

## Part A. PERSONAL INFORMATION

CV date	06/06/2026
---------	------------

First name	Iván		
Family name	Villegas Pérez		
Gender	Male	Birth date	
Social Security, Passport, ID number			
e-mail	ivanvillegasperez@protonmail.com	URL Web	ivanvillegas7.github.io
Open Researcher and Contributor ID (ORCID)		0009-0001-2300-603X	

### A.1. Education

Degree/Master	University	Year
Master in Physics	University of Oslo	2023/2025
Degree in Physics	University of Cantabria	2019/2023

## Part B.

### CV SUMMARY

I hold a Master's degree in Physics from the University of Oslo, where I specialized in astroparticle physics within the Nuclear and Particle Physics' program. My research interest lies in indirect dark matter detection, particularly through  $\gamma$ -ray observations with Imaging Atmospheric Cherenkov Telescopes (IACTs). During my Master's thesis within the MAGIC Collaboration, I performed Bayesian Jeans analyses of the globular cluster M15 in order to constrain its dark matter density distribution and compute astrophysical J-factors relevant for indirect dark matter searches with Imaging Atmospheric Cherenkov Telescopes (IACTs). This work involved Markov chain Monte Carlo methods, statistical modeling, and the comparison of several dark matter halo parametrizations. The results contributed to a forthcoming MAGIC publication on searches for annihilating dark matter signals from M15, for which I am one of the corresponding authors.

As a member of the MAGIC Collaboration, I gained substantial experience in high-energy astrophysics and scientific communication. I presented my results at several international meetings, including MAGIC's General Meeting (2024), the 28<sup>th</sup> Nordic Particle Physics Meeting (2025) and the MAGIC+LST F2F Science Meeting (2025). I also completed a six-week technical shift at the MAGIC site (*Observatorio del Roque de los Muchachos*, La Palma, Spain), contributing to telescope operations, troubleshooting, data-taking activities, and commissioning tasks related to the preparation of new facilities.

Previously, I interned at the *Instituto de Física de Cantabria* (IFCA) in the Observational Cosmology and Instrumentation group, where I worked on the CalSat project: the development and characterization of a calibration source for ground-based CMB polarization experiments. This experience provided me with a solid background in instrumentation and detector calibration.

I completed my Bachelor's degree at the University of Cantabria, with a specialization in fundamental physics, astrophysics and cosmology. During my ERASMUS exchange year I strengthened and developed strong adaptability to international research environments. My Bachelor's thesis focused on the simulation, detection and characterization of exoplanet transits using Kepler data.

cross my academic path, I have developed strong programming and scientific computing skills in Python, C++, and MATLAB, together with experience using Linux environments, Git/GitHub, and scientific writing in LaTeX. I also have experience with statistical analysis, Monte Carlo methods, numerical modeling, and  $\gamma$ -ray astrophysical data processing. I am fluent in English (C1), have an intermediate knowledge of German (B1) and basic Norwegian.



These experiences have provided me with a solid scientific foundation, hands-on research expertise and the technical skills needed to succeed in high-energy astrophysics or related fields.

### **B.1. Brief summary of the Undergraduate Thesis (or equivalent) and score obtained.**

In my Final Degree Project, exoplanet detection techniques and various data cleaning techniques obtained from the Kepler space telescope have been studied, going for the use of a median filter. Data from the Kepler satellite and its noise have been analyzed. Based on this information, a Python program has been developed to read and clean the data, enabling the characterization of the studied exoplanet as long as the mass, radius, and temperature of the star are known. Firstly, to verify the functionality of the used program, various simulations were conducted, addressing issues and making the code as efficient as possible. Once it was confirmed that the developed program returns numerical values consistent with the input values, the effectiveness of this data cleaning method has been tested. The dependence of the relative error has been obtained by varying different parameters, with the highest dependence found when altering the periods of the planetary transit and, to a greater extent, the period of stellar variability. The main advantage of this method is that, regardless of the amount of noise, it is capable of accurately obtaining the period of the planetary transit. However, it excessively relies on fitting the stellar variability to a sine function. This leads to a significant error source, mainly because the variability of stars is often not described by such a curve, nor does it necessarily follow this type of oscillation.

