

Joshua Pughe-Sanford

PHD CANDIDATE, CENTER FOR NON-LINEAR DYNAMICS

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Education

2017-Present	Georgia Institute of Technology , Atlanta, GA Ph.D. in Physics (Expected, Summer 2023) M.S. in Mathematics (Expected, Summer 2023) GPA: 3.9
2015-2017	Emory University , Decatur, GA B.S. in Physics with Highest Honors (Summa Cum Laude) Minor in Mathematics GPA: 3.9
2013-2015	Oxford College , Decatur, GA A.A. with Honors GPA: 3.9

Honors and Awards

2022	Herbert P. Haley Fellowship, Georgia Institute of Technology	\$4,000
2022	Emelio Fellowship Nominee, Georgia Institute of Technology	
2022	Travel Grant, Georgia Institute of Technology	\$1,000
2017-2021	Presidential Fellow, Georgia Institute of Technology	\$20,000
2017-Present	Phi Beta Kappa, Honors Society	
2016	Travel Grant, Princeton University	\$1,500
2016-Present	Sigma Phi Sigma, Physics Honors Society	
2015-Graduation	Dean's List, Emory University	
2013-Present	Phi Eta Sigma, National Honors Society	
2013-2015	Honors List, Oxford College	

Publications

- P1. **J. L. Pughe-Sanford** and R. O. Grigoriev, "Point vortices predict extended vortex interactions in two-dimensional turbulence," (*in preparation*)
- P2. **J. L. Pughe-Sanford**, S. Quinn, L. L. Balabanski, and R. O. Grigoriev, "Inferring turbulent averages through regression," (*in preparation*)
- P3. **J. L. Pughe-Sanford**, C. J. Crowley, W. Toler, R. O. Grigoriev, and M. F. Schatz, "**Observing a Dynamical Skeleton of Turbulence in Taylor-Couette Flow Experiments**," *Phil. Trans. A* (*accepted*)
- P4. **J. L. Pughe-Sanford**, C. J. Crowley, W. Toler, M. C. Krygier, R. O. Grigoriev, and M. F. Schatz, "**Turbulence tracks recurrent solutions**," *Proceedings of the National Academy of Sciences*, vol. 119, no. 34, p. e2120665119, 2022
- P5. M. C. Krygier, **J. L. Pughe-Sanford**, and R. O. Grigoriev, "**Exact coherent structures and shadowing in turbulent Taylor-Couette flow**," *Journal of Fluid Mechanics*, vol. 923, p. A7, 2021

- P6. S. Boettcher and **J. L. Pughe-Sanford**, “Renormalization of Discrete-Time Quantum Walks with non-Grover Coins,” *Journal of Statistical Mechanics: Theory and Experiment*, vol. 2018, p. 033103, 2017
- P7. **J. L. Pughe-Sanford**, “Properties of Quantum Walks within Various One Dimensional Media,” *Honors Thesis*, 2017

Conference Talks

- C1. **J. L. Pughe-Sanford** and R. O. Grigoriev, “Vortex Interactions: a Low-Dimensional Approach to the Inverse Cascade.” APS DFD Indianapolis, 2022 (recorded)
- C2. W. Toler, C. J. Crowley, **J. L. Pughe-Sanford**, R. O. Grigoriev, and M. F. Schatz, “Simultaneous shadowing of multiple Exact Coherent Structures in experimental Taylor-Couette flow.” APS DFD Indianapolis, 2022
- C3. **J. L. Pughe-Sanford**, M. C. Krygier, and R. O. Grigoriev, “Can We Connect a Dynamical Description and a Statistical Description of Turbulence?.” APS DFD Phoenix, 2021
- C4. C. J. Crowley, **J. L. Pughe-Sanford**, W. Toler, R. O. Grigoriev, and M. F. Schatz, “Time evolution of turbulent Taylor-Couette flow is robustly captured by Exact Coherent Structures.” APS DFD Phoenix, 2021
- C5. W. Toler, C. J. Crowley, **J. L. Pughe-Sanford**, R. O. Grigoriev, and M. F. Schatz, “Transition to turbulence in experimental small-aspect Taylor-Couette flow.” APS DFD Phoenix, 2021
- C6. **J. L. Pughe-Sanford** and R. O. Grigoriev, “Dynamics and statistics of weakly turbulent Taylor-Couette flow in terms of exact coherent structures.” APS DFD Chicago, 2020
- C7. W. Toler, C. J. Crowley, **J. L. Pughe-Sanford**, K. Sands, M. F. Schatz, and R. O. Grigoriev, “Experimental tests of dynamical and statistical relevance of exact coherent structures in turbulent small-aspect-ratio Taylor-Couette flow.” APS DFD Chicago, 2020
- C8. C. J. Crowley, W. Toler, **J. L. Pughe-Sanford**, K. Sands, R. O. Grigoriev, and M. F. Schatz, “Identifying turbulent shadowing of 3D Exact Coherent Structures from measurements of 2D-2C velocity measurements in small-aspect-ratio Taylor-Couette flow.” APS DFD Chicago, 2020
- C9. **J. L. Pughe-Sanford** and R. O. Grigoriev, “Heteroclinic Connections as Predictors of Extreme Events in Weakly Turbulent Flow.” APS DFD Seattle, 2019 (recorded)
- C10. **J. L. Pughe-Sanford**, “Numerical Methods for Determining the Walk Dimension of Quantum Walks.” Emory University SIRE Symposium, 2017

