honours thesis where we calculated the holographic complexity of the Klebanov-Strassler background.
- 2020 Worked under Dr. Andrew Frey, refining previous work and calculating complexity in QFT. Large portion of the summer was spent cleaning up the work from 2019 to prepare it for publishing (see arXiv:2110.09630).
- 2019 Worked under Dr. Andrew Frey calculating the holographic complexity of scalar collapse in AdS. Made use of general relativity to derive analytical equations and python to numerically solve for the complexity using the data from simulations of scalar collapse. Both volume and action forms were calculated.

2018 Worked under Dr. Russell Mammei developing coated guides for the UCN experiment at TRIUMF. I coated guides with multiple materials, and tested the coatings to determine their effectiveness. These coatings were performed on small scale guides, but a method for full size guides was developed.

## Awards

- 2024 Canada Graduate Scholarship-Doctoral (CGS D). NSERC offers the CGS D to the highestscored Postgraduate Scholarships-Doctoral (PGS D) applicants. Value: \$105,000 over 36 months.
- 2022 Chancellor's Gold Medal for the Highest Standing in Science (Honours). The medals are given to the students who secure the highest overall standing determined by the final grades obtained in the best 90 or 120 credit hours completed, as applicable, that satisfy degree requirements.
- 2022 Gold Medal for Achievement in a Major (Honours) Physics. This medal is awarded at Convocation to the student with the highest overall average in the major.
- 2021 Student of Highest Distinction, for achieving a sessional grade point average between 4.00 and 4.50.
- 2021 Academic Proficiency Scholarship (Winnipeg Rh Institute)
- 2021 Sir William Stephenson Scholarship awarded annually to one or two students who demonstrate outstanding academic achievement, superior leadership qualities on or off campus, and the potential to make a valuable contribution to Canada.
- 2021 Brian J. Hyslop Memorial Scholarship in Physics, awarded to a student enrolled at The University of Winnipeg in the honours degree in physics, recipients will have worked under the supervision of a faculty member in the Department of Physics on a research project, further consideration will also be given to students interested in pursuing a master's degree in physics.
- 2021 Randy Kobes Poster Contest Prize.
- 2021 IPP Summer Student Program: Undergraduate Research Experience at CERN & in Canada
- 2021 NSERC Undergraduate Student Research Award to work under the supervision of Dr. Andrew Frey.
- 2020 Student of Highest Distinction, for achieving a sessional grade point average between 4.00 and 4.50.
- 2020 Crawford Campbell Memorial Scholarship It will be awarded to a continuing student in the General, 4-year, or Honours Mathematics program of scholarly ability and entering Advanced Calculus (now known as Introduction to Mathematical Analysis).
- 2020 William L. Dyker Memorial Scholarship Awarded annually to a student who has completed 30 credit hours and is continuing at The University of Winnipeg in any undergraduate degree program.
- 2020 Chancellor W. John A. Bulman Scholarship Awarded to an outstanding student or students in any undergraduate degree program.
- 2020 Academic Proficiency Scholarship (Winnipeg Rh Institute)
- 2020 Randy Kobes Poster Contest Prize Awarded for placing first in the 15th Annual Randy Kobes Poster Symposium in the Math and Theoretical Physical Science section, presenting my summer 2020 research to a general public audience.
- 2020 Dr. Herbert Shubin Memorial Scholarship in Physics Awarded annually to the most promising student entering the final year of the 4-year Physics program.

