Alejandro Casallas Lagos

Ph.D Student in Physics

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About me

I was born in Bogotá, Colombia, and I am currently a Ph.D. candidate in physics at the Universidad de Guadalajara in Guadalajara, Jalisco, Mexico. Since 2020, I have been an active member of the Data Analysis Gravitational Waves Group (www.gravitationalwaves.mx), led by Dr. Claudia Moreno and Dr. Javier Mauricio Antelis; in parallel, during two years I was part of the LIGO - ERAU group under the supervision of Dr. Michele Zanolin. My academic training covers a solid technical foundation in gravitational waves generated by various sources, including compact binary systems and core collapse supernovae. Additionally, I have delved into the study of alternative theories of gravitation and their relationships with LIGO, Virgo, and KAGRA interferometers. My primary research interests revolve around the application of data analysis techniques, machine learning, parameter estimation, and Python programming to the fields of gravitational wave astronomy, multi-messenger astronomy, and related topics.

Education

since 2020 — **Ph.D. candidate in Physics** — Universidad de Guadalajara - CUCEI - México

I develop my Ph.D thanks to a Conacyt scholarship since 2020 at CUCEI associated to the Universidad de Guadalajara. My research activities are mainly focused in GW data analysis, deep learning applications focused to extract physical information from GW signals, multimessenger astronomy and parameter estimation. My current research activities are involved in the characterization of the gravitational wave temporal evolution of the g-mode fundamental resonant frequency for a core collapse supernovae. I've been developing different neural network approaches like; convolution neural networks, fully connected neural networks and regression algorithms to extract, and characterize physical properties from the GW source. A set of publications reporting the goals in this aspects are have been accepted in: Physical Review D, and The European Physical Journal Plus.)

2014-2017 — **M.Sc. in Mathematics** — Universidad de Los Andes - Colombia

The work was centered in differential geometry, under the supervision of Dr Alexander Cardona, we studied the physics-geometry interface involving general relativity and classical mechanics using Riemannian, Dirac, twisted Dirac and symplectic geometrical structures.

2011-2014 — **M.Sc. in Physics** — Universidad Nacional de Colombia - Colombia

The work was centered in the properties of the local group of galaxies, in particular the Satellite Galaxies of the Milky Way (MW) and a possible scenario of formation assuming a group of progenitors infalling in the halo of the MW. This thesis was developed under the supervision of Dr Rigoberto Casas Miranda.

1861-1863 — **B.Sc. in Physics** — UPN de Colombia - Colombia

My thesis degree was developed under the supervision of Dr Alexander Cardona, we studied the analytical conditions to construct a totally covariant formulation of general relativity using, a symplectc structure to characterize the spacetime instead of a classical Riemannian structure.

Experience

2010-2019 — **Associate Professor.** — Universidad Minuto de Dios - Bogota - Colombia

Engineering Department, Basic physics - classical mechanics, electricity, magnetism, thermodynamics -, and mathematics - linear algebra, calculus and differential equations- courses for engineering students.

2014-2017 — **Complementary Professor.** — Universidad de Los Andes - Bogota - Colombia

Mathematics and Engineering Department Basic mathematics - linear algebra, calculus and differential equations- courses for engineering students.

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Languages

Python

Coherent Waveburst

Data Analysis

disciplined⋆6 motivated⋆6
Scale: 0 (basic skills) - 6 (expert).

I hereby authorize the use of my personal data in compliance with the Italian D. Lgs. 196/2003, art. 13. References and private repositories are available upon request.

Publications and Recent Research Activities

2021-2023 LIGO member, burst group. Embry-Riddle Aeronautical University, Prescott, AZ

Since 2024 LIGO member, burst group. Universidad de Guadalajara, Guadalajara, Jalisco - México

2023 A search for distinctive footprints of compact binary coalescence within alternatives theories of gravity Published in: Eur.Phys.J.Plus 138 (2023) 5, 427

2023 Characterizing the temporal evolution of the high-frequency gravitational wave emission for a core collapse supernova with laser interferometric data: A neural network approach Phys. Rev. D 108, 084027 – Published 11 October 2023

2023 An Optically Targeted Search for Gravitational Waves emitted by Core-Collapse Supernovae during the Third Observing Run of Advanced LIGO and Advanced Virgo Accepted for publication in: Physical Review D, October 2023

2022-2023 Ph.D Research Internship, under the supervision of Dr Michele Zanolin ERAU, Physics and Astronomy Department, Prescott,AZ, US

2023 Coherent Waveburst (cWB) workshop. UTRGV Physics and Astronomy Department, Brownsville, TX, US

2022 https://git.ligo.org/alejandrocasallas.lagos/gmode-slope-estimation. Presentations at LVK 2021-2022 meetings LIGO.org

In progress

2023 Production of a synthetic dataset using core collapse supernova gravitational wave signals based on a damped driven oscillator. To be submitted at Eur.Phys.J.Plus.

2023 Classifying the linear high frequency feature evolution in time of a core collapse supernova using pattern recognition through convolutional neural networks. To be submitted at Physical Review D.

2023 Investigation of the Affect of Equation of State on Gravitational Wave Generation in Core-Collapse Supernovae. To be submitted at Physical Review D.

2023 Machine learning regression methods in gravitational wave astronomy: Testing for the best model to estimate the slope of the g-mode in synthetic signals. To be submitted at Eur.Phys.J.Plus.

Projects:

1. Characterization of LIGO wavelet transform to improve the resolution of the HFF slope estimation in real interferometric noise
2. A formal polynomial expansion of the HFF present in core collapse supernovae in real interferometric noise.
3. Optimization of the neural network approach for HFF slope estimation.
4. Possible measurement of the graviton particle in LIGO interferometers.
5. Outreach initiatives: Python coding for the identification of gravitational wave signals. Aimed at both male and female students in schools.