PHILIP ADAM LEMAITRE

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University of Innsbruck, Institute for Theoretical Physics

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EDUCATION

University of Innsbruck, Austria. *July 2023 - Present*
Ph. D. Physics
Graduating Thesis:
Supervised by Hans J. Briegel

University of Waterloo, Canada. *Sep. 2020 - Oct. 2022*
M.Sc. Physics
Nominated for the Dean of Science award
Graduating Thesis: "Atomic Shell Structure in a Ring Polymer Formulation of Orbital-Free Density Functional Theory"
Supervised by Russell B. Thompson

University of Guelph, Canada. *Sep. 2015 - Feb. 2020*
B.Sc., Honours - Theoretical Physics
Recognized on the Dean's Honours List (2017-2020)
Graduating Thesis: "An Analysis of the Equilibrium Configurations and Stability of Thin Spherical Matter Shells in Relativistic and Newtonian Gravity"
Supervised by Eric Poisson

RESEARCH INTERESTS

- **Artificial intelligence and machine learning**
- **Relativistic quantum information**
- **Quantum foundations and contextuality**
- **Quantum gravity**
- **Philosophy of agency**

RESEARCH EXPERIENCE

Doctoral Thesis, Institute for Theoretical Physics, University of Innsbruck *July 2023 - Present*
Supervised by Hans J. Briegel

Master's Thesis, Department of Physics and Astronomy, University of Waterloo *Sep. 2020 - Aug. 2022*
Supervised by Russell B. Thompson
"Atomic Shell Structure in a Ring Polymer Formulation of Orbital-Free Density Functional Theory": Using a classical self-consistent field-theoretic model of ring polymers in 3+1 dimensions, which my supervisor showed was equivalent to quantum density functional theory in 3 dimensions, I was able to successfully predict the spontaneous emergence of shell structure and symmetry-breaking in neutral atoms up to neon — without the use of atomic orbitals. After having employed partial atomic shell information and a spherical-averaging approximation, I further extended the results to encompass all atoms on the periodic table and showed that the predicted binding energies were within 3% of the Hartree-Fock values up to krypton, and within 10% up to radon; a novel, exact self-interaction correction that I helped to implement meant that the model was equivalent to Hartree-Fock theory. To accomplish these goals I developed

the spectral representation of the model equations for general non-orthogonal basis functions and designed a computer program to numerically solve the spectral equations self-consistently using angular Gaussian basis functions in particular. (Access thesis here)

Bachelor's Thesis, Department of Physics, University of Guelph *Sep. 2018 - June 2019*
Supervised by Eric Poisson
"An Analysis of the Equilibrium Configurations and Stability of Thin Spherical Matter Shells in Relativistic and Newtonian Gravity": I worked closely with my supervisor to develop a simplified stellar model of compact stars based on thin spherical shells in both relativistic and Newtonian gravity, finding the equilibrium sequences and conditions on the equation of state that connect the vanishing of the mass derivative with the onset of unbounded shell expansion/contraction after small perturbations. Two distinct cases emerged: the unstable case mentioned above and the stable case, which predicted small shell oscillations. I also developed a numerical integration routine to solve the full equations of motion for the shell, producing simulations of a stable configuration and an unstable configuration evolving into a black hole. This model demonstrates the connection between the maximum mass of a neutron star and the onset of dynamical instability leading to the formation of a black hole, using accessible techniques to introductory students of general relativity.

PROFESSIONAL WORK EXPERIENCE

Expert AI Data Trainer in Mathematics, Invisible Technologies *Oct. 2022 - Sep. 2023*

- Used a combination of knowledge on pedagogy and advanced mathematics to evaluate and train natural language-based artificial intelligence engines to solve mathematical problems
- Proactively outlined new research directions for the client and created process documentation
- Helped to onboard/mentor new team members, creating demonstration videos and workflow documentation for them
- Helped create quality control processes for the team and other prospective clients, along with metrics to benchmark model performance
- Worked collaboratively with a small team of experts whose work aided the client in launching one of the biggest public artificial intelligence products

TEACHING EXPERIENCE

Mathematics and Physics Tutor, Paper Tutoring *Sep. 2022 - Mar. 2023*

- Tutored students from elementary to high school level in all areas of mathematics and physics covered before university. Responsibilities included planning and preparing exercises, completing student progress reports, and interacting with prospective clients.

Teaching Assistant, University of Waterloo *Sep. 2020 - Aug. 2022*

- PHYS 111 - Physics I
  - Responsibilities: proctoring examinations, supervising student groups, leading tutorials, grading assignments, moderating student question and answer forum via Discord
- NE 216 - Advanced Calculus and Numerical Methods I
  - Responsibilities: grading tests and office hours
- PHYS 233 - Introduction to Quantum Mechanics
  - Responsibilities: supervising student groups, leading tutorials, office hours, grading assignments and student progress reports
- PHYS 256L - Optics Laboratory
  - Responsibilities: grading lab reports and final projects, virtual office hours via Piazza
- PHYS 442 - Electricity and Magnetism III

   – Responsibilities: grading assignments

Mathematics Tutor, University of Guelph   *Sep. 2019 - June 2020*

- Tutored students in undergraduate linear algebra, calculus, advanced calculus, and differential equations. Responsibilities included planning and preparing exercises.

EXTRACURRICULAR AND VOLUNTEER EXPERIENCE

Content Contributor, SymPy - Computer Algebra Package in Python   *Sep. 2022 - Present*

- Contributed an algorithm to the physics submodule in SymPy that computes the integral of three real spherical harmonics.
- Currently working on a number of other codes in the quantum physics section.

Peer Mentoring, University of Guelph and University of Waterloo   *Sep. 2017 - Sep. 2022*

- Assisted fellow students with their understanding of course material through explanation and problem solving guidance.
- Offered physics-related career advice to fellow students and connected them with helpful resources.

