JEAN PIERRE TWAGIRAYEZU

Research Assistant | Ph.D. Candidate in Experimental Astroparticle Physics

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ABOUT ME

I am a Ph.D. candidate working on experimental neutrino astroparticle physics research spanning data analysis and software development for scientific applications. My primary research focus revolves around identifying point sources of astrophysical neutrinos using data from Neutrino Telescopes. Current research includes producing Monte Carlo Simulation for the Pacific Ocean Neutrino Experiment (P-ONE), development of event reconstruction algorithms for the P-ONE, conducting statistical data analysis to forecast the sensitivity of the P-ONE to astrophysical point sources of neutrinos, and design and optimization studies for the P-ONE..

EDUCATION

Doctor of Philosophy (Ph.D.) in Physics | Michigan State University

Jan 2020 – 2025 East Lansing, MI, USA

- Performance studies for the Pacific Ocean Neutrino Experiment (P-ONE)
- Advisors: Tyce DeYoung, Nathan Whitehorn

Master of Science (M.S.) in Physics | Michigan State University

Aug 2018 – May 2020 East Lansing, MI, USA

- Experimental Astroparticle Physics, IceCube Neutrino Observatory.
- Advisor: Professor Tyce DeYoung

Master of Science in Mathematical Sciences | African Institute for Mathematical Sciences

Aug 2017 – Jun 2018 Kigali, Rwanda

- Mathematical Sciences

Bachelor of Education (Hons.) in Physics | University of Rwanda, College of Education

Sep 2011 – Jul 2015 Kigali, Rwanda

- Bachelor of Education in Physics (Major) and Mathematics (minor)

TECHNICAL SKILLS

Python | C++ (basic) | shell (basic) | Icecube icetray | Latex | Numpy | Pandas | Scipy | Sklearn | Tensorflow | Keras | Matplotlib | Jupyter Notebook | Git/Github | Statistical Data Analysis | Machine / Deep Learning | Advanced Maths | Astroparticle Physics | Scientific Computing | Software development | Teaching | Communication | Presentation | Team work

RESEARCH EXPERIENCE

Research Assistant | Michigan State University, Pacific Ocean Neutrino Experiment (P-ONE)

Aug 2021 – 2025 East Lansing, MI, USA

- collaborated with a team of software engineers and scientists to study the performance studies of the Pacific Ocean Neutrino Experiment (P-ONE) using Monte Carlo simulations.
- conducting statistical data analysis to forecast the sensitivity of the P-ONE to astrophysical point sources of neutrinos
- co-development of track event reconstruction algorithms for the Pacific Ocean Neutrino Experiment (P-ONE).
- processing large datasets of Monte Carlo simulations from neutrino event generation to detector response simulation for the P-ONE using high-performance computing clusters

- Member of the the Pacific Ocean Neutrino Experiment Collaboration
- Skills: statistical data analysis, software development (python, git) · scientific computing, astroparticle physics, teamwork, and presentation.

Research Assistant | Michigan State University, IceCube Neutrino Observatory

May 2020 – Aug 2021 | East Lansing, MI, USA

- Use likelihood method and photon propagation for energy reconstruction of cascade events from IceCube Monte Carlo Simulation dataset on high-performance computing clusters and GPUs.
- Member of the IceCube Collaboration, IceCube monitoring shift for data quality and detector operation.
- Skills: IceCube icetray software, C++, git, Python, Numpy, data visualization, scientific computing, astroparticle physics, teamwork and presentation

Student Researcher | African Institute for Mathematical Sciences (AIMS)

Apr 2018 – Jun 2018 | AIMS Rwanda, Kigali, Rwanda

- developed a kernel regression model with network cohesion data using graph-based regularization techniques.

Student Assistant | University of Rwanda, College of Education

Jul 2014 – Jul 2015 | Kigali, Rwanda

- Participated in monitoring the daily operation of CALLISTO station at the University of Rwanda in Kigali, an e-CALLISTO antenna to collect data for monitoring solar radio flares

TEACHING EXPERIENCE

Teaching Assistant | Michigan State University, Center for Integrative Studies in General Science

Spring 2019, Fall 2019, Spring 2020 | East Lansing, MI, USA

- Teaching and grading three sections of Introductory Physics (Lab), ISP 209L.

Teaching Assistant | Michigan State University, Physics and Astronomy department

Aug 2018 – Dec 2018 | East Lansing, MI, USA

- Conduct help room sessions, assist in class demo setup for PHY 232 Introductory Physics II
- Skills: Teaching and communication.

Physics Teacher | Kagarama Secondary School

Feb 2017 – Aug 2017 | Kigali, Rwanda

- Teaching upper and lower secondary Physics courses. Designed and delivered course lessons, conducted physics laboratory sessions, graded assignments

Physics Teacher | Saint Paul International School (SPIS)

Jan 2016 – Aug 2017 | Kigali, Rwanda

- Teaching Cambridge As & A Level Physics courses. Designed and delivered course lessons, conducted physics laboratory sessions, graded assignments

Physics Teacher | APRED Ndera Secondary School

July 2015 – Jan 2016 | Kigali, Rwanda

- Teaching upper secondary Physics courses. Designed and delivered course lessons, conducted physics laboratory sessions, graded assignments

Physics Teacher | Nu-Vision High School (N.V.H.S)

Sep 2014 – Jul 2015 | Kigali, Rwanda

- Teaching Lower secondary school Physics classes. Designed and delivered course lessons, graded assignments

MENTORING EXPERIENCE

Mentoring Undergraduate Students | Michigan State University, P-ONE Research Group

Spring 2023 – Spring 2025 | East Lansing, MI, USA

- I have mentored two Undergraduate students working in the MSU P-ONE Research Group to work on the different projects ranging from using computing clusters to produce Monte Carlo Simulation, development of neutrino events track reconstruction using Monte Carlo Simulation and do P-ONE geometry optimization studies.

