Sofía Álvarez-López

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Research Interests

As a member of the LIGO Scientific Collaboration, my main research interest is gravitational-wave (GW) (astro)physics. Much of my work focuses on detector characterization and data calibration efforts to assist in GW searches and discoveries. I also find fascinating new challenges and detections coming up in next-generation gravitational-wave observatories, such as LISA and the Cosmic Explorer.

Education

Ph.D. in Physics — Starting Fall 2023
Massachusetts Institute of Technology, Cambridge, MA

Bachelor of Science in Physics — Aug. 2017 - Jun. 2023
Universidad de los Andes, Bogotá, Colombia
GPA: 4.77/5.0

Bachelor of Science in Systems and Computing Engineering — Aug. 2018 - Jun. 2023
Universidad de los Andes, Bogotá, Colombia
GPA: 4.77/5.0

Minor in Astronomy — Aug. 2022 - Jun. 2023
Universidad de los Andes, Bogotá, Colombia

Awards and Honors

Mitacs Globalink Research Internship Awardee ($12.000 CAD) — 2022

- The Mitacs Globalink Research Internship is a competitive initiative for undergraduates in which top-ranked applicants participate in a fully-funded 12-week research internship under the supervision of Canadian university faculty members. I was selected from a pool of 1000+ Colombian undergraduates.

Semestral Excellence Award Nominee — 2022, 2023

- Recognition given to the undergraduate student who has obtained the highest GPA in their major in the last semester.
- Nominated in Physics (2nd place) and Computer Science (3rd place) among 370 and 800 students, respectively.

Ramón de Zubiría Award Nominee — 2022

- Recognition given to the undergraduate student with the highest GPA in their major.
- Nominated in Physics (2nd place) among 370 students.

Grace Hopper Celebration Scholar ($450 USD) — 2021

- The Grace Hopper Celebration (GHC) is the world's largest gathering of women technologists. GHC provides scholarships to individuals whose application stands out based on merit and purpose, and who could not otherwise attend the celebration.

Publications

Alvarez-Lopez, S., Liyanage, A., Ding, J., Ng, R., McIver, J. "GSpyNetTree: A signal-vs-glitch classifier for gravitational-wave event candidates." *Status: Submitted to Classical and Quantum Gravity.* arXiv: https://arxiv.org/abs/2304.09977 (2023).

Cely, S., Rueda, C., **Álvarez-López, S.**, Sánchez, M.F., Ávila, C.A., "Reconstructing soft tissue X-ray images using phase retrieval algorithms." *In prep* (2023).

Raimbaud, P., **Álvarez-López, M.S.**, Figueroa, P., Hernandez, J.T., "Influence of Depth Cues on Eye Tracking Depth Measurement in Augmented Reality Using the MagicLeap Device." *2020 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)* (2020), pp. 210-214. DOI: 10.1109/VRW50115.2020.00045

Research Experiences

Developing a gravitational-wave signal vs detector transient noise classifier for the fourth LIGO-Virgo-KAGRA observing run (O4)
University of British Columbia (Vancouver, BC) May 2022 - Present
Mitacs Globalink Research Internship
Mentored by Dr. Jess McIver

- Focused on using Machine Learning to prepare the Gravity Spy Convolutional Neural Network Decision Tree (GSpyNetTree) to automatically distinguish between gravitational-wave (GW) signals and detector glitches using time-frequency visualizations of LIGO and Virgo data. GSpyNetTree will be a fundamental part of the GW candidate validation pipeline for O4, as a Data Quality Review (DQR) task.
- Performed validation studies to evaluate GSpyNetTree's readiness for O4, including its performance in a broad array of background noise, new sources of glitches, and the likely occurrence of overlapping glitches and GWs.
- Used various LIGO Collaboration tools, such as the LALSuite and pyCBC, as well as Gravity Spy, and LIGO-DV, to simulate GWs and retrieve detector glitches (respectively) to build training sets for GSpyNetTree.
- I have given several talks and posters on this research, and a paper on this topic will be soon sent to P&P review within the LIGO Collaboration.
- Incorporating and implementing the upgrades to GSpyNetTree required for O4 has now become my Undergraduate Thesis Project, co-supervised by Dr. Jess McIver and Dr. Alejandro Garcia (Universidad de los Andes).