Teaching Experience

Georgia Institute of Technology

- Assisted in Teaching Graduate Level Courses (not as TA) 2019, 2022
- PHYS 7224, Non-Linear Dynamics
 - PHYS 8823, Math Methods
- Head Teaching Assistant 2018-2019
- Managed a team of TAs and lead them in how to communicate each weeks material to students
 - Helped design an online forum where students could post questions and get answers from their peers and myself in real time.
- Teaching Assistant 2017-2018
- Taught Undergraduate Physics I Lab
 - Earned 4.9/5.0 on my student teacher evaluations

Service

Georgia Institute of Technology

Physics Allies for Wellness (PAW)

2022

- A founding member of an association that provides space to address social injustices in the physics department, and university at large, in a manner that prioritizes the safety and anonymity of all involved

Graduate Association of Physics (GAP)

2017-2018

- Led and coordinated Physics Forum, where each week a graduate student would present their work to their departmental peers

Research Experience

Georgia Institute of Technology, with R. Grigoriev

2018-Present

I currently work in the Center for Non-linear science, studying methods of simplifying high-dimensional, non-linear systems through understanding their non-ergodic, invariant manifolds.

- Utilized adjoint based optimization to predict when a system will exhibit extreme behavior
- Developed a novel method for approximating a systems statistical behavior from minimal recurrent data
- Developed a robust and low-dimensional method for determining when turbulence is well approximated by a recurrent solution to Navier-Stokes, in systems with arbitrarily many continuous symmetries
- Created a fast numerical scheme for determining the minimal distance between vectors in systems with arbitrarily many continuous symmetries

Emory University, with S. Boettcher

2016-2018

I studied the rate at which classical and quantum probability densities traverse various self-similar graphs. Notably, these investigations provided insight into how unitary dynamics allow graphs to be traversed ballistically, whereas classical dynamics do not.

- Studied the asymptotic rate of expansion of quantum systems over self-similar graphs using the renormalization group
- Developed a code suite for simulating and analyzing one-dimensional persistent-classical and quantum walks

Princeton University, with F. Calaprice

2014-2018

The majority of my time at Princeton was spent with the SABRE collaboration, where we searched for the weakly-interacting, massive dark matter candidate particles (known as WIMPs).

- Helped design and construct the SABRE scintillating-crystal detector.
- Helped design and commission the Sabre insertion system. Design specifications required it to be airtight, chemically resistant, and precisely-controlled.
- Managed relations with numerous internal and external collaborators, acquiring custom parts for the collaboration as well as moderating interpersonal conflicts.

I also briefly worked with the Borexino collaboration, which focuses mostly on Neutrinos. Polonium is a large source of error for both SABRE and Borexino, as it creates a “erroneous” signals, similar to those of interest, as it decays.

- Designed and constructed an automated, non-invasive, wireless, liquid level monitoring system for Princeton’s polonium distillation system.

- Determined the efficiency of Borexino's distillation columns at the National Underground Laboratory at Gran Sasso, Italy.
- Designed and built an enclosure that maximizes the yield of polonium depositions onto silver foils.

Oxford College, with R. Conceicao

2014-2015

At Oxford College I had my first foray into mathematics, which spurred me to continue studying math to this day (albeit now in a much more applied way).

- Studied the Collatz Conjecture and its polynomial corollary.
- Derived a formula for predicting the total stopping time of all monic polynomials with coefficients in a ring of modulo n .

Work Experience

B-Line Logic, Atlanta, GA

2014-2016

I was a Core Developer with B-Line Logic, a business that developed efficient tools for distilling Big Data into a small set of optimal actions plans that an employee could choose from and act on, color-coded by optimality.

- Created a predictive-analytics engine for supply chain management.
- Developed system architecture for a distributed event correlation system.
- Managed relations with clients such as Delta Airlines and Cardinal Health.

Interests and Skills

Language (Native)	English
Language (Conversational)	Spanish, Italian, German
Coding (Languages)	Java, MATLAB, Python, Assembly (ask about this), C++
Coding (Skills)	Machine Learning, big data, PDE simulation, objective function optimization, high-dimensional datasets, data visualization, pattern recognition
Robotics	Built a miniature self balancing, Segway-like robot piloted by an Arduino. Built a robotic hand that tracks the motion of a user-worn glove
Game Design	Created a 3D, single-player game with AI-controlled enemies