Alexander B. Atanasov

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Education

Harvard University
PhD. Theoretical Physics, 2018 – present.

Yale University
M.S. Mathematics, 2018.
B.S. Physics, B.S. Mathematics, 2018.
Honors: Pi Beta Kappa, *magna cum laude*, distinction in both majors.
Senior Thesis: "Magnetic Monopoles, 't Hooft Lines, and Geometric Langlands"
GPAs: Physics 3.97; Mathematics 4.00; Total 3.92

Thomas Jefferson High School for Science and Technology
Concentration in Optics and Modern Physics, 2014.
GPA: 3.92 unweighted

Publications

4. Alexander B. Atanasov and Erik Schnetter. *Sparse Grid Discretizations based on a Discontinuous Galerkin Method.*. October 2017. Submitted to *Journal of Classical and Quantum Gravity*. (arXiv:1710.09356)

3. Alexander B. Atanasov and James C. Ellenbogen. *Simple, accurate electrostatics based formulas for calculating ionization potentials, electron affinities, and capacitances of fullerenes.* Phys. Rev A95. March 2017.

2. Alexander B. Atanasov and Erik Schnetter. *GalerkinSparseGrids.jl: A Module for Sparse Grid Discretization using Discontinuous Galerkin Bases.* github.com/ABAtanasov/GalerkinSparseGrids.jl. August 2016.

1. Alexander B. Atanasov. *Complex Analysis: In Dialogue & Appendix of Color Plots.* CreateSpace Publishing. October 2013. (Amazon)
A book written in high school, teaching complex analysis via Socratic dialogue.

Works in Progress:

***** Alexander B. Atanasov. *Representations of the Physical Universe.* Expected Publication: Fall 2018. 200/550 Pages written. [link]
Book on the ideas of mathematical physics, based off lectures given at ISSYP.

Research

Undergraduate Researcher: 3D Conformal Bootstrap and the Ising Model
Yale Dept. of Physics – Supervised by Prof. David Poland
August 2016 - Present

- Developed a module to perform numerical investigations on 3D conformal field theories (CFTs) sharing similar operator structures to the 3D Ising model.
- Excluded a large portion of previously unexplored potential CFTs using a technique called θ-scan. Found new numerical bounds for the $\mathcal{N} = 1$ supersymmetric Ising CFT.
- Supplemented by directed reading on topics in three-dimensional CFT and relationship to 3D quantum field theories towards senior thesis in the spring.

Software Engineering Intern: Machine Learning and Computer Vision
Google Inc. – *Supervised by* Dr. Nhat Vu
Summer 2017

- Worked to port TensorFlow models onto embedded devices for real-time face detection and recognition, achieving a 6x speedup in run-through time for inference from the start of the project without loss in accuracy.
- Presented results to Hiroshi Lockheimer and the mobile machine vision teams.

Visiting Researcher: Sparse Grid Discretization for Relativistic Astrophysics
Perimeter Institute for Theoretical Physics – *Supervised by* Dr. Erik Schnetter
Summer of 2016, Winter of 2016-2017

- One of seven students selected internationally to participate in Perimeter's undergraduate program.
- Studied numerical solutions to Einstein's equations and Galerkin methods in hyperbolic differential equations.
- Designed and implemented a sparse-grid based solver for hyperbolic equations, decreasing cost at resolution N in d-dimensions from $O(N^d)$ to $O(N \log^{d-1} N)$. Successfully evolved a wave equation in $6+1$ dimensions with high accuracy and low memory requirements. Paper submitted for publication.
- Organized 10 meetings of weekly undergraduate lecture seminar. Presented two lectures on complex and algebraic geometry in physics.
- Engaged high schoolers in the ISSYP program as a lecturer and guest mentor.

Undergraduate Researcher: Dynamical Models of Recurrent Neural Networks
Yale School of Medicine, Dept. of Psychiatry N3 Division – *Under* Dr. John Murray
January 2016 - Present

- Built TensorFlow-based package for modeling neural dynamics in various cognitive tasks.
- Used CUDA, the Yale computing cluster, and tools in high-dimensional data science to generate results for upcoming publication.

