Zigfried Hampel-Arias

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Personal

DOB: 15 June, 1987
Languages: English (native), Spanish (native), French (intermediate), Greek (basic)

Education

UW-Madison
Ph.D., Physics, 2017.
M.S., Physics, 2012.
Fields: Particle Astrophysics, Scientific Computing

Rice University
B.S., Chemical Physics, 2009.

Dissertation

Cosmic Ray Observations at the TeV Scale with the HAWC Observatory
Analyses of the all-particle energy spectrum from $10-500$ TeV, energy dependence of cosmic ray Moon shadow, and the spectrum of a regional excess in the cosmic ray anisotropy. Methods include iterative Bayesian unfolding, GPU-accelerated Markov Chain Monte Carlo for parameter estimation, machine learning algorithm testing for event classification, and GPU cosmic-ray simulations for detector calibration.

Current Research

Los Alamos National Laboratory, USA
10/2021 - Present
Staff Scientist engaged in enhancing remote sensing analysis capabilities using robust statistical methods and advanced machine learning techniques. Primarily involved in hyperspectral image analysis and anomaly detection, machine learning for astrobiology and reinforcement learning methods for multi-body orbital mechanics.

Awards & Fellowships

Embassy Science Fellowship (DoE/DoS)
11/2024 – 12/2024

DoE NA22 Research Funding (as PI)
10/2023 – 10/2024

LANL LDRD Exploratory Research Funding (as PI)
10/2023 – 10/2026

TAMU Adjunct Faculty, Joint Appointee
09/2023 – Present

LANL Early Career ISR Mini-Grant (as PI)
04/2023 – 04/2024
04/2022 – 04/2023

Belgian American Educational Foundation Research Fellowship
06/2017 – 06/2018

Wallonie-Bruxelles International Short Stay Fellowship
06/2017 – 09/2017

US Fulbright Alumni Ambassador
12/2012 – 12/2017

NSF Graduate Research Fellowship
05/2011 – 05/2014

US Fulbright Research Fellowship
08/2009 – 06/2010

Publications As Major Contributor

New Methods for New Space: Multi-Sensor Change Detection in Remote Sensing Imagery
Book chapter in *Pattern Recognition and Computer Vision in the New AI Era*.
Publication spring 2025.

2D Spectral Representations and Autoencoders for Hyperspectral Imagery
SSIAI 2024 - Proceedings (pp. 45-48); doi: 10.1109/SSIAI59505.2024.10508608.

Adaptive Radio Frequency Target Localization
Proceedings of the 42nd IMAC (pp. 117-128); doi:10.1007/978-3-031-68142-$4_1$5.

Physics-guided Neural Networks for Hyperspectral Target Identification
Proc. SPIE 12675, Volume 1267503 (2023); doi:10.1117/12.2684140.

Ensemble Segmentation for Improved Background Estimation and Gas Plume Identification in Hyperspectral Images
Proc. SPIE 12675, Volume 1267506 (2023); doi:10.1117/12.2677729.

Experiments in Anomalous Change Detection
Proceedings of the SPIE, Volume 12519, id. 125190P 17 pp. (2023) doi:10.1117/12.2666569.

Localizing Radio Frequency Targets Using Reinforcement Learning
IEEE ROSE 2021, pp. 1-7 doi: 10.1109/ROSE52750.2021.9611756.

Multimodal Approach for DeepFake Detection
49th IEEE Applied Imagery Pattern Recognition Workshop (AIPR), 2020, pp. 1-9, doi: 10.1109/AIPR50011.2020.9425192.

L2RPN: Learning to Run a Power Network in a Sustainable World
NeurIPS 2020 White Paper. ChaLearn

All-sky Measurement of the Anisotropy of Cosmic Rays at 10 TeV and Mapping of the Local Interstellar Magnetic Field
Astrophys. J. **871**, 96 (2019). arXiv:1812.05682

Observation of Anisotropy of TeV Cosmic Rays with Two Years of HAWC
Astrophys. J. **865**, 57 (2018). arXiv:1805.01847

PyUnfold: A Python Package for Iterative Unfolding
Journal of Open Source Software, **3**(26), 741 (2018). 10.21105/joss.00741

Constraining the $\bar{p}/p$ Ratio in TeV Cosmic Rays with the Moon Shadow
Phys. Rev. D **97**, 102005 (2018). arXiv:1802.08913

All-Particle Cosmic Ray Spectrum Measured by the HAWC from 10–500 TeV
Phys. Rev. D **96**, 122001 (2017). (**Editor's Suggestion**) arXiv:1710.00890

Probing Cosmic-Ray Propagation with TeV γ-Rays from the Sun with HAWC
PoS: Proceedings of the 35th ICRC (Busan), 2017. arXiv:1708.03732

All-Particle and Light-Component Cosmic Ray Energy Spectrum Measured by the HAWC Experiment
PoS: Proceedings of the 35th ICRC (Busan), 2017. arXiv:1801.05526

Other Publications

"DeepFake Detection Challenge."
IQT Labs, In-Q-Tel Blog, Part I & Part II.

