# MICHAEL GENNARI

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**Current Address**
5-195 Erb Street West
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## RESEARCH INTERESTS

Nuclear many-body problem, *ab initio* nuclear models (no-core shell model), low-energy quantum chromodynamics (QCD), chiral effective field theory, particle physics, machine learning

## EDUCATION

**Candidate for Bachelor of Science –** *University of Waterloo, Waterloo ON 2014 - present*
Honours Co-operative Mathematical Physics
- **Relevant Courses:** Introduction to Particle Physics, Quantum Theory 2, Quantum Physics 3, Introduction to Groups, Introduction to Quantum Information Processing, Quantum Physics 2
- **Research Project:** Ongoing research project in machine learning and the nuclear many-body problem with Dr. Petr Navrátil and Dr. Roger Melko

## SUMMARY OF QUALIFICATIONS

- Degree in mathematical physics contained a heavy focus on theoretical physics, with additional pursuit in pure mathematics and advanced quantum theory
- Involved with TRIUMF for upwards of a year, performing work in the theory group under Dr. Petr Navrátil on nuclear density and applications from *ab initio* (first principles) theory
- Collaborated with Dr. Matteo Vorabbi at TRIUMF and first authored two manuscripts as a direct result of work on nuclear density in the no-core shell model
- Currently working on an undergraduate research project with Dr. Petr Navrátil and Dr. Roger Melko focused on machine learning and its applications to the nuclear many-body problem
- Received award from the Canadian Institute of Nuclear Physics (CINP), put towards travel expenses for presenting work completed at TRIUMF
- Proficiency as an educator achieved through direct tutoring and volunteering positions

## PUBLICATIONS

**Microscopic optical potentials derived from *ab initio* translationally invariant nonlocal one-body densities**
> *Michael Gennari, Matteo Vorabbi, Angelo Calci, and Petr Navrátil. Phys. Rev. C 97, 034619 (2018).*

**Kinetic density from *ab initio* theory**
> *Michael Gennari and Petr Navrátil. arXiv:1808.10537 (2018).*

# RESEARCH EXPERIENCE

**TRIUMF, Theory Group –** Vancouver, BC Canada
**Researcher in Theoretical Nuclear Physics –** January 2017 to present
**Supervisor –** Dr. Petr Navrátil

- Derived and implemented a translationally invariant (centre-of-mass free) nonlocal nuclear density in the no-core shell model (NCSM), to be used in improving predictions of nuclear reactions and comparisons with density functional theory (DFT)
- Collaborated with Dr. Matteo Vorabbi at TRIUMF by using nonlocal nuclear density to produce accurate and more consistent optical potentials for nuclear reactions involving light nuclei
- Obtained an analytic expression for the nuclear kinetic density, an input of DFT derived from nuclear density, to view amplified effects of translational invariance and to allow communities to compare centre-of-mass removal techniques across different many-body methods
- Constructed natural nucleon orbitals and subsequently an orthogonal transformation using the one-body density matrix, improving convergence of traditional NCSM calculations in exotic nuclei
- Performed analysis on modern two- and three-nucleon chiral effective field theory interactions

**University of Waterloo, Department of Physics and Astronomy –** Waterloo, ON Canada
**Research Project in Machine Learning and the Many-Body Problem –** September 2018 to present
**Supervisor –** Dr. Roger Melko

- Working on training recurrent neural networks (RNNs) to improve infinite basis extrapolation results for nuclear properties, such as the ground state energy of nuclear systems
- Attempting to use machine learning in conjunction with natural orbitals to further improve convergence trends in nuclear many-body calculations

# AWARDS AND HONOURS

**Student Travel Award from Canadian Institute of Nuclear Physics, 2018** – *University of Waterloo*
- Presented a research award of 500.00 CAD by the Canadian Institute of Nuclear Physics towards travel to the Canadian Undergraduate Physics Conference 2018 (CUPC)

**President's Scholarship of Distinction, 2015** – *University of Waterloo*
- Presented an academic scholarship of 2000.00 CAD by the University of Waterloo with additional funding for research within the Department of Physics and Astronomy