- 2020 Manitoba Scholarship and Bursary Initiative Scholarship for the Fall/Winter 2019-20 academic year for academic excellence.
- 2020 NSERC Undergraduate Student Research Award to work under the supervision of Dr. Andrew Frey.
- 2019 Student of Highest Distinction, for achieving a sessional grade point average between 4.00 and 4.50.
- 2019 Academic Proficiency Scholarship (Herbert L. Draper Fund).
- 2019 Lawson Scholarship in Mathematics, awarded to a student of outstanding academic promise who is entering or continuing Major work in the Mathematics Major at The University of Winnipeg.
- 2019 Brian J. Hyslop Memorial Scholarship in Physics, awarded to a student enrolled at The University of Winnipeg in the honours degree in physics, recipients will have worked under the supervision of a faculty member in the Department of Physics on a research project, further consideration will also be given to students interested in pursuing a master's degree in physics.
- 2019 Isbister Undergraduate Scholarship, two scholarships are offered to two top students in Arts and two to two top students in Science.
- 2019 Rev. John H. and Mrs. Myrtle (Webster) Shemilt Scholarship, awarded annually to a full-time student in any undergraduate degree program of The University of Winnipeg. Preference will be given to student from Manitoba or northwestern Ontario.
- 2019 NSERC Undergraduate Student Research Award to work under the supervision of Dr. Andrew Frey.
- 2018 Sandra and Harvey Secter Scholarship, awarded to one or more outstanding students in any Faculty who demonstrate a commitment to their community.
- 2018 Henry Doidge Memorial Scholarship in Physics, awarded to a student with standing in first year Physics who is entering the second year of the Physics Major program.
- 2018 Donald S. Grant Memorial Scholarship for Excellence in Mathematics, given to a continuing student in Mathematics and Statistics who has attained a high standing in 6 credit hours of introductory calculus.
- 2017 Crystal Lake Developers, Ltd. Award, for outstanding marks in both Pre-Calculus and Physics.
- 2017 Casera Credit Union Limited Bursary.
- 2017 Oakbank Credit Union Peer Tutor Recognition Award, for tutoring peers in mathematics.
- 2017 Special Entrance Scholarship, for having an average greater than 95 between Pre-Calculus, English, and one other course.

#### Accomplishments

- 2024 Accepted into and attended the Simons Collaboration on Extreme Electrodynamics of Compact Sources (SCEECS) Summer School.
- 2021 Placed third in the 16th Annual Randy Kobes Poster Symposium in the Math and Theoretical Physical Science section, presenting my summer 2021 research with CERN to a general public audience.
- 2021 Spoke on behalf of the science department at the 2021 University of Winnipeg Awards Night of Excellence.
- 2020 Competed in the University Physics Competition in the Fall of 2020, and received a bronze medal. Of the 346 teams that competed, 99 teams (29%) were ranked as Bronze Medal Winners.
- 2020 Held a 20 minute virtual seminar at the 2020 Winnipeg Institute for Theoretical Physics annual Summer Student Symposium, where I presented my 2019/2020 research to a group of theoretical physicists and research students.
- 2020 Placed first in the 15th Annual Randy Kobes Poster Symposium in the Math and Theoretical Physical Science section, presenting my summer 2020 research to a general public audience.
- 2019 Presented at the Summer Student Colloquium, where I shared my work experience from summer 2019 to encourage other students to participate in summer research.
- 2019 Competed in the University Physics Competition in the Fall of 2019, and received a silver medal. Of the 305 teams that competed, 60 teams (20%) were ranked as Silver Medal Winners.
- 2019 Competed in the 14th Annual Randy Kobes Poster Symposium in the Math and Theoretical Physical Science section, presenting my summer 2019 research to a general public audience.
- 2019 Presented at the NSERC USRA Celebration Luncheon, where I gave a brief presentation explaining the research I had conducted during the summer.
- 2018 Competed in the University Physics Competition in the Fall of 2018, and received a silver medal. Of the 281 teams that competed, 50 teams (18%) were ranked as Silver Medal Winners.

## Work Experience

#### University of Toronto

2024	TA for PHY151: Foundations of Physics I.
2024	TA for PHY152: Foundations of Physics II.
2023	TA for PHY131: Introduction to Physics I.
2023	TA for PHY132: Introduction to Physics II.
2022	TA for PHY131: Introduction to Physics I.

#### University of Winnipeg

2019-2022	TA for PHYS-1101:	Foundations of Physics.
2022	TA for PHYS-3301:	Quantum Mechanics.
2021	TA for PHYS-2105:	Mathematical Physics I.
2021	TA for PHYS-3403:	Thermal and Statistical Physics.
2021	TA for PHYS-3203:	Advanced Mechanics.
2020	TA for PHYS-3202:	Intermediate Mechanics.
2020	TA for PHYS-2302:	Modern and Thermal Physics.
2019	TA for PHYS-2201:	Electricity and Magnetism.
2018-2019	TA for PHYS-1301:	Introduction to Physics.

# Student Involvement

2020-2022	Elected Vice President of the University of Winnipeg Physics Student Association (UW-
	PSA).
2017-2022	Member of UWPSA.
2017-2018	Member of the UWPSA Treasury Committee.

# Media Appearances

2022 Physics Grad Wins Prestigious Scholarship, 2022 Sir William Stephenson Scholar.

Last updated: September 11, 2024