HONOURS AND AWARDS

IODE Gladys Raiter Bursary for Graduate Study   *Oct. 2021*
Awarded to graduate students with ties to Waterloo region and with high overall academic standing in their program. Valued at 5000 CAD.

Science Graduate Award   *Sep. 2020 - Aug. 2022*
Awarded to full-time thesis-based graduate students at the University of Waterloo. Valued for at least 1500 CAD per term.

Marie Curie Graduate Student Award   *Sep. 2020 - Aug. 2022*
Awarded for academic excellence during graduate study at the University of Waterloo. Valued for at least 800 CAD per term.

Graduate Research Studentship   *Sep. 2020 - Aug. 2022*
Awarded to aid thesis-based graduate students at the University of Waterloo in the completion of their thesis. Valued for at least 2285 CAD per term.

Linda S. Allen Memorial Graduation Prize   *June 2020*
Awarded for overcoming significant obstacles and remaining in good academic standing during the completion of a bachelors degree at the University of Guelph. Valued at 1000 CAD.

Eglestaff Scholarship   *Mar. 2019*
Awarded for academic excellence during the third year of undergraduate study at the University of Guelph. Valued at 750 CAD.

SKILLS

Research Skills

- Mathematical modelling and numerical analysis
- Scientific computing
- Analytical and numerical approach to problem-solving
- Scientific written and oral communications
- Detail-oriented and highly organized

Computing Skills

- Programming languages: Python (proficient), LaTeX (proficient), Fortran (novice)
- Operating systems: Microsoft Windows (proficient), MacOS (proficient), Ubuntu Linux (novice)
- Maintain personal GitHub repository containing quantum chemistry and machine learning programs

PUBLICATIONS

P. A. LeMaitre, "Harvesting Contextuality from the Vacuum". *Phys. Rev. D* 113, 045001 (2026).

P. A. LeMaitre, T. R. Perche, M. Krumm, and H. J. Briegel, "Universal Quantum Computer from Relativistic Motion". *Phys. Rev. Lett.* 134, 190601 (2025).

M. A. Kealey, P. A. LeMaitre, and R. B. Thompson, "Fermion exchange in ring polymer quantum theory". *Phys. Rev. A* 109, 052819 (2024).

P. A. LeMaitre, M. Krumm, and H. J. Briegel, "Multi-Excitation Projective Simulation with a Many-Body Physics Inspired Inductive Bias". *Artificial Intelligence* 352, 104489 (2026).

P. A. LeMaitre and R. B. Thompson, "On the Origins of Spontaneous Spherical Symmetry-Breaking in Open-Shell Atoms Through Polymer Self-Consistent Field Theory". *J. Chem. Phys.* 158, 064301 (2023).

P. A. LeMaitre and R. B. Thompson, "Gaussian Basis Functions for a Polymer Self-Consistent Field Theory of Atoms". *Int. J. Quantum Chem.* 123(12), e27111 (2023).

P. LeMaitre and E. Poisson, "Equilibrium and stability of thin spherical shells in Newtonian and relativistic gravity". *Am. J. Phys.* 87, 961-970 (2019).

PRESENTATIONS

Talks:

LeMaitre, Philip A.. "A Universal Quantum Computer From Relativistic Motion".
15th Relativistic Quantum Information North Conference, University of Naples Federico II, Napoli, Italy *June. 2025*

LeMaitre, Philip A.. "Physical Characteristics and Manifestations of Agents".
Innsbruck-Konstanz-Hannover Meeting on Physics and Philosophy, Maria Waldrast, Austria *Sep. 2024*

LeMaitre, Philip A.. "A Universal Quantum Computer From Relativistic Motion".
14th Relativistic Quantum Information North Conference, Charles University, Prague, Czechia *Aug. 2024*

LeMaitre, Philip A.. "A Multi-Excitation Projective Simulation Agent".
DPG Spring Meeting 2024, TÜ Berlin, Berlin, Germany *Mar. 2024*

LeMaitre, Philip A.. "Spontaneous Spherical Symmetry-Breaking in Open-Shell Atoms Through Polymer Self-Consistent Field Theory".
36th Symposium on Chemical Physics, University of Waterloo, Waterloo, Canada *Nov. 2022*

LeMaitre, Philip A.. "Atomic Shell Structure in a Polymer-Based Approach to Orbital-Free Density-Functional Theory".
2022 Canadian Association of Physicists Congress, McMaster University, Hamilton, Canada *June 2022*

LeMaitre, Philip A.. "Thin-Shells as Neutron Stars: A Simple Stellar Model With Great Insight".
Canadian Undergraduate Physics Conference 2019, McGill University, Montreal, Canada *Nov. 2019*

Posters:

LeMaitre, Philip A.. "A Universal Quantum Computer from Relativistic Motion".
QISS 2025 Conference, University of Vienna, Vienna, Austria *April 2025*

LeMaitre, Philip A.. "Quantum Multi-Excitation Projective Simulation".
6th Seefeld Quantum Information Workshop, Wellnesshotel Schönruh, Seefeld, Austria *June 2024*

LeMaitre, Philip A.. "Towards a Multi-Excitation Projective Simulation Agent".
Innsbruck-Konstanz Meeting on Physics and Philosophy, Lamm Hotel, Bregenz, Austria *Sep. 2023*

AFFILIATIONS

- Regular member of the Canadian Association of Physicists *Oct. 2022 - Oct. 2023*
- Graduate member of the Canadian Association of Physicists *Nov. 2020 - Oct. 2022*
- Undergraduate affiliate member of the Canadian Association of Physicists *Nov. 2019 - Nov. 2020*