"What AI Can and Cannot Do for the Intelligence Community."
Defense One, Defense One, 5 Jan., 2021, Article link.

"Why IQT made the COVID-19 Diagnostic Accuracy Dash App."
Modern Data, Modern.Data, 27 August, 2020, Article link.

"Learning to Run a Power Network Challenge."
Gab41, IQT Labs, 4 May, 2020, Article link.

"Expecting the Unexpected – Cosmic Ray Physics in Argentina."
Fulbright Blog, Institute of International Education, 13 Feb., 2013, Article link.

Reviewer Activities

Geoscience and Remote Sensing Letters (2022, 2023)
Center for Security & Emerging Technology Invited reviewer for publications:
Tracking AI Investment, 06/2020.
Mapping the AI Investment Activities of Top Global Defense Companies, 10/2021.
NM LEEP Member of the Strategic Leadership Council (2020 – Present)
NeurIPS, CVPR, ICCV Reviewer for LatinXinAI Workshops, 2019 – Present.
Journal of Open Source Software Codebases and publications, 08/2018 – Present.

Selected Presentations

Machine Learning and Generative Modeling: A Physicist's Perspective
Invited Talk – Texas A&M University (11/11/2024)

Machine Learning for Hyperspectral Imagery Applications: Trusting Our Models
Invited Talk – Utah State University (15/10/2024)
Invited Talk – NATO Remote Sensing Working Group at LANL (24/10/2023)

Hyperspectral Target Identification using Physics-Guided Neural Networks with Explainability and Feature Attribution
International Geoscience and Remote Sensing Symposium (19/07/2023)

Approaches for Multi-modal Synthetic Media Detection
Invited Talk – Applied Imagery Pattern Recognition,
49$^{\text{th}}$ Annual IEEE AIPR 2020, Online (15/08/2020)

Operationalize COVID-19 Statistics with Dash: Featuring IQT's COVID-19 Diagnostic Accuracy Tool
Invited Webinar Talk – Plotly Dash (23/09/2020). Webinar link.

Cosmic Ray Observations with HAWC & GPU Simulations at TeV-Scales
Invited Talk for UG Astroparticle Seminar, Geneva, Switzerland (7/2/2018)
Invited Talk for MPIK Physics Seminar, Heidelberg, Germany (28/11/2016)
Invited Talk for RUB Astrophysics Seminar, Bochum, Germany (23/11/2016)

Unfolding Techniques and GPU Simulations at the TeV Scale with HAWC
Poster at SuGAR Solvay Workshop, IIHE, ULB, Belgium (24/1/2018)

TeV Scale Cosmic Ray Observations with the HAWC Observatory
Poster at ICFA Instrumentation School, UCI, La Habana, Cuba (5/12/2017)

Cosmic Ray Propagation Simulations and Spectral Features in the TeV Anisotropy
Invited Talk for Cosmic Ray Anisotropy Workshop,
UDG, Guadalajara, Mexico (10/10/2017)

Las partículas mas energéticas del universo: rayos cósmicos
Invited Public Talk for Semana Mundial del Espacio,
UDG CUCEI, Guadalajara, Mexico (9/10/2017)

Observation of the Moon and Sun with HAWC
Talk at TeVPA 2017, OSU, Ohio, USA (7/8/2017)

Very High Energy Cosmic Ray Observations with HAWC
Invited Talk for ULB-IIHE Seminar, Brussels, Belgium (14/10/2016)

Unfolding the All-Particle Cosmic Ray Spectrum Measured with HAWC
Talk at the American Physical Society, Salt Lake City, USA (18/4/2016)

Towards a Measurement of the e^+e^- Flux Above 1 TeV with HAWC
Poster at 34th ICRC, The Hague, Netherlands (5/8/2015)

Skills

Programming:	Python, C, C++, GitHub, SVN, OpenCL, CUDA, PyOpenGL, PyTorch, TensorFlow
Analysis:	Data Analysis, Unfolding Techniques, MCMC, GPGPU, Machine Learning
Other:	InQTel Leadership Program Graduate, Grant Writing, Student Mentoring

Public Codebases

PyUnfold Iterative Statistical Unfolding Package. Documentation

COVID Diagnostic Testing Dash App. Toolkit Webpage

DeepFake Detection App.

