Pablo Villanueva Domingo

PhD in Physics,
specialized in Cosmology and Deep Learning

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Last update: July 28, 2021

Personal data

Present position	Research assistant 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	Cosmology, Dark Matter, 21 cm cosmology, Reionization, Primordial Black Holes.

Education

2016-2021 **PhD in Physics, *cum laude***, Instituto de Física Corpuscular - Universitat de València.
PhD thesis: *Shedding light on Dark Matter through 21 cm Cosmology and Reionization constraints.*
Advisors: Olga Mena Requejo, Sergio Palomares Ruiz.

2015–2016 **Master in Advanced Physics**, Speciality in theoretical physics. Universitat de València (UV).

2011–2015 **Bachelor of Physics**, Universitat de València (UV).

Fellowships, contracts & awards

2021-Now Research contract *Técnico superior de apoyo a la investigación, CIDEGENT/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*. IFIC.

Dec. 7 2018 *Constraints on Dark Matter scenarios through 21 cm Cosmology*. 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 & meetings

Jul. 2021 *CAMELS meeting*, online, organized by Princeton University and Flatiron CCA.
- **Talk:** *Predicting halo masses with Graph Neural Networks.*

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.*

Courses & schools

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.

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 *Astronomical Data Analysis school ADA IX*. Universitat de València (UV).

Feb. 2017 Course *Data analysis and machine learning -Phyton-*. Universitat de València (UV).

As well as other special courses and schools on theoretical physics, cosmology and computational tools.

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).
Apr.- May. 2018	1 month at Institut de Ciències del Cosmos - Universitat de Barcelona (ICCUB).
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	Python (NumPy, SciPy, Matplotlib, pandas...), C, C++, C#, Fortran, SQL, HTML.
Software	Mathematica, LaTeX, MATLAB, Gnuplot.

Machine Learning

ML packages	PyTorch, Tensorflow/Keras, PyTorch Geometric, Scikit-learn.
Neural Nets	Convolutional Neural Nets (CNNs), U-Nets, Generative Adversarial Nets (GANs), Graph Neural Nets (GNNs), Long short-term memory (LSTM).
Other	Random forests, Natural Language Processing, Reinforcement Learning.

See my webpage for some examples of my work with neural networks.

Languages

Spanish (mother tongue), Catalan (mother tongue), English (fluent), Portuguese (basics).

Outreach & additional work experience

Feb. 2021	Outreach video about the astronomer Sandra M. Faber within the proyect *Pioneras - Recordando a Lise Meitner*.
2020 - Now	Journal referee for Monthly Notices of the Royal Astronomical Society (MNRAS).
2016 - 2017	Collaboration in the organization of the outreach event *Feria-Concurso Experimenta*. València.
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.
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
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. D101(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

References

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Dr. Francisco Villaescusa Navarro
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Dr. Laura Lopez Honorez
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Prof. Nickolay Y. Gnedin
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