Tatsuya Daniel

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Research Interests

General relativity, modified theories of gravity, gravitational waves, early universe cosmology, quantum gravity, and machine learning.

Education

Brown University, Ph.D. in Physics — Sep 2020 – present

- **Relevant Coursework:** General Relativity, Advanced Quantum Mechanics, Quantum Field Theory

Massachusetts Institute of Technology, Bachelor of Science in Physics — Sep 2016 – May 2020

- Minors in Mathematics and German
- **Relevant Coursework:** Classical and Quantum Mechanics, Statistical Mechanics, Relativity, Electromagnetism, Vibrations and Waves, Experimental Physics, Linear Algebra, Differential Equations, Probability and Random Variables, Fundamentals of Statistics, Real and Complex Analysis

Research Experience

Graduate Research Assistant, Brown University – Providence, RI — 2021 – present
Advised by Stephon Alexander

- Doctoral Thesis title TBA

Research Intern, Microsoft – Redmond, WA — 2021
Advised by Jaron Lanier

- Explored correspondence between theoretical physics, matrix models and machine learning in an “autodidactic universe" project
- Devised new method to quantify the difference between physical theories using the Kullback-Leibler (KL) divergence

Visiting Researcher, Chapman University – Orange, CA — 2020 – 2021
Advised by Justin Dressel

- Investigated applications of Clifford algebra to acoustics, electromagnetism, water waves, and gravity
- Derived spin densities for acoustic fields with sources, dual electromagnetism, and water waves

Undergraduate Research Opportunity Program, MIT Kavli Institute for Astrophysics and Space Research – Cambridge, MA — Sep 2019 – May 2020
Advised by Anna Frebel

- Studied distribution of low-metallicity stars in the Milky Way
- Utilized unsupervised machine learning algorithms to analyze star data from various satellite missions

Undergraduate Research Intern, University of Tokyo, Institute for Physics of Intelligence – Tokyo, Japan — Jul 2019 – Mar 2020
Advised by Tilman Hartwig

- Implemented unsupervised machine learning algorithms to cluster groups of early-universe stars
- Developed a new Python algorithm to group elements using dendrograms and clustering coefficients

Undergraduate Research Intern, University of Heidelberg, Center for Theoretical Astrophysics – Heidelberg, Germany — Jun 2019 – Jul 2019
Advised by Ralf Klessen

- Learned a semi-analytic 1D feedback model for isolated massive clouds to calculate shell dynamics and shell structure simultaneously in star formation

Publications

Gravitational Waves in Chern-Simons-Gauss-Bonnet Gravity Mar 2024
Tatsuya Daniel, Leah Jenks, Stephon Alexander
10.1103/PhysRevD.109.124012

An SZ-Like Effect on Cosmological Gravitational Wave Backgrounds Jul 2023
Tatsuya Daniel, Marcell Howard, Morgane König
10.1088/1475-7516/2023/12/041

Spacetime geometry of acoustics and electromagnetism May 2023
Lucas Burns, ***Tatsuya Daniel***, Stephon Alexander, Justin Dressel
10.1007/s40509-024-00317-8

An Exact Fermionic Chern-Simons-Kodama State in Quantum Gravity Jul 2022
Stephon Alexander, ***Tatsuya Daniel***, Marcell Howard, Morgane König
10.1103/PhysRevD.106.106012

The Ashtekar Variables and a Varying Cosmological Constant from Dynamical Chern-Simons Gravity Jul 2022
Stephon Alexander, ***Tatsuya Daniel***, João Magueijo
10.48550/arXiv.2207.08885

Stellar Metallicities from SkyMapper Photometry. II. Precise Photometric Metallicities of $\sim$ 280,000 Giant Stars with [Fe/H] < -0.75 in the Milky Way Oct 2020
Anirudh Chiti, Anna Frebel, Mohammed Mardini, ***Tatsuya Daniel***, Xiaowei Ou, Anastasiia Uvarova
10.3847/1538-4365/abf73d

The Metal-poor Metallicity Distribution of the Ancient Milky Way Oct 2020
Anirudh Chiti, Anna Frebel, Mohammed Mardini, ***Tatsuya Daniel***
10.3847/2041-8213/abd629

Teaching Experience

Graduate Tutor Fall 2022
PHYS 0070: Analytical Mechanics
- Mentored two students twice a week to improve understanding of material and class performance

Guest Lecturer Apr 2022
PHYS 0060: Foundations of Electromagnetism and Modern Physics
- Maxwell's Equations and Electromagnetic Waves

Graduate Teaching Assistant Fall 2020 - Spring 2022
PHYS 0030: Basic Physics A
PHYS 0040: Basic Physics B
PHYS 0050: Foundations of Mechanics
PHYS 0060: Foundations of Electromagnetism and Modern Physics
- Held office hours and graded lab reports (PHYS 0030, PHYS 0050)
- Led recitation sections and problem-solving sessions 2-3 times per week (PHYS 0040, PHYS 0060)
- Proctored and graded exams (PHYS 0030, PHYS 0040)

Talks

Caribbean Future of Science Symposium Mar 2024
Gravitational Waves in Chern-Simons-Gauss-Bonnet Gravity
- Contributed talk

Perimeter Institute for Theoretical Physics, Cosmology Group Meeting Nov 2023
Probing String-Modified Gravity in Neutron Stars
- Invited talk

McGill University, Cosmo-ph Group Meeting Oct 2023
Probing String-Modified Gravity in Neutron Stars
- Invited talk

28th International Symposium on Particles, Strings, and Cosmology Jun 2023
Probing String-Modified Gravity in Neutron Stars
- Invited talk

Rutgers University, Math-Physics Seminar Feb 2023
A Time-Varying Cosmological Constant from Dynamical Chern-Simons Gravity
- Invited talk

Rutgers University, Math-Physics Seminar Dec 2022
Canonical quantization of gravity and the Wheeler-DeWitt Equation
- Invited talk

University of Pittsburgh, Particle Physics Astrophysics and Cosmology Center Seminar Nov 2022
A Time-Varying Cosmological Constant from Dynamical Chern-Simons Gravity
- Invited talk

National Society of Black Physicists Conference Nov 2022
A Time-Varying Cosmological Constant from Dynamical Chern-Simons Gravity
- Contributed talk

Chapman University, Spin Group Meeting Sep 2022
Probing Modifications to General Relativity in Neutron Stars
- Invited talk

NEXUS Summer Workshop Aug 2022
A Time-Varying Cosmological Constant from Dynamical Chern-Simons Gravity
- Contributed talk

Simons-NSBP Scholars Program Jun 2022
Using Neutron Stars to test modified theories of gravity
- Invited talk

NEXUS Summer Workshop Jun 2021
Identifying the Chemical Enrichment Channels of the Early Universe
- Contributed talk

University of Tokyo, Institute for Physics of Intelligence Group Meeting Jan 2020
Machine Learning and Early Universe Chemical Enrichment Channels
- Invited talk

Additional Experience And Awards

Award of Excellence as a Graduate Teaching Assistant May 2021
- Nominated and selected for department award

Ruhr Fellowship Summer 2018
- Selected for competitive program connecting highly motivated undergraduate students from top universities in the United States with the Ruhr Area of Germany

Skills

Languages and Software: Python, C, C++, Mathematica, R, Matlab, Java, Unix, LaTeX, git

Professional Organizations

Brown Theoretical Physics Center 2021 - present

National Society of Black Physicists 2021 - present