**Dean's Honours List, 2015** – *University of Waterloo*
- Achieved status on the Dean's Honours list in 2015

**Distinction in Science, 2014 –** *Saltfleet District High School*
- Provided an academic scholarship of 400.00 CAD towards university education

**Distinction in Mathematics, 2014** – *Saltfleet District High School*
- Provided an academic scholarship of 300.00 CAD towards university education

## CONFERENCES, WORKSHOPS AND PRESENTATIONS

**Canadian Undergraduate Physics Conference (University of Alberta, Canada – August, 2018)**
- Obtained one of four 500.00 CAD student travel awards from the Canadian Institute of Nuclear Physics to attend the largest undergraduate conference in North America

**Data Science and Quantum Computing Workshop (TRIUMF, Canada – June, 2018)**
- Attended a workshop dedicated to exploring how machine learning and quantum computing can be used to enhance research output in high performance and large-scale computing

**WestGrid Research Computing Summer School (University of British Columbia, Canada – June, 2018)**
- Summer school covering introductory and advanced topics in high performance computing, parallel programming (FORTRAN, C, Python), parallelization with CUDA, and scientific visualization

**10th International Conference on Direct Reactions with Exotic Beams (Matsue, Japan – June, 2018)**
- Presented poster on nuclear density from *ab initio* theory at DREB 2018, a conference devoted to the latest experimental and theoretical research in nuclear reactions with exotic nuclei

**Nuclear Science Summer School (Michigan State University, U.S.A. – May, 2018)**
- Summer school covering introductory topics in nuclear physics such as experimental techniques, modern detectors, and recent advancements in theoretical work

**Progress in Ab Initio Techniques in Nuclear Physics (TRIUMF, Canada – February, 2017 and 2018)**
- Attended and presented at TRIUMF workshop focused on new developments in *ab initio* nuclear theory, with focuses on progress in first-principles nuclear structure and reaction calculations

**American Physical Society Division of Nuclear Physics (Pittsburgh, U.S.A. – October, 2017)**
- Presented work during the conference experience for undergraduates (CEU) aimed at students who conduct research in nuclear physics, allowing for the display of research to a professional community

**Advisory Committee on TRIUMF Theory Group Session (TRIUMF, Canada – W2017, F2018, W2018)**
- Theory group presentation to National Research Council of Canada on nonlocal nuclear density and nuclear kinetic density

## TEACHING AND VOLUNTEER EXPERIENCE

**Department of Physics and Astronomy, University of Waterloo –** September 2015 to present
**Physics Interconnected Mentor**
- Volunteered in the Department of Physics and Astronomy by assisting with a first-year mentorship and tutoring program for incoming physics majors
- Met on a weekly basis with multiple students for several hours to provide academic and community support

**Guelph - Humber Math Centre –** January 2016 to April 2016
**Math Centre Staff**
- Worked as a mathematics, physics, and engineering tutor to convey challenging concepts in academia during both one on one and group tutoring sessions at the Math Centre
- Collected data on the effectiveness of math centre tutoring and advertising strategies to determine the most effective teaching and promotion techniques

## TECHNICAL SKILLS

- Knowledge of high performance scientific computation and parallelization (OpenMP and MPI) techniques using FORTRAN
- Additional experience with data science and visualization in Python, minor experience with R
- Experienced with utilizing external computing grids for calculations, such as Oak (University of British Columbia), Cedar (Simon Frasier University), and Cougar (TRIUMF)
- Proficient with shell scripting and Linux based operating systems
- Fluent in LaTeX
- Other minor experience includes HTML, CSS, JavaScript (with AngularJS framework), and C++

## CURRENT VISITOR STATUS

- **TRIUMF, Theory Group** in Vancouver, Canada
- **Perimeter Institute** in Waterloo, Canada

## ACADEMIC REFERENCES

- **TRIUMF, Theory Group** in Vancouver BC
  - Dr. Petr Navrátil: navratil@triumf.ca
  - Dr. Matteo Vorabbi: mvorabbi@triumf.ca
  - Dr. Anna McCoy: amccoy@triumf.ca
- **Perimeter Institute and University of Waterloo** in Waterloo ON
  - Dr. Roger Melko: rgmelko@uwaterloo.ca