

# 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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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.

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## 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.

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## 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).

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## 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

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## Outreach

- Feb. 2021 [Outreach video](#) about the astronomer Sandra M. Faber within the project *Pioneras - Recordando a Lise Meitner*.
- 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.

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## Additional work experience

- 2020 Journal referee for Monthly Notices of the Royal Astronomical Society (MNRAS).
- Apr. - May 2016 Research work: *Baryonic acoustic oscillations and wavelets*. Observatorio Astronómico de la Universitat de València (OAUV). 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.

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## Publications

- Apr. 2021 Pablo Villanueva-Domingo and Kiyotomo Ichiki.  
*21 cm Forest Constraints on Primordial Black Holes*.  
[arXiv: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.](#), 28 May 2021; [arXiv:2103.12087](#)
- Jan. 2021 Pablo Villanueva-Domingo and Francisco Villaescusa-Navarro.  
*Removing Astrophysics in 21 cm maps with Neural Networks*.  
[The Astrophysical Journal](#), 907(1):44, 2021; [arXiv: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](#), 2006(06):026, 2020; [arXiv: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](#)101(8):083502, 2020; [arXiv: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., D100\(4\):043540, 2019; arXiv:1906.07735](#)
- Jan. 2019 Laura Lopez-Honorez, Olga Mena and Pablo Villanueva-Domingo.  
*Dark Matter microphysics and 21 cm observations.*  
[Phys. Rev., D99\(2\):023522, 2019; arXiv: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](#)

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## References

### **Dr. Olga Mena Requejo**

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### **Prof. Jordi Miralda Escudé**

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