Reconstructing blood-vessel X-ray images using phase retrieval algorithms
Universidad de los Andes August 2022 - Present
Mentored by Dr. Carlos Ávila

- Collaborated on designing and implementing the X-ray experimental set-up.
- Applied affine transformations to the images and implemented several phase retrieval algorithms in Python that allowed us to visualize the internal structure of blood vessels without using contrast agents
- Wrote final report and gave a poster presentation poster on method/results.
- A publication on our results is in preparation and it will be submitted to a Medical Physics journal.

Phenomenological study of Z' boson searches at the LHC on same-flavor lepton final states
Universidad de los Andes August 2021 - May 2022
Mentored by Dr. Andrés Flórez

- Simulate the production of Z' bosons via the Drell-Yan mechanism and its associated Standard-Model background processes, using high energy physics software such as `Delphes`, `pyROOT`, and `MadGraph`.
- Analyzed various cinematic and topologic variables (e.g., cross-section, transverse momentum, and invariant mass) to accurately segregate the Z' boson signals we were interested in investigating.
- Wrote final report and gave a presentation on method/results.

Studying entanglement routing for quantum networks
University of California, Santa Cruz ISRP June 2021 - August 2021
Mentored by Dr. Chen Qian

- Research intern as part of the International Summer Research Program (ISRP) at UCSC.
- Studied concurrent entanglement algorithms in Quantum Networks and implemented a quantum network simulator in Python, upgrading the original model, which was written in Kotlin.
- Worked alongside UCSC students and other international interns.
- Evaluated with an exceptional performance during the internship by my mentor.

Studying the dynamics of bio-polymers similar to the von-Willebrand factor
Universidad de los Andes June 2019 - August 2020
Max Planck Tandem Group on Computational Biophysics
Mentored by Dr. Camilo Aponte-Santamaria and Ph.D. student Helman Amaya

- Performed Brownian dynamics simulations for polymers similar to the von-Willebrand factor using C++ and GROMACS, which was part of a broader project aiming to understand the dynamics of bio-inspired polymers in shear flows.

Building mixed reality applications to improve human-decision making during the construction process
Universidad de los Andes June 2019 - August 2020
IMAGINE Visual Computing Laboratory
Mentored by Dr. Tiberio Hernández and Ph.D. student Pierre Raimbaud

- Proposed a project in which I studied the influence of depth cues on eye-tracking depth measurement in augmented reality.
- I developed the virtual environment program for the experiments I conducted and performed the data analysis for our project.
- Our results were published for the IEEE VR 2020 conference, as part of the Perceptual and Cognitive Issues in AR workshop, in Atlanta, GA.
- I presented the results as the only undergraduate in the workshop.

Teaching

Teaching Assistant

- Electromagnetism I (2021)
- Differential Calculus (2018)
- Object Oriented Programming and Algorithmic I (2018)
- Computational Infrastucture (2020)

Grader

- Quantum Mechanics I (2021)
- Transactional Systems (2020)

Talks

"GSpyNetTree status for O4" April 2023
UBC LIGO meeting
University of British Columbia, Vancouver, BC.

"GSpyNetTree as a DQR task: current status and plan for the 4th LIGO-Virgo observing run January 2023
LIGO Detector Characterization face-to-face Winter meeting
Livingston, LA.

"GSpyNetTree: The Gravity Spy Convolutional Neural Network Decision Tree" August 2022

- UBC LIGO monthly meeting, University of British Columbia, Vancouver, BC.
- LIGO Detector Characterization Call.

"Discovering gravitational-wave signals: Analysis and visualization of LIGO data" April 2022
Astronomy and Astrophysics seminar
Universidad de los Andes, Bogotá D.C., Colombia

"Introduction to the detection of gravitational-waves with advanced LIGO"
February 2022
Astronomy and Astrophysics seminar
Universidad de los Andes, Bogotá D.C., Colombia

"Phenomenological study of Z' boson searches at the LHC on same-flavor lepton final states" November 2021
High Energy Physics and Phenomenology seminar
Universidad de los Andes, Bogotá D.C., Colombia

"Influence of Depth Cues on Eye Tracking Depth Measurement in Augmented Reality using the MagicLeap" March 2020
IEEE Virtual Reality Conference 2020
Atlanta, GA

Posters

"GspyNetTree: distinguishing gravitational-wave signals from detector transient noise for the fourth LIGO-Virgo-KAGRA observing run."

