Iván Villegas Pérez

ivanvillegasperez@protonmail.com — LinkedIn — GitHub — OrcID ivanvillegas7.github.io

RESEARCH PROFILE

MSc physicist specialized in astroparticle physics and indirect dark matter searches with gamma-ray telescopes. Research experience within the MAGIC Collaboration focused on Bayesian modelling of dark matter density profiles, J-factor computations, and statistical analyses relevant for indirect dark matter searches with Imaging Atmospheric Cherenkov Telescopes. Interested in dark matter phenomenology, γ-ray astrophysics, and high-energy particle astrophysics.

RESEARCH INTERESTS

Experimental particle and astroparticle physics, detector instrumentation, signal processing, data analysis for high-energy physics, γ-ray astronomy, computational methods in experimental physics

EDUCATION

University of Oslo (UiO), Oslo, Norway — August 2023 — June 2025
Master of Science in Nuclear and Particle Physics — Cumulative grade: 8.1/10
Thesis Title: Analysis of the dark matter density profile of the globular cluster M15

University of Cantabria (UniCan), Santander, Spain — September 2019 — June 2023
Bachelor of Science: Fundamental Physics — Cumulative grade: 7.93/10
Thesis Title: Simulación, detección y caracterización de tránsitos de exoplanetas con la misión espacial Kepler

ACADEMIC EXPERIENCE

MAGIC Collaboration — Oslo, Norway
MSc student at UiO — November 2023 — June 2025

- Performed Bayesian Jeans analyses of stellar kinematic data for the globular cluster M15.
- Computed astrophysical J-factors using multiple dark matter halo parametrizations (Einasto, Burkert, Zhao–Hernquist).
- Applied Markov chain Monte Carlo (MCMC) methods and statistical model comparison techniques.
- Contributed to indirect dark matter searches with the MAGIC telescopes.
- Completed a six-week technical shift at the *Observatorio del Roque de los Muchachos* (La Palma, Spain), contributing to telescope operations and data-taking activities.
- Presented results at international collaboration meetings and conferences.
- Co-author and corresponding author of a MAGIC Collaboration manuscript currently in preparation.

Instituto de Física de Cantabria (IFCA) — Santander, Spain
Student Intern — Spring 2023

- Development and characterization of an instrumental calibration source for CMB polarization experiments.
- Work at the interface between instrumentation, calibration, and data analysis.
- Study of systematic effects in detector response.
- Exposure to space-borne and ground-based experimental constraints.

PROJECTS

Analysis of the dark matter density profile of the globular cluster M15 — Oslo, Norway
M.Sc. Research project (MAGIC Collaboration) — November 2023 — June 2025

- Computation of astrophysical J-factors for the globular cluster M15 using CLUMPY.
- Implementation and comparison of different dark matter density profiles (Einasto, NFW, cored models).
- Study of tidal effects and their impact on the expected γ-ray flux.
- Interpretation of results in the context of indirect dark matter searches with IACTs.
- Available here.

Computing the CMB power spectrum — Oslo, Norway
Course project (Cosmology II, MSc at UiO) — Spring 2024

- Computation of the CMB temperature angular power spectrum using publicly available cosmological data.
- Numerical implementation of spherical harmonic decomposition and power spectrum estimation.
- Comparison of theoretical predictions with observational results.

- Available here.

Simulación, detección y caracterización de tránsitos de exoplaneta con la misión espacial Kepler Santander, Spain
Bachelor's Thesis (Trabajo de Fin de Grado) September 2022 — June 2023

- Simulation and detection of exoplanet transit signals using photometric data from the *Kepler* space mission.
- Implementation of transit detection algorithms and characterization of planetary parameters.
- Analysis of noise sources and systematic effects in space-based photometric observations.
- Available here.

A review of "Calibration Satellite for Ultrasensitive Cosmic Microwave Background Polarization ground-based Experiments" Master's Thesis Santander, Spain
Undergraduate Research Project (IFCA-University of Cantabria) Spring 2023

- Design and characterization of an on-board calibration source for CMB polarization experiments.
- Study of instrumental systematics affecting ground-based CMB telescopes.
- Contribution to feasibility studies for a low Earth orbit (LEO) calibration mission.
- Available here.