Mentoring High School Students | UN Ivy STEM Connect - AIMS Rwanda, Lycee de Kigali

Dec 2017 – Apr 2018 | Kigali, Rwanda

- Provided mentorship to students from Lycee de Kigali, a secondary school, in Mathematics and Physics with AIMS Rwanda students and Ivy league students studying in the USA.

SELECTED PUBLICATIONS

As Primary Author

1. Jean Pierre Twagirayezu, Hans Niederhausen, Stephen Sclafani, Nathan Whitehorn, Mehr Nisa, Shiqi Yu, and Robert Halliday. "**Performance of the Pacific Ocean Neutrino Experiment (P-ONE)**". in: *PoS* ICRC2023 (2023), p. 1175

2. Jean Pierre Twagirayezu. "**Kernel Regression with Network Cohesion**". MA thesis. The African Institute for Mathematical Sciences, Rwanda, 2018

Co-author, IceCube collaboration

1. IceCube Collaboration*†, R Abbasi, M Ackermann, J Adams, JA Aguilar, M Ahlers, M Ahrens, JM Alameddine, AA Alves Jr, NM Amin, et al. "**Observation of high-energy neutrinos from the Galactic plane**". In: *Science* 380.6652 (2023), pp. 1338–1343

2. IceCube Collaboration*†, R Abbasi, M Ackermann, J Adams, JA Aguilar, M Ahlers, M Ahrens, JM Alameddine, C Alispach, AA Alves Jr, et al. "**Evidence for neutrino emission from the nearby active galaxy NGC 1068**". In: *Science* 378.6619 (2022), pp. 538–543

3. Inspire HEP: **J.P. Twagirayezu**, **ARXIV**, **Google Scholar**

Co-author, P-ONE collaboration

1. Felix Henningsen. "**Pacific Ocean Neutrino Experiment: Expected performance of the first cluster of strings**". In: *PoS* ICRC2023 (2023), p. 1053

COMPUTATIONAL COURSES

Machine Learning Application in Physics | Michigan State University

Spring 2023 | East Lansing, MI, USA

Object Oriented Programming (Python) | Educative.io

Fall 2022 | Online

Statistical Methods for Data Analysis (Python) | Michigan State University

Fall 2020 | East Lansing, MI, USA

Methods in Computational Modelling (Python, git, Unit testing) | Michigan State University

Fall 2019 | East Lansing, MI, USA

Big Data and Machine Learning (Theory & Application in R) | AIMS Rwanda

Fall 2018 | Kigali, Rwanda

Scientific software development in Python | AIMS Rwanda

Fall 2018 — Kigali, Rwanda

Scientific Computing and Latex (Unix Basics) | AIMS Rwanda

Fall 2018 — Kigali, Rwanda

LANGUAGES

English: Proficient

French: Basic

Kinyarwanda: Native

CONFERENCES AND WORKSHOPS

Pacific Ocean Neutrino Experiment Collaboration Meeting | Parallel talk

13-16 Nov 2024 — Chicago, IL, USA

Pacific Ocean Neutrino Experiment Collaboration Meeting | Parallel talk

13-17 May 2024 — Erlangen, Germany

The American Physical Society's April Meeting 2024 | Parallel talk

3-6 April 2024 — Sacramento, California

Workshop on the Science Prospects and Optimization of P-ONE | Parallel talk

8-12 Jan 2024 — Erlangen, Germany

Pacific Ocean Neutrino Experiment Collaboration Meeting | Parallel talk

13-18 Nov 2023 — Philadelphia, PA, USA

National Society of Black Physicists 2023 Conference | Parallel talk

09 Nov - 12 Nov 2023 — Knoxville, TN, USA

38th International Cosmic Ray Conference (ICRC2023) | Poster Presentation

July 26 - August 3, 2023 — Nagoya, Japan

Pacific Ocean Neutrino Experiment Collaboration Meeting | Parallel talk

May 8-12, 2023 — Krakow, Poland

National Society of Black Physicists 2022 Conference | Poster Presentation

November 6 - November 9 2022 — Charlottesville, VA, USA

Pacific Ocean Neutrino Experiment Collaboration Meeting | Parallel talk

September 23-24, 2022 — Vancouver, Canada

International Conference on Neutrino and Astrophysics | Poster Presentation

May 30 - June 4, 2022 — Virtual, Seoul, South Korea

Pacific Ocean Neutrino Experiment Collaboration Meeting | Parallel talk

May 23-24, 2022 — Germany, Munich

IceCube Neutrino Observatory Collaboration Meeting | Attendee

September 20-23, 2021 — Virtual, Madison, USA

IceCube Neutrino Observatory Collaboration Meeting | Attendee

March 17-26, 2021 — Virtual, Aachen, Germany

IceCube Neutrino Observatory Collaboration Meeting | Attendee

September 14-25, 2020, 2020 — Virtual, Madison, USA

IceCube Neutrino Observatory Collaboration Meeting | Attendee

May 9-15, 2020 — Virtual, Brussels, Belgium

Workshop on Geophysical Monitoring and Modelling for Sustainable Energy and Geohazard Solutions | Attendee

September 15-25, 2014 — Kigali, Rwanda

African School on Space Science: Related Applications and Awareness for Sustainable Development of the Region | Attendee

June 30 - July 11, 2014 — Kigali, Rwanda