ASHIFUL BHUIYAN

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Toronto, ON

SUMMARY

Dedicated professional with a robust foundation in mathematical physics and computational methods. Experienced in numerical modeling, simulation-based research, and machine learning applications in physics. Proven ability to lead academic initiatives, demonstrated by co-founding a successful tutoring business. Skilled in data analysis, scientific computing, and technical communication. Committed to advancing knowledge through rigorous analysis, innovative research, and collaborative problem-solving.

RESEARCH FOCUS

Primary interest in **Computational Physics** and **Numerical Relativity**, with a focus on developing high-order numerical solvers for partial differential equations in complex systems. Experienced in implementing **Spectral Element Methods (SEM)** and finite difference schemes to model wave propagation and fluid dynamics. Additional expertise in **Scientific Machine Learning**, specifically in neural network architectures, reinforcement learning, and statistical data analysis for complex systems.

EDUCATION

McMaster University — Hamilton, ON
M.Sc. in Physics — Sept 2025 – *In Progress*
Selected Coursework: Topics in Numerical Analysis **(A+)**, Computational Physics **(A+)**, Advanced Quantum Mechanics (B+)

York University — Toronto, ON
Non-degree Studies — Sept 2024 – June 2025
Selected Coursework: Data Science **(A+)**, Elementary Particle Physics (B+), Mathematical Statistics (B+)

Trent University — Peterborough, ON
Honors B.Sc. in Mathematical Physics — May 2019
Minor in Biology
Selected Coursework: Advanced Numerical Methods **(A)**, Electromagnetic Theory **(A)**, Statistical Mechanics (A-), Advanced Classical Mechanics (A-), Combinatorics (A-)

TEACHING AND LEADERSHIP EXPERIENCE

Gifted Center — Toronto, ON
Director & Co-founder — *Sept 2024 – Present*

- Founded and lead a STEM education organization, managing digital outreach and curriculum development for high school and university students.
- Designed academic programs and resources across mathematics, physics, and science curricula.
- Designed custom lesson plans and learning strategies targeting conceptual gaps, helping students improve from failing grades to the 80-100%
- Delivered personalized teaching in university level mathematics and physics, ranging from introductory calculus to advanced classical mechanics.
- Designed customized learning strategies focused on enhancing analytical problem-solving skills, mathematical reasoning, and conceptual understanding in STEM subjects.

PROJECTS

Implementation of Spectral Element Method (SEM) for PDE Solvers
Course Project: Topics in Numerical Analysis (Dr. B. Protas)
Implemented a high-order Spectral Element Method solver in Python from scratch to solve Poisson and Wave equations. Constructed global mass and stiffness matrices using Gauss-Lobatto-Legendre (GLL) quadrature and Lagrange polynomial basis functions. Applied weak formulation and direct stiffness summation to handle element connectivity. Implemented a Leapfrog time-stepping scheme for the wave equation and performed rigorous error analysis, verifying exponential convergence (spectral accuracy) against exact solutions
github.com/AshifulBhuiyan/Spectral-Element-Method

Numerical Gravity: Geodesic Simulations in General Relativity
Course Project: Computational Physics (Dr. A. Shi)
Developed a Python-based symplectic integrator to model particle geodesics in Schwarzschild spacetime. Derived the effective potential from the metric and implemented Brent's method to determine initial conditions for specific orbital geometries. Conducted a comparative stability analysis between RK4 and Velocity Verlet algorithms, demonstrating the necessity of symplectic integration for long-term energy conservation in Hamiltonian systems. Validated the model by reproducing the anomalous perihelion precession of Mercury, confirming second-order post-Newtonian corrections absent in standard theoretical approximations.
github.com/AshifulBhuiyan/Geodesic-Simulation-GR

Natural Convection in Multi-Component Fluid Mixtures
Research Project Advisor: Prof. M.D. Rahman (York University)
Developed a Python toolkit to simulate 2D natural convection in rectangular enclosures for clear fluids and porous media. Work focused on extending the vorticity-streamfunction solver to handle **n-component mixtures**, incorporating **Concentration Rayleigh**, **Schmidt**, and **Soret numbers** into the momentum and mass transfer equations. Implemented and visualized exact analytical solutions for temperature and concentration fields in elliptical domains to verify numerical schemes.
github.com/AshifulBhuiyan/Natural-Convection-Enclosure

Music Popularity Prediction from Spotify Audio Features
Course Project: Data Science (Dr. J. Diaz-Rodriguez)
Developed models to estimate the popularity of songs using over 2 million entries from the Spotify API. Applied data cleaning, clustering, and feature engineering to extract signals from audio features (e.g., tempo, loudness). Benchmarked models including AdaBoost, Random Forest, and Neural Networks; achieved 86% recall on top-performing tracks. Integrated a pricing tool to estimate royalties based on the predicted popularity.
huggingface.co/ConquestAce/Spotify-Popularity-Predictor

Two-Body Decay Simulation (π^0)
Course Project: Elementary Particle Physics (Dr. N. Blinov)
Simulated the decay process $\pi^0 \to \gamma\gamma$ using Python. Generated synthetic data using a uniform distribution and applied two-body kinematic analysis in both rest and lab frames. Used these results to explore momentum conservation and relativistic invariance.
github.com/AshifulBhuiyan/Two-Body-Decay

Collider Event Analysis – Estimating Neutrino Species
Course Project: Elementary Particle Physics (Dr. N. Blinov)
Analyzed proton-proton collision data to estimate the number of neutrino species. Processed datasets using Python to reconstruct missing energy and mass distributions. Applied statistical techniques to fit energy spectra and infer the number of undetectable decay products based on conservation laws.
github.com/AshifulBhuiyan/Analyzing-Collider-Events

EXTRA-CURRICULAR

Gzowski College Cabinet 2015-2018
Sustainability Ambassador *Peterborough, ON*

- Led campus-wide sustainability initiatives and mandatory risk-assessment training while collaborating with cross-disciplinary student teams to promote environmental awareness.

Kawartha Muslim Religious Association 2017-2018
Media Coordinator *Peterborough, ON*

- Produced digital media, managed website content, and organized outreach events to enhance community engagement.