Application of Schrödinger's equation in a box using a single, double and triple slit configuration Oslo, Norway
Course project (Computational Physics, BSc at UniCan/ERASMUS at UiO) Fall 2021

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- Developed Python-based numerical implementations for solving the time-independent Schrödinger equation.
- Applied numerical methods to study quantum-mechanical systems and eigenvalue problems.
- Implemented scientific visualization tools for wavefunctions and energy spectra.
- Available here.

PUBLICATIONS

Journal Articles

- Saturni, F. G., Maggio, C., Villegas-Pérez, I., D'Amico, G., Doro, M., & Manganaro, M., *Indirect dark matter searches in the globular cluster M15 with the MAGIC telescopes.* Manuscript in preparation for submission **(Corresponding author)**.

CONFERENCE PROCEEDINGS AND CONTRIBUTIONS

- Oral presentation — MAGIC+LST Face-to-Face Science Meeting 2025, Garching, Germany.
- Oral presentation — 28th Nordic Particle Physics Meeting 2025, Svingvoll, Norway.
- Oral presentation — MAGIC General Meeting 2024, Łódź, Poland.

SELECTED COURSES

Master's Courses

- Methods and Instrumentation for Nuclear and Particle Physics
- Particle Physics
- Relativistic Quantum Field Theory
- Cosmology II
- Astroparticle Physics
- Bayesian Cosmological Data Analysis

Bachelor's Courses

- Quantum Mechanics
- Astrophysics
- General Relativity
- Advanced Computation
- Astronomy
- Computational Physics
- Introduction tu Nuclear and Particle Physics

AWARDS

Erasmus+ Scholarship Oslo, Norway
Exchange program at the University of Oslo 2022–2023

High Academic Distinction in High School Santander, Spain
Ranked 6th in the Regional Physics Olympiad 2019

$6^{\mathbf{th}}$ place at the Physics Olympics in Cantabria Santander, Spain
Ranked 6th in the Regional Physics Olympiad 2019

OTHER EXPERIENCES

Project Technician in the Business Innovation Area Cantabria, Spain
SODERCAN 2026 — Present

- Support for innovation and R&D projects involving companies, public institutions, and technology initiatives.
- Preparation and review of technical and administrative project documentation.
- Participation in project evaluation and innovation strategy activities.
- Experience working in multidisciplinary and collaborative environments.

Basketball Head Coach (Under-12) Cantabria, Spain
Escuela Municipal (E. M.) Piélagos 2017 — 2018

- Leadership and mentoring of youth teams.
- Organization of training sessions and competitions.
- Development of communication and teamwork skills.

SKILLS

- Experimental data analysis.
- Signal processing (time-series, noise, systematics).
- Statistical inference & Bayesian methods.
- Familiarity with large experimental software frameworks.
- Willingness and ability to learn electronics / photonics / ML techniques.

- **Programming & Scientific Computing:** Python, C++, MATLAB, Linux/Unix environments, Git/GitHub, LaTeX.
- **Scientific Tools:** `ROOT, CLUMPY, NumPy, SciPy, Matplotlib, pandas`.
- **Data Analysis:** Statistical modelling, Monte Carlo simulations.
- **Languages:** Spanish (native), English (C1), German (B1) and Norwegian (basic).

REFERENCES

Dr. Giacomo D'Amico
Postdoc researcher, Gamma-ray Group, Institut de Física d'Altes Energies (IFAE), Barcelona, Spain
E-mail: gdamico@ifae.es
Scholar Profiles: Google Scholar — OrcID

Dr. Francesco G. Saturni
Fixed-term staff researcher, Relativalistic and Particle Astrophysics, Italian National Institute for Astrophysics (INAF), Roma, Italy
E-mail: francesco.saturni@inaf.it
Scholar Profiles: Google Scholar — OrcID

Prof. Heidi Sandaker
Professor, High Energy Physics, University of Oslo, Oslo, Norway
E-mail: Heidi.Sandaker@cern.ch
Scholar Profiles: University of Oslo - Personal Page — OrcID

Prof. Diego Herranz Muñoz
Professor, Modern Physics, University of Cantabria and IFCA (CSIC-UC), Santander, Spain
E-mail: herranz@ifca.unican.es
Scholar Profiles: IFCA - Personal Page — UC - Personal Page — Google Scholar — OrcID

Dr. Francisco Javier Casas Reinares
Permanent Hired Doctor, Cosmology and Instrumentation, Instituto de Física de Cantabria (IFCA, CSIC-UC), Santander, Spain
E-mail: casas@ifca.unican.es
Scholar Profiles: IFCA - Personal Page — Google Scholar — OrcID