# Joshua Pughe-Sanford

GRADUATE RESEARCH ASSISTANT, CENTER FOR NON-LINEAR DYNAMICS

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## Education

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

## Honors and Awards

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| 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**, S. Quinn, L. L. Balabanski, and R. O. Grigoriev, "Inferring turbulent averages through regression," *(in preparation)*

P2. **J. L. Pughe-Sanford**, C. J. Crowley, W. Toler, M. C. Krygier, R. O. Grigoriev, and M. F. Schatz, "Turbulence tracks reccurent solutions," *PNAS (in revision)*

P3. 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

P4. 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

P5. **J. L. Pughe-Sanford**, "Properties of Quantum Walks within Various One Dimensional Media," *Honors Thesis*, 2017

# Conference Talks

C1. **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

C2. 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

C3. 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

C4. **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

C5. 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

C6. 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

C7. **J. L. Pughe-Sanford** and R. O. Grigoriev, "Heteroclinic Connections as Predictors of Extreme Events in Weakly Turbulent Flow." APS DFD Seattle, 2019

C8. **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) *2022*
- PHYS 7224, Non-Linear Dynamics

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 $\qquad$ *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 Naiver-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 $\qquad$ *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 $\qquad$ *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 $\qquad$ *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

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| Language (Native) | English |
| Language (Conversational) | Spanish, Italian, German |
| Coding (Languages) | Java, MATLAB, Python, Assembly (ask about this), C++ |
| Coding (Skills) | Big Data, simulation, high-dimensional datasets, data visualization, pattern recognition, machine learning |
| 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 |