

Pablo Villanueva Domingo

PhD student at IFIC (UV-CSIC)
on Cosmology and Deep Learning

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Personal data

Present position PhD student at Instituto de Física Corpuscular (IFIC) - Universitat de València (UV).
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INSPIRE-HEP [P.Villanueva.Domingo.1](https://inspirehep.net/literature/1987441)

Main interests Machine Learning, Deep learning, Data science, Natural Language Processing.
Research interests Cosmology, Dark Matter, 21 cm cosmology, Reionization, Primordial Black Holes, Large scale structure.

Education

2016-Now **PhD in Physics**,
Instituto de Física Corpuscular (IFIC) - Universitat de València (UV).
PhD project: *Dark Matter and 21 cm Cosmology*.
Advisors: Olga Mena Requejo, Sergio Palomares Ruiz..

2015–2016 **Master in Advanced Physics**, Speciality in theoretical physics.
Universitat de València (UV).
Master thesis: *21 cm Cosmology, Warm Dark Matter and Reionization*.
Advisor: Olga Mena Requejo.

2011–2015 **Bachelor of Physics**,
Universitat de València (UV).
Bachelor thesis: *Non-standard cosmology: relativistic species in the early universe*.
Advisor: Olga Mena Requejo.

Fellowships, contracts & awards

2021-Now Research contract *Técnico superior de apoyo a la investigación, CIDEAGENT/2018/019, CPI-21-108*. Instituto de Física Corpuscular (IFIC).

2017-2021 PhD fellowship *Ayuda para contrato predoctoral para la formación de doctores (FPI), Ref. SEV-2014-0398-16-3*. Instituto de Física Corpuscular (IFIC). Advisors: Olga Mena Requejo, Sergio Palomares Ruiz.

Dec. 2016 1st prize, in collaboration with Jaime Bautista Navío, in the *XXVII edición del Premio Rotary al Fomento del Trabajo Experimental en Física* awarded by the Rotary Club Valencia-Centro.
Advisor: Vicent J. Martínez.
Title of the work: *Medida del brillo superficial límite con corrientes de marea*.

2016-2017 PhD contract *Sabor y origen de la materia (SOM).CPI-16-242. PROMETEU per a grups d'investigació d'Excel·lència de la Conselleria d'Educació, Cultura i Esport. CPI-16-242*. Instituto de Física Corpuscular (IFIC). Advisors: Olga Mena Requejo, Sergio Palomares Ruiz.

- 2016 Research introduction fellowship *Iniciación a la investigación Severo Ochoa*. Instituto de Física Corpuscular (IFIC). Advisor: Olga Mena Requejo.

Seminars

- Dec. 6 2019 *Constraining Dark Matter scenarios through 21 cm cosmology*. Université Libre de Bruxelles, Brussels, Belgium.
- Oct. 14 2019 *Constraining Primordial Black Hole scenarios with 21 cm cosmology*. Department of Astrophysical Sciences, Princeton University, USA.
- May 6 2019 *Exploring Dark Matter scenarios through 21 cm Cosmology*. Instituto de Física Corpuscular (IFIC).
- Dec. 7 2018 *Constraints on Dark Matter scenarios through 21 cm Cosmology*. Instituto de Física Corpuscular (IFIC).
- Oct. 25 2018 *Constraining astrophysical and Dark Matter scenarios with EDGES and Reionization data*. University of Nagoya, Japan.
- Oct. 23 2018 *Constraining astrophysical and Dark Matter scenarios with EDGES and Reionization data*. Kavli IPMU, University of Tokyo, Japan.

Conferences & workshops

- Nov. 2020 *AI@IFIC (Artificial Intelligence at IFIC)*. Instituto de Física Corpuscular (IFIC).
• **Talk:** *Recovering the Dark Matter density field from 21cm maps via CNNs*.
- Apr. 2020 Hackaton *CoronaHack - AI vs. Covid-19*. Online, organized by mindstream-ai.
- Jun. 2019 *Invisibles19 Workshop*. Jardí Botànic de la UV, València. **Member of the local organizing committee.**
• **Talk and poster:** *Local 21 cm signal from Primordial Black Holes*.
- Mar. 2019 Symposium *Data science symposium, bridging fundamental research and industry*. Universidade do Minho, Braga, Portugal.
- Sep. 2018 *IGM 2018: Revealing Cosmology and Reionization history with the Intergalactic Medium*. Kavli IPMU, University of Tokyo, Japan.
- May 2018 *Statistical Challenges in 21st Century Cosmology*. Universitat de València (UV).
- Nov. 2017 *Physics opportunities with a new universe's view: the SKA radio telescope*. Instituto de Física Corpuscular (IFIC).
• **Talk:** *Warm dark matter and cosmic reionization*.
- Sep. 2017 *Meeting on Fundamental Cosmology*. Centro de Estudios de Física del Cosmos de Aragón (CEFCA).
• **Talk:** *Warm dark matter and the ionization history of the Universe*.
- Apr. 2017 *IberiCOS 2017*. Universitat de València (UV).
- May 2016 *Planck 2016*. Universitat de València (UV).

