

Om Arora

Researcher in Theoretical Physics & Mathematics · Quantitative Developer

omarora3747@gmail.com | +91-9971389828 | Delhi, India

omarora.in | linkedin.com/in/omarora | ORCID: 0009-0007-4151-7945 | ResearchGate

PROFILE

High school researcher working at the intersection of theoretical physics, pure mathematics, and quantitative finance. Published work addresses foundational problems in Yang-Mills gauge theory and quantum gravity. Active contributor to the AIMO3 AI-for-mathematics competition. Pursuing research in topological data analysis applied to financial markets and in software-defined defence protocol architectures. Seeking advanced research programmes and quantitative internships that reward rigorous cross-disciplinary thinking.

PUBLICATIONS

Yang-Mills Theory with a Scalar Field: A Unified Model for Confinement and Mass Gap · *IJRES* 2023
Scalar field extension to the Yang-Mills Lagrangian addressing the mass gap problem (Clay Millennium Prize). Proposes a mechanism generating dynamical gauge boson mass while preserving classical gauge invariance.

Quantum Geometric Entanglement Theory: A Unified Model for the Emergence of Spacetime · *IJRES* 2023
Quantum information framework in which spacetime geometry emerges from entanglement structure of fundamental quantum degrees of freedom, bridging quantum mechanics and general relativity.

A Gauge-Invariant Stueckelberg Extension of Yang-Mills Theory · *Preprint* 2026
Stueckelberg mechanism for non-Abelian Yang-Mills theory generating gauge boson mass without spontaneous symmetry breaking. Constructs BRST cohomology; Stueckelberg scalar decouples in the massless limit recovering standard Yang-Mills.

A Software-Defined Protocol Translation Architecture for Multi-Domain Defence Asset Integration · *Manuscript in Preparation* 2026
Addresses interoperability between MIL-STD-1553B avionics and STANAG 4586 unmanned systems. Three contributions: (1) gap analysis of 49 field-level incompatibilities; (2) software-defined middleware using a protocol-agnostic Common Internal Representation (CIR) reducing translation complexity from $N(N-1)$ pairwise paths to $2N$ adapter implementations; (3) simulation-based validation via asyncio

Topological Methods for Financial Market Analysis · *Manuscript in Preparation* 2026
Topological Fragmentation Index (TFI) derived from persistent homology of rolling equity correlation networks as a cross-sectional alpha factor. Statistically significant in Fama-MacBeth regressions on the S&P 500 with walk-forward validation and multiple testing correction.

RESEARCH EXPERIENCE

AI for Mathematical Olympiads — AIMO3 Team Member · *STEMvibe Foundation* Jan 2026 – Present | Remote

- Contributing to a team of 20 mathematicians and developers building an open-source AI capable of solving IMO-level problems with fully verifiable proofs.
- Working on the AIMO3 Kaggle competition solving 110 original problems at National-to-International Olympiad standard.
- Developing Dataset as well as the LaTeX-parsing and agentic AI systems integrated with symbolic reasoning engines.
- Hands-on experience with H100 GPU infrastructure, large-scale distributed training, and frontier AI reasoning research.

Independent Researcher — Theoretical Physics & Applied Mathematics · *Self-Directed* May 2023 – Present | New Delhi

- **Yang-Mills / gauge theory:** scalar field extension and Stueckelberg mechanism for non-Abelian mass generation; published in *IJRES* and preprint.
- **QGET:** entanglement-based framework for emergence of spacetime geometry; published *IJRES* 2023.
- **Defence systems:** software-defined protocol translation for MIL-STD-1553B and STANAG 4586; manuscript in preparation 2026.
- **Topological finance:** Topological Fragmentation Index via Vietoris-Rips persistent homology on equity correlation networks; manuscript in preparation 2026.
- Self-study: Tong's Cambridge QFT and GR; Nakahara *Geometry, Topology, and Physics*; Shreve *Stochastic Calculus for Finance I & II*; Hatcher *Algebraic Topology*.