BirdsEye - RL on RF.

Charged Particle Geomagnetic GPU Toolkit.

CNN Rotational Convolution Layer.

CypherCat Machine Learning Vulnerability API.

Previous & Other Positions

New Mexico LEEP, Los Alamos, USA
11/2020 – Present
Advisor to New Mexico LEEP, serving on the Strategic Leadership Council.

In-Q-Tel Inc, Menlo Park, USA
09/2018 – 09/2021
Senior Data Scientist engaged in machine learning research. Project lead on RF localization with reinforcement learning methods; using GAN for enhancing utility of synthetic imagery for remote sensing; multimodal deepfake detection; dashboard development for various research projects (COVID diagnostic tool, deepfake detection, internal investment data visualization). Served as sponsor to two projects and co-sponsor to one project for Stanford University's Hacking for Defense program over three terms. Technical evaluation of startups considered for investment.

Insight Data Science, Menlo Park, USA
06/2014 – 08/2018
Artificial Intelligence Fellow
Project: Towards a rotationally invariant layer for convolutional neural networks.

IIHE, ULB, Belgium
06/2017 – 06/2018
Postdoctoral Fellow in IceCube group at Inter-University Institute for High Energies, Université Libre de Bruxelles, Belgium.
Projects: Iterative Unfolding, MCMC codebase development, Gen-2 SiPM testing.

UW-Madison, USA
09/2014 – 09/2016
IT Administrator for PostleLab in Psychology & Neuroscience Dept.
09/2010 – 04/2017
Graduate Research Fellow in Department of Physics. NSF Fellow 2011-2014.

Centro Atomico Bariloche, Argentina
08/2009 – 06/2010
Fulbright Research Scholar at the Pierre Auger Observatory
Project: High Energy Muon Simulations & Water Quality Analysis

Physics Dept, Rice University, USA & CERN, France & Switzerland
05/2008 – 05/2009
Undergraduate Research Assistant
Project: CMS Endcap Muon System Commissioning Studies

C-NR, Los Alamos National Laboratory, USA
05/2004 – 07/2007
Undergraduate Research Assistant
Project: Aqueous Radiochemical Methods Development for Nuclide Separation

Professional Organizations

LANL NM LEEP
11/2020 – Present

Institute of Electrical and Electronics Engineers
09/2020 – Present

Association for the Advancement of Artificial Intelligence
05/2019 – Present

LatinXinAI
03/2019 – Present

American Physical Society
08/2012 – Present

Society for the Advancement of Chicanos and Native Americans in Science (SACNAS)
08/2012 – 08/2015

Teaching

Utah State University
Co-mentoring Utah State graduate student in HSI research funded through LANL via subcontract. Summer 2022 – Present

Stanford University
Mentoring of two CS229 undergraduate students for project on generative adversarial networks. Project summary, Spring 2020

Insight Data Science
Recurring Guest Lecturer, Spring 2019 – Present
A Guide to GitHub & Collaborative Coding

Physics Department, UW-Madison
Guest Lecturer, Acoustics for Musicians, Fall 2016

WIPAC, Physics Department, UW-Madison
Student Mentor, Jan. 2015 – Dec. 2016
Mentoring of two undergraduate research assistants through various HAWC astrophysics projects related to machine learning classification techniques and map-making optimization.

Physics Department, Rice University
Discussion Section & Grading, Computational Physics, Spring 2009

Computational & Applied Mathematics, Rice University
Discussion Section & Grading, Partial Differential Eqs, Fall 2008

Outreach Activities

08/2018 – 09/2021
Introduced new content type to IQT Labs: impact videos. Co-wrote & narrated the first two videos on the VOiCES dataset, and Poseidon cyber-security network analysis tool.

08/2018 – Present
Academic & professional mentor for LatinXinAI members.

08/2010 – 05/2017
Volunteer for Wisconsin IceCube Particle Astrophysics Center (WIPAC). Participating in various WIPAC outreach programs including ice drilling demonstrations at Wisconsin public schools and 'Explorando las Ciencias' bilingual program for the Spanish-speaking community.

12/2012 – 05/2017
Fulbright Alumni Ambassador (AA). Participating in Fulbright outreach at 2013 National SACNAS Conference, informational and recruiting sessions at UW-Madison, UT-San Antonio and St. Mary's University.