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). Parc Científic, C/ Catedrático José Beltrán, 2. Paterna, 46980; Spain.
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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 & awards

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 Experimenta*. València.
May 2016	Collaboration in the organization of the scientific dissemination 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.
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
Mar. 2021	Pablo Villanueva-Domingo, Olga Mena and Sergio Palomares-Ruiz. *A brief review on primordial black holes as dark matter.* arXiv:2103.12087 Submitted to *Frontiers in Astronomy and Space Sciences - section Cosmology* as an invited contribution.
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; https://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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