Multi-scale Modeling of Carbon Nanomaterials
MITRE Corporation Student Program – *Supervised by* Dr. James Ellenbogen
Summer of 2014 & 2015. Winter of 2014-2015 & 2015-2016

- Studied techniques in quantum chemistry and density functional theory.
- Developed electrostatic model with quantum modification from symmetry breaking to account for the scaling regularity of the capacitance trends of certain carbon nanostructures. Published results.

SEAP Program: Plasma Cloud Generation using Cavity Resonators
Naval Research Laboratory – *Supervised by* Dr. Paul Bernhardt
Summer of 2013

- Studied electromagnetic wave equations and impedance in transmission lines, cavity resonators, and waveguides. Built voltage amplifier and tuned impedance to generate plasma clouds in confined region.

Conferences Attended

"Bootstrap 2018 Workshop and Summer School"
Caltech, Pasadena CA, June 2-14 2018
"Gauge Theory, Geometric Langlands, and Vertex Operator Algebras"
Perimeter Institute, Waterloo ON, March 21-25 2018

Talks

The Geometric Satake Correspondence in Physics
Seminar on the Langlands Program, Mar. 2017 (notes: [1][2])
Conformal Field Theories beyond Two Dimensions
Yale Graduate Representation Theory Seminar, Nov. 2017 (notes)
2D Conformal Field Theory and Lattice Models of BPZ
Seminar: Topics in Conformal Field Theory for Prof. David Poland, Dec. 2016 (notes)
Instantons on $\mathbf{R}^4$, Nakajima Quiver Varieties, and the Heisenberg Algebra
Seminar: Topics in Representation Theory for Prof. Igor Frenkel, Nov. 2016 (notes: [0][1][2])
6j-symbols and the Tetrahedron
Seminar in Modern Algebra for Prof. You Qi, Apr. 2016 (notes)
Phase Transitions in Graphs and the Margulis-Russo Theorem
Seminar in Modern Combinatorics under Prof. Van Vu, Dec. 2015

Teaching

Grader and TA, Computer Science Department
Yale University
- Deep Learning Theory and Applications, Spring 2018

Grader and TA, Mathematics Department
Yale University
- Representation Theory, Spring 2018
- Intro. to Complex Analysis, Fall 2016 & Fall 2017
- Vector Analysis on Manifolds, Spring 2017 & Spring 2017
- Intro. to Abstract Algebra, Fall 2015

Guest Mentor and Lecturer
Perimeter International Summer School for Young Physicists
- Presented Lecture on *Covariance, Contravariance, Manifolds, and their Flows* for high school audience (lecture video here).

Awards and Fellowships

Phi Beta Kappa
2018, for academic performance at Yale University
Howard L. Schultz Prize
2018, awarded to outstanding senior in the Yale physics department
Yale College Mellon Fellowship
2018, towards participating in an international colloquium on the geometric Langlands program in physics for senior thesis research
Yale Morse College Richter Fellowship
2016, towards international study at the Perimeter Institute
Yale Dean's Research Fellowship
2016, towards research in computational neuroscience
William L. Putnam Mathematics Competition Top 300
2016, 2018
U.S.A. Physics Olympiad Semifinalist
2013

Languages and Skills

English (native), Bulgarian (native), Latin (proficient)

Programming Languages (most to least proficient):

Python, Mathematica, Julia, C, C++, Java, Matlab/Octave, HTML, Excel, R

Parallel and High-Performance Computing Tools:

TensorFlow, OpenMP, MPI, CUDA, Julia Toolkit

Strong background in tutoring, public speaking, and academic lecturing.

Last but not least, LaTeX.

References

James Ellenbogen
Nanosystems Group
MITRE Corporation
ellenbgn@mitre.org

David Poland
Theory Group, Dept. of Physics
Yale University
david.poland@yale.edu

Erik Schnetter
Strong Gravity Group
Perimeter Institute
eschnetter@perimeterinstitute.ca

John Murray
Dept. of Psychiatry N3 Division
Yale School of Medicine
john.murray@yale.edu

Philsang Yoo
Dept. of Mathematics
Yale University
philsang.yoo@yale.edu