Courses & schools

- Jun. 2020 School *Cosmology Summer School 2020*. University of Michigan.
- Apr.-May 2020 Course *Introduction to Machine Learning for Particle Physicists*. Instituto de Física Corpuscular (IFIC).
- Jun. 2019 *Invisibles19 School*. Laboratorio subterráneo de Canfranc (LSC). **Member of the local organizing committee.**
• **Poster:** *Local 21 cm signal from Primordial Black Holes*.
- Mar. 2019 School *Data science in (astro)particle physics and cosmology: the bridge to industry*. Universidade do Minho, Braga, Portugal.

- Jan. 2019 Course *Effective Field Theory*. Instituto de Física Corpuscular (IFIC).
- Jun. 2018 School *Cosmological Applications from First Stars, Reionization and 21-cm Observations*. Institut de Ciències del Cosmos Universitat de Barcelona (ICCUB).
• Talk and poster: *EDGES result versus CMB and low-redshift constraints on ionization histories*.
- May 2018 School *8th IDPASC School*. Instituto de Física Corpuscular (IFIC).
- May 2018 School *Astronomical Data Analysis school ADA IX*. Universitat de València (UV).
- Mar. 2018 Course *Anomalies in Quantum Field theory*. Instituto de Física Corpuscular (IFIC).
- Feb. 2018 Course *Theories of modified gravity*. Universitat de València (UV).
- Jan. 2018 Course *Constrained Hamiltonian systems*. Universitat de València (UV).
- Oct. 2017 School *Hot topics in cosmology*. Institut de Ciències del Cosmos - Universitat de Barcelona (ICCUB).
- Sep.-Dec 2017 Course *Group theory*. Universitat de València (UV).
- May 2017 Course *Computer tools in particle physics*. Instituto de Física Corpuscular (IFIC).
- Apr. 2017 Course *From QFT to holography and back*. Instituto de Física Corpuscular (IFIC).
- Mar. 2017 Course *Overview of Astrophysical Gas Dynamics and Numerical Simulations*. Institut de Ciències del Cosmos - Universitat de Barcelona (ICCUB).
- Mar. 2017 School *The IFT School on Cosmology Tools*. Instituto de Física Teórica (IFT).
- Feb. 2017 Course *Data analysis and machine learning -Phyton-*. Universitat de València (UV).
- Oct. 2016 Course *Transiciones de Fase y Fenómenos Críticos - Superconductividad*. Universitat de València (UV).
- May 2016 Course *Scientific Python*. Instituto de Física Corpuscular (IFIC).
- Apr. 2016 Course *Black holes in general relativity and beyond*. Universitat de València (UV).
- Feb. 2013 Course *Asymptotic methods*. Universitat de València (UV).

Research stays

- Nov.- Dec. 2019 3 weeks at Service de Physique Théorique, Université Libre de Bruxelles, Brussels, Belgium.
- Sep.- Oct. 2019 1 month at Department of Astrophysical Sciences, Princeton University, New Jersey, USA.
- Sep.- Nov. 2018 2 months at Kavli IPMU, University of Tokyo, Japan, within the project *RISE InvisiblesPlus(69057-InvisiblesPlus-H2020-MSCA-RISE)*.
- Jun.- Jul. 2018 1 month at Institut de Ciències del Cosmos - Universitat de Barcelona (ICCUB), Barcelona, Spain.
- Apr.- May. 2018 1 month at Institut de Ciències del Cosmos - Universitat de Barcelona (ICCUB), Barcelona, Spain.
- Jun.- Aug. 2017 2 months at Fermi National Accelerator Laboratory (Fermilab), Illinois, USA, within the project *RISE InvisiblesPlus(69057-InvisiblesPlus-H2020-MSCA-RISE)*.

Skills

Computation

Programming languages	Python (NumPy, SciPy, Matplotlib, pandas...), C, C++, C#, Fortran, SQL, HTML.
Scientific software	Mathematica, LaTeX, MATLAB, Gnuplot.
Cosmological software	CLASS, CAMB, 21cmFAST, Recfast, CosmoRec, Ares.

Machine Learning

ML packages PyTorch, Tensorflow/Keras, PyTorch Geometric, Scikit-learn.

Neural Nets **Main experience with Neural Nets:** Convolutional Neural Nets (CNNs), UNets, Generative Adversarial Nets (GANs), Graph Neural Nets (GNNs).

Other experience: Recurrent Neural Nets (RNNs), Long short-term memory (LSTM), Random forests, Natural Language Processing, Reinforcement Learning.