Score: 8.8/10

### **B.2. Brief summary of the Master's Thesis and score obtained.**

Dark matter constitutes approximately 25% of the total energy content of our universe and despite having evidence for its existence, its precise nature is unknown. In this work, I have studied the dark matter density distribution of the globular cluster M15 in order to derive the so-called astrophysical factor ( $J$ ) which quantifies the dark matter content along a line of sight. This result will be used in the analysis of the data taken by the gamma ray observatory MAGIC, either to enable the detection of a dark matter signal or to constrain key particle parameters (such as mass, annihilation cross-section, and lifetime). With this goal in mind, I performed a Markov chain Monte Carlo Jeans analysis on the kinematic data of M15 member stars, testing three different density profiles – Einasto, Burkert, and Zhao-Hernquist. The derived astrophysical factors are consistent with those reported in previous studies. A statistical test on the reduced  $\chi^2$  posterior distributions indicates that cuspy profiles (Einasto and Zhao-Hernquist) provide the best fit. Specifically, for an integration angle of  $0.5^\circ$  the dark matter distribution in M15 is best described by a cuspy profile, with  $J(0.5^\circ) \in [2.5 \cdot 10^{23}, 8 \cdot 10^{26}] \text{ GeV}^2/\text{cm}^5$ , or  $\log_{10}(J(0.5^\circ)/(\text{GeV}^2/\text{cm}^5)) \in [23.4, 25.7]$ . Additionally, I showed that M15's dark matter halo is spatially extended with respect to the MAGIC telescopes' point spread function, regardless of the used profile. This result implies the need for extended-source analysis methods in MAGIC observations of M15.

Score: B



## Part C. RELEVANT SCIENTIFIC RESULTS

### C.1. Manuscripts in Preparation.

Searches for annihilating dark matter signals from the globular cluster M15 with MAGIC, F. G. Saturni, *et al.* Manuscript in preparation (corresponding author).

### C.2. Conferences and meetings.

2025 – MAGIC+LST Face to Face (F2F) Science Meeting, Garching, Germany. Type of participation: Contributed oral presentation, *Analysis of the dark matter density profile of M15*.

2025 – The 28th Nordic Particle Physics Meeting, Svingvoll, Norway. Type of participation: Contributed oral presentation, *Analysis of the dark matter density profile of M15*.

2024 – MAGIC General Meeting, Łódź, Poland. Type of participation: *Contributed oral presentation, Analysis of the dark matter density profile of M15*.

2024 – Nordic Conference on Dark Matter Searches, Bergen, Norway. Type of participation: *Attendee*.

2024 – MAGIC Face-to-Face Meeting, Padova, Italy. Type of participation: *Attendee*.

### C.3. Research projects and research lines.

M.Sc. Thesis: Analysis of the dark matter density profile of the globular cluster M15, University of Oslo, 2025 (author). Available [here](https://hdl.handle.net/10852/120910): <https://hdl.handle.net/10852/120910>

Course project (Cosmology II): Computing the CMB power spectrum, University of Oslo, 2024 (author). Public [GitHub repository](https://github.com/ivanvillegas7/CMB_power_spectrum) available: [https://github.com/ivanvillegas7/CMB\\_power\\_spectrum](https://github.com/ivanvillegas7/CMB_power_spectrum)

B.Sc. Thesis: *Simulación, detección y caracterización de tránsitos de exoplanetas con la misión espacial Kepler*, University of Cantabria, 2023 (author). Available [here](https://hdl.handle.net/10902/30224): <https://hdl.handle.net/10902/30224>

Undergraduate research project (IFCA internship): A review of “Calibration Satellite for Ultrasensitive Cosmic Microwave Background Polarization ground-based Experiments” Master’s Thesis, IFCA-University of Cantabria, 2023 (author). Public [GitHub repository](https://github.com/ivanvillegas7/CalSat_for_Ground-based_CMB_experiments) available: [https://github.com/ivanvillegas7/CalSat\\_for\\_Ground-based\\_CMB\\_experiments](https://github.com/ivanvillegas7/CalSat_for_Ground-based_CMB_experiments)

Course project (Computational Physics): Application of Schrödinger’s equation in a box using a single, double and triple slit configuration, University of Oslo, 2021 (corresponding author). Public [GitHub repository](https://github.com/ivanvillegas7/Schrodinger_equation) available: [https://github.com/ivanvillegas7/Schrodinger\\_equation](https://github.com/ivanvillegas7/Schrodinger_equation)