- February 2023: APS Conferences for Undergraduate Women in Physics (CUWiP). (APS CUWiP Epitome.)

"GSpyNetTree: Improving Gravity Spy classifications toward O4"

- September 2022: 2022 LIGO-Virgo-KAGRA meeting poster session, Cardiff University, Cardiff, Wales.

"Reconstructing blood-vessel X-ray images using phase retrieval algorithms"

- December 2022: Physics undergraduate research and outreach fair, Universidad de los Andes, Bogotá D.C., Colombia.

Relevant Coursework

Physics: Thermodynamics, Classical Mechanics, Electromagnetism, Quantum Mechanics, Statistical Mechanics, Open Clusters, Intermediate Physics Laboratory, Mathematical methods, Computational methods for physicists, Particle Physics, Particle Accelerators and their Applications.

Systems and Computing Engineering: Quantum Computing and Cryptography, Structural mathematics and logic, Data structures, Algorithm design and analysis, Modeling, Simulation and Optimization, Scientific Programming, Visual Analytics, Machine Learning Techniques.

Astronomy: Open Clusters: an observational perspective, Galactic Astronomy, Planetary Astronomy.

Mathematics: Calculus, Differential Equations, Linear Algebra I and II

Skills

- Programming languages: Python, Julia, Matlab, C/C++, Java, Kotlin, Go, Swift, JavaScript/TypeScript
- Operating systems: Mac OS, Linux
- Astronomy software: IRAF/ds9
- LIGO tools: LIGO-dv, LALSuite, pyCBC
- Others: LaTeX, Git, Bash, SQL, GlobeGL, Vega-Lite, HTML, CSS

Collaborations and Professional Memberships

Student member of the LIGO Scientific Collaboration
Student member of the Colombian Network of Women Scientists ("*Red Colombiana de Mujeres Científicas*")

Outreach

Gravitational-wave outreach activities September 2020 - present

- Presented an outreach motivational talk on my research in gravitational-waves at LIGO during the "International Science Day" for first semester students.
- Contributed to the Gravity Spy blog, an initiative of LIGO's Gravity Spy project members to showcase work on detector characterization and interface with both the public and the scientific community.

Girl Up Campus Club Founding Member and President
Universidad de los Andes Jan. 2018 - Dec. 2020

- Willing to advocate for women (specially in STEM), I founded the first Girl Up Campus Club in Colombia. Girl Up is a United Nations Foundation initiative which aims to help adolescent girls in developing countries. We develop activities in favor of Girl Up's objectives (health, education, gender equality and abolition of gender violence) whilst empowering women in our own community, so that every girl and every woman is able to achieve her dreams and her full potential.
- Made part of Girl Up + Disney's global campaign: Dream Big, Princess.
- Organized and held various conferences with recognized University forums (+200 people reached) to empower young women to consider careers in STEM and discuss gender bias in STEM fields with female colombian Physics Faculty.

Volunteer and Panelist, Professional Orientation Forum May 2018 - Nov 2018

- Volunteer and panelist in the Women for Colombia ("*Mujeres por Colombia*") forum for low-income high school female students to motivate them to get into STEM, to increase women's participation in these fields. I have been a panelist in Physics and Systems and Computing Engineering.

Volunteer, Colombian Network of Female Scientists (RCMC) Sep. 2019

- I represented RCMC as a volunteer at the outreach event "*Cacharrear con Ciencia-ExpoCiencia*" in which we introduced to 700+ primary and middle school stu-

dents the work of the female Physics Nobel Laureates and showcased demonstration experiments.

Grants

I was given a partly-funded travel grant from the Computer Science Department to present my talk at the IEEE Virtual Reality Conference in Atlanta, GA, representing Universidad de los Andes.

Mentorship

Mentee, OneQuantum and KeySight Technologies — Oct. 2021 - Dec. 2021

- Selected as a mentee, under the guidance of Katiuscia Cassemiro Ph.D., to build soft skills, and gain beyond-the-classroom abilities in quantum computing.

Mentor, Compas Program — Jan. 2021 - Jun. 2021

- Mentored a first-semester Physics student.

Extracurricular Activities

Tennis and Piano

- I love playing tennis and playing the piano in my free time