Languages

Spanish Mother tongue

Catalan Mother tongue

English Fluent

Portuguese Basics

Additional work experience

2020 Journal referee for Monthly Notices of the Royal Astronomical Society (MNRAS).

Apr. 2017 Collaboration in the organization of the scientific dissemination event *Feria-Concurso Experimental*. València.

May 2016 Collaboration in the organization of the scientific dissemination event *Feria-Concurso Experimental*. València.

Apr. - May 2016 Research work: *Baryonic acoustic oscillations and wavelets*. Observatorio Astronómico de la Universitat de València (OAUUV). Advisors: Vicent J. Martínez, Pablo Arnalte Mur.

Feb. - Jun. 2015 Introduction to research work: *Light nuclei in Big Bang Nucleosynthesis*. Instituto de Física Corpuscular (IFIC). Advisor: Olga Mena Requejo.

2013 Teacher of private math and physics lessons.

Publications

Apr. 2021 Pablo Villanueva-Domingo and Kiyotomo Ichiki.
21 cm Forest Constraints on Primordial Black Holes.
[arXiv:2104.10695](https://arxiv.org/abs/2104.10695)

Mar. 2021 Pablo Villanueva-Domingo, Olga Mena and Sergio Palomares-Ruiz.
A brief review on primordial black holes as dark matter.
[Front. Astron. Space Sci.](https://arxiv.org/abs/2103.12087), 28 May 2021; [arXiv:2103.12087](https://arxiv.org/abs/2103.12087)

Jan. 2021 Pablo Villanueva-Domingo and Francisco Villaescusa-Navarro.
Removing Astrophysics in 21 cm maps with Neural Networks.
[The Astrophysical Journal](https://arxiv.org/abs/2006.14305), 907(1):44, 2021; [arXiv:2006.14305](https://arxiv.org/abs/2006.14305)

Jun. 2020 Laura Lopez-Honorez, Olga Mena, Sergio Palomares-Ruiz, Pablo Villanueva-Domingo and Samuel J. Witte.
Variations in fundamental constants at the cosmic dawn.
[JCAP](https://arxiv.org/abs/2004.00013), 2006(06):026, 2020; [arXiv:2004.00013](https://arxiv.org/abs/2004.00013)

Apr. 2020 Pablo Villanueva-Domingo, Olga Mena and Jordi Miralda-Escudé.
Maximum amplitude of the high-redshift 21-cm absorption feature.
[Phys. Rev. D](https://arxiv.org/abs/1912.09488)101(8):083502, 2020; [arXiv:1912.09488](https://arxiv.org/abs/1912.09488)

Aug. 2019 Olga Mena, Sergio Palomares-Ruiz, Pablo Villanueva-Domingo, and Samuel J. Witte.
Constraining the primordial black hole abundance with 21-cm cosmology.
[Phys. Rev.](https://arxiv.org/abs/1906.07735), D100(4):043540, 2019; [arXiv:1906.07735](https://arxiv.org/abs/1906.07735)

Jan. 2019 Laura Lopez-Honorez, Olga Mena and Pablo Villanueva-Domingo.
Dark Matter microphysics and 21 cm observations.
[Phys. Rev.](https://arxiv.org/abs/1811.02716), D99(2):023522, 2019; [arXiv:1811.02716](https://arxiv.org/abs/1811.02716)

- Jun. 2018 Miguel Escudero, Laura Lopez-Honorez, Olga Mena, Sergio Palomares-Ruiz and Pablo Villanueva-Domingo.
A fresh look into the interacting dark matter scenario.
[JCAP, 1806\(06\):007, 2018; arXiv:1803.08427](#)
- May 2018 Samuel Witte, Pablo Villanueva-Domingo, Stefano Gariazzo, Olga Mena and Sergio Palomares-Ruiz.
EDGES result versus CMB and low-redshift constraints on ionization histories.
[Phys. Rev., D97\(10\):103533, 2018; arXiv:1804.03888](#)
- Apr. 2018 Pablo Villanueva-Domingo, Stefano Gariazzo, Nickolay Y. Gnedin and Olga Mena.
Was there an early reionization component in our universe?
[JCAP, 1804\(04\):024, 2018; arXiv:1712.02807](#)
- Jan. 2018 Pablo Villanueva-Domingo, Nickolay Y. Gnedin, and Olga Mena.
Warm Dark Matter and Cosmic Reionization.
[The Astrophysical Journal, 852\(2\):139, 2018; arXiv:1708.08277](#)
- Nov. 2017 Laura Lopez-Honorez, Olga Mena, Sergio Palomares-Ruiz and Pablo Villanueva-Domingo.
Warm dark matter and the ionization history of the Universe.
[Phys. Rev., D96\(10\):103539, 2017; arXiv:1703.02302](#)

References

Dr. Olga Mena Requejo

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