TECHNICAL PROJECTS

- TESS Light Curve Analysis Pipeline** · github.com/Vector-Pi/tess-pipeline 2025
- BLS transit search, 8-parameter MCMC fitting (batman + emcee), GP detrending, TTV analysis. Validated on Pi Mensae c and WASP-126b. 25 offline tests passing.
- CMB Power Spectrum Analysis with Planck 2018 Public Data** · github.com/Vector-Pi/cmb-planck 2025
- SMICA map download, TT/EE/BB spectra with f_{sky} correction, CAMB Λ CDM comparison, $n_s/H_0/\Omega_b h^2$ sensitivity study. 39 offline tests.
- Variable Star Light Curve Classifier** · github.com/Vector-Pi/varstar-classifier 2025
- Lomb-Scargle period estimation, Fourier decomposition (R_{21} , R_{31} , ϕ_{21}), random forest classification across 6 variable star classes. 60 offline tests.
- HydroCure — IoT Edema Management System** · *Team Lead* 2023
- Sensor-based edema monitoring device. Top 10 nationally; selected for Indo-Nepal Science Exhibition.
- Sudarshana — ML Border Monitoring System** · *Developer* 2023
- RFID and deep neural network system for real-time trespass detection. Top 100, Avishkaar Makeathon Nationals 2023; Finalist, IIT Delhi Hackathon 2023.

EDUCATION

- High School** · *Junior Year (Class of 2026)* 2025 – Present | India
- Preparing for JEE 2027.
 - AP Calculus BC (Expected 5) · AP Physics C: Mechanics (Expected 5) · AP Chemistry (Expected 5).
 - Student Ambassador, Neurotitan & National Student Research Institution (NSRI).
- Adarsh Public School — Class X (CBSE)** · *Distinction in Mathematics and Science* 2024 – 2025 | Delhi, India
- OTIS 2025 — Selected Participant, Dr. Evan Chen (MIT)** 2025
- Highly selective advanced mathematical olympiad training programme.*
- Associate, Atal Innovation Mission** · *Government of India* Jun 2020 – Mar 2025 | Delhi
- Established and managed school Atal Tinkering Lab (ATL). Mentored 150+ peers. Led teams to national and international exhibitions.

TECHNICAL SKILLS

- Programming:** Python (NumPy, Pandas, SciPy, scikit-learn, PyTorch, statsmodels) · C++ (STL, Eigen) · LaTeX · SQL
- Mathematics:** Differential Geometry · Lie Groups & Algebras · Algebraic Topology · Stochastic Calculus · PDEs · Measure Theory
- Physics:** Quantum Field Theory · General Relativity · Yang-Mills Gauge Theory · BRST Quantisation · Quantum Information
- Quant Finance:** Options Pricing · Factor Models · Backtesting · Persistent Homology (GUDHI, ripser) · Fama-MacBeth
- Defence / Sys:** MIL-STD-1553B · STANAG 4586 · Protocol Translation · async · UDP · Middleware Architecture
- ML / AI:** Deep Neural Networks · Random Forests · Time Series Analysis · Anomaly Detection · Symbolic Reasoning
- Tools:** Git · lightkurve · CAMB · healpy · QuantLib · Logic Pro · FL Studio · AutoCAD
- Languages:** English (Native) · Hindi (Native) · Punjabi (Professional) · Russian (Limited) · French (Elementary)

HONOURS & RECOGNITION

- Published author in theoretical physics as a high school student — two works in IJRES and arXiv preprint.

- Selected participant, OTIS 2025 — Dr. Evan Chen’s advanced mathematical olympiad training programme (MIT).
 - Qualified for Indo-Nepal Science Exhibition (HydroCure, 2023).
 - Top 100 teams, Avishkaar Makeathon Nationals 2023; Finalist, IIT Delhi Hackathon 2023.
 - AIMO3 team contributor — Kaggle competition for AI-based mathematical reasoning (2026).
-