DUNCAN WILKIE

PERSONAL INFORMATION

Born Arkansas, 3 July 2002

email dwilk14@lsu.edu

"The aim of theory really is, to a great extent, that of systematically organizing past experience in such a way that the next generation, our students and their students and so on, will be able to absorb the essential aspects in as painless a way as possible..." — Michael Attiyah

EDUCATION

2019— Bachelor of Science in Physics · 3.87 GPA

Louisiana State University

As it's my primary discipline, I've taken a generalist's undergraduate curriculum, with classes from instrumentation electronics to solid state theory to gravitational wave astronomy.

2019— Bachelor of Science in Math · 3.70 GPA

Louisiana State University

Having attempted (at my grades' expense) to exhaust the undergraduate curriculum in pure mathematics as fast as possible, I've been taking graduate classes since sophomore year, with an eye towards the differential, (pseudo-)Riemannian, and algebraic geometry essential for advanced theoretical physics.

RESEARCH PROJECTS

Oct 2022— Mission Control Software for Lunar Payloads

Atlantis Industries

I was hired as a senior software engineer by Dr. Chancellor's startup, formed to commercialize technologies the lab and I had developed in an academic setting, initially funded through a US Space Command phase-II small business research grant. A flagship project of the company is Tiger Eye, a small, light, and low-power radiation detector developed for spaceflight applications. In partnership with Intuitive Machines, this detector is to be flown on a 5-year cislunar orbital mission, gathering data for space weather modeling. Transplanting much of the interface work done in summer '21, I've begun writing MacOS software for interacting with the payload, fetching and displaying its data whenever available.
Advisor: Jeffery Chancellor · jeff@spartanphysics.com

Nov 2021— A PHITS Python Porcelain

SpaRTAN Physics

Many modern computational physics programs present Python interfaces. I noticed at our group meetings that graduate students were struggling with the Particle and Heavy Ion Transport code System's card-based interface, so I offered to write a new, object-oriented one in Python that writes the analogous input file for an object tree, runs the transport code on it, and parses the output file to return for the user's further computational needs. This is tantamount to required tooling if one wants to run machine learning computations; for instance, a graduate project for automated design of spacecraft shielding requires kludgy, ad-hoc workarounds that slow the project tremendously. So far, the "forward-mode" part is completely written but not completely tested, while the output parsing (using a port of Haskell's Parsec library) can't be called complete in any sense, despite extensive labor.
Advisor: Jeffery Chancellor · jeff@spartanphysics.com

Nov 2021— **An Emacs Mode and Invocation Script for PHITS**

SpaRTAN Physics

Learning to use PHITS for the above project, I wanted better editor support and a POSIX-compliant shell interface, so I wrote it. The former involves theme-aware syntax highlighting, automatic indentation and alignment, and keystroke execution and viewing of calculation results. The latter lets one select which parallelization scheme to use and handles otherwise tedious quirks of the MPI binary.

Summer 2021 **Spaceflight Radiation Detector Development**

SpaRTAN Physics

I was the primary software developer of an iOS-based interface for ADVACAM's MiniPIX detectors, doing 100% of the Swift app development and much of the embedded C implementation of Apple's proprietary iAP2 protocol. Each was my first program in its respective language. The work was intended to fly on SpaceX's Inspiration 4 mission, and we hope it'll become useful for medical physics researchers. Advisor: Jeffery Chancellor · jeff@spartanphysics.com

AY 2020 **Independent Reading in Quantum Information**

COVID left few traditional research opportunities, so I self-directed some quantum information reading. I began with the Chuang-Nielsen text, and later started to pick up papers in categorical quantum mechanics when I learned of its namesake mathematical field via classes touching on algebraic topology. Specifically, that of Abramsky and Coecke outlining the field and Selinger and Valiron's entailing application of linear logic's lambda calculi to quantum computation piqued my interest, as I had been playing with Lisps, which, philosophically, are a direct implementation of Church's classical construction as a programming language.

Summer 2020 **Data Science Intern**

J. B. Hunt Transport Services

With the pandemic parking me back home and making academic development difficult, I found a remote position in which I could learn computer science skills likely to be useful in physics projects. I trained a machine learning model that estimates the repair time of tractors from basic data (e.g. mileage, repair location) based on Yandex's CatBoost that, to my knowledge, remains deployed. My work was twofold: port the massive, old IBM DB2 query over to Azure MySQL, and to produce a better model of the resulting data. The hybrid categorical-continuous nature of the data led to best performance by a CatBoost model among dozens tested within a hyperparameter optimization framework, beating the existing SPSS model by a difference in mean absolute percent error of 10%.

AY 2019 **Selected Readings in Functional Analysis**

I was directed to read about some of the basics of Lesbegue integration, function spaces, semigroup theory, divergent series, and asymptotic analysis. Specifically, Hardy's "Divergent Series," Yosida's "Operational Calculus: A Theory of Hyperfunctions," and Estrada's "A Distributional Approach to Asymptotics" were major points of focus, alongside smaller passages from other works and non-published, one-on-one instruction. This work was to result in a poster on weak ODE solutions, but plans were called off due to COVID-induced cancellation of the poster session (and in-person meetings). Advisor: Frank Neubrander · neubrand@math.lsu.edu

PRESENTATIONS

October 2021 **Embedded Development for Spaceflight Radiation Detectors**

LaSPACE Council Meeting

Showcase of the summer 2021 research described above at a statewide poster session for undergraduate and graduate students funded through NASA EPSCoR.

Authors: Duncan Wilkie, Jacob Miller, Jared Taylor, Jeffery Chancellor

COMPUTER EXPERIENCE

- Extensive
  - Python and its EDSLs
  - GNU/Linux, in theory and practice
  - GNU Emacs and Emacs Lisp
  - Embedded C (Texas Instruments' ARM CPUs)
  - Swift and SwiftUI
  - Scheme Lisp, GNU Guix, and reproducible computation
  - Parser combinators
  - Java
  - Numerical C++
  - Gnuplot
  - LaTeX and TikZ
  - SageMath
- Moderate
  - Haskell
  - Fortran 77 and 90
  - Parser generators and EBNF
  - GNU Octave/MATLAB
  - Z80 and ARM Assembly
  - GDB
  - Profiling and optimization
- Cursory
  - Clash, SystemVerilog, and electronic design automation
  - Compiler architecture and intermediate representations
  - RISC-V
  - CERN ROOT
  - Rust
  - Lua
  - R

TEACHING

AY 2018 · High/elementary school math and ACT prep tutoring job.

Aug 2019— · Informal homework help for other physics majors.

Fall 2020 · Engineering physics recitation leader.

Apr 2022— · Presentations on relativity and differential geometry, discussions, and homework help in a math Discord server.

AWARDS

2019- · LSU Ann and Clarence P. Cazalot Jr College of Science Honors Scholar

AY 2021 · Louisiana Space Grant Consortium Undergraduate Research Assistantship

2022 · LSU Goldwater Fellowship Nominee

October 21, 2022