

Álvaro Parra-López, Physicist



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🏠 Álvaro Parra-López

in alvaroparralopez

Personal Details

- ◇ **Born:** 02/12/97
- ◇ **Nationality:** Spanish
- ◇ **Gender:** male (he/him/his)
- ◇ **Address:** calle Villa de Marin 42, 9A, 28029, Madrid, Spain
- ◇ **Phone number:** (0034) 654 730132

Current Professional Situation

- Dec 2021 –
- ◇ **PhD candidate - Formación de Profesorado Universitario (FPU) Fellow**
Department of Theoretical Physics and IPARCOS, Complutense University of Madrid
PhD in Physics (2021-2024)
Thesis title: "Cosmological production of dark matter in the Universe and in the laboratory"
Supervisors: Prof. José A. R. Cembranos and Prof. Luis J. Garay
Thesis deposited in Oct 2024, expected defense date Dec 2024

Education

- Oct 2021 – Dec 2024
- ◇ **PhD in Physics**
Complutense University of Madrid, Spain
Thesis title: "Cosmological production of dark matter in the Universe and in the laboratory"
Supervisors: Prof. José A. R. Cembranos and Prof. Luis J. Garay
Cum Laude (With Honors)
- Oct 2019 – Oct 2021
- ◇ **Master of Science in Physics (120 ECTS)**
Heidelberg University, Germany
Master's thesis: "A universe on top of a Bose-Einstein condensate"
Supervisor: Prof. Stefan Floerchinger
Overall mark obtained: 1.0 (scale from 5.0 to 1.0)
- Aug 2018 – Jun 2019
- ◇ **ERASMUS+ Exchange Student**
University of Oslo, Norway
Courses from Master's in Physics
Specialisation in Theoretical Physics
- Sep 2015 – Jul 2019
- ◇ **Bachelor of Science in Physics (240 ECTS)**
University of Murcia, Spain
Bachelor's thesis: "Synchronization in quantum systems"
Supervisors: Prof. Miguel Ortuño Ortín and Prof. Joakim Bergli
Overall mark obtained: 9.11 (scale from 0 to 10)
Award for the Outstanding Graduate of the Year
- Sep 2013 – Jun 2015
- ◇ **General Certificate of Education (*Bachillerato*), Science and Technology specialisation**
IES Vega del Táder, Molina de Segura, Spain
Overall mark obtained: 10 (scale from 0 to 10)
Pass with high distinction (honor mention)

Short Stays



- Sep 2023 – Nov 2023 ◇ **Doctoral International Mobility Stay (3 months)**
Hearne Institute for Theoretical Physics, Louisiana State University, USA
Three months at the Hearne Institute for Theoretical Physics at Louisiana State University (LSU) to study entanglement in cosmologically produced pairs under the supervision of Prof. Iván Agulló

Grants and Awards

- 2023 ◇ **Ayudas para movilidad FPU Fellowship**, Spanish Ministry of Science, Innovation and Universities (MICIU)
 ◇ **Top 10 Breakthroughs of the Year 2023 for Nature study**, Physics World
- 2021 ◇ **Formación de Profesorado Universitario (FPU) Fellowship**, Spanish Ministry of Science, Innovation and Universities (MICINN)
- 2019 ◇ **Award of the Outsantind Graduate of the Year**, University of Murcia
- 2018 ◇ **Erasmus+ Fellowship**, European Union
- 2015 ◇ **Honor mention in General Certificate of Education**, Region of Murcia
- 2013 ◇ **Scholarship "Summer Teens" English Course**, Region of Murcia
 ◇ **Honor mention in Regional Math Olympiad**, Campus Mare Nostrum




Research Publications

- 1 Ivan Agullo, Adrià Delhom, and **Álvaro Parra-López**. "Toward the observation of entangled pairs in BEC analog expanding universes". In: *Phys. Rev. D* 110 (Dec. 2024), p. 125023. [DOI: 10.1103/PhysRevD.110.125023](#).
- 2 Christian F. Schmidt, **Álvaro Parra-López**, Mireia Tolosa-Simeón, Marius Sparn, Elinor Kath, Nikolas Liebster, Jelte Duchene, Helmut Strobel, Markus K. Oberthaler, and Stefan Floerchinger. "Cosmological particle production in a quantum field simulator as a quantum mechanical scattering problem". In: *Phys. Rev. D* 110 (Dec. 2024), p. 123523. [DOI: 10.1103/PhysRevD.110.123523](#).
- 3 Marius Sparn, Elinor Kath, Nikolas Liebster, Jelte Duchene, Christian F. Schmidt, Mireia Tolosa-Simeón, **Álvaro Parra-López**, Stefan Floerchinger, Helmut Strobel, and Markus K. Oberthaler. "Experimental Particle Production in Time-Dependent Spacetimes: A One-Dimensional Scattering Problem". In: *Phys. Rev. Lett.* 133 (Dec. 2024), p. 260201. [DOI: 10.1103/PhysRevLett.133.260201](#).
- 4 Jose A.R. Cembranos, Luis J. Garay, **Álvaro Parra-López**, and Jose M. Sánchez Velázquez. "Vector dark matter production during inflation and reheating". In: *Journal of Cosmology and Astroparticle Physics* 2024.02 (Feb. 2024), p. 013. [DOI: 10.1088/1475-7516/2024/02/013](#).
- 5 Álvaro Álvarez-Domínguez, José A. R. Cembranos, Luis J. Garay, Mercedes Martín-Benito, **Álvaro Parra-López**, and Jose M. Sánchez Velázquez. "Operational realization of quantum vacuum ambiguities". In: *Phys. Rev. D* 108 (Sept. 2023), p. 065008. [DOI: 10.1103/PhysRevD.108.065008](#).
- 6 Jose A.R. Cembranos, Luis J. Garay, **Álvaro Parra-López**, and Jose M. Sánchez Velázquez. "Late vacuum choice and slow roll approximation in gravitational particle production during reheating". In: *Journal of Cosmology and Astroparticle Physics* 2023.08 (Aug. 2023), p. 060. ISSN: 1475-7516. [DOI: 10.1088/1475-7516/2023/08/060](#).
- 7 Celia Viermann, Marius Sparn, Nikolas Liebster, Maurus Hans, Elinor Kath, **Álvaro Parra-López**, Mireia Tolosa-Simeón, Natalia Sánchez-Kuntz, Tobias Haas, Helmut Strobel, Stefan Floerchinger, and Markus K. Oberthaler. "Quantum field simulator for dynamics in curved spacetime". In: *Nature* 611.7935 (Nov. 2022), pp. 260–264. ISSN: 1476-4687. [DOI: 10.1038/s41586-022-05313-9](#).
- 8 Natalia Sánchez-Kuntz, **Álvaro Parra-López**, Mireia Tolosa-Simeón, Tobias Haas, and Stefan Floerchinger. "Scalar quantum fields in cosmologies with $2 + 1$ spacetime dimensions". In: *Phys. Rev. D* 105 (May 2022), p. 105020. [DOI: 10.1103/PhysRevD.105.105020](#).

- 9 Mireia Tolosa-Simeón, **Álvaro Parra-López**, Natalia Sánchez-Kuntz, Tobias Haas, Celia Viermann, Marius Sparn, Nikolas Liebster, Maurus Hans, Elinor Kath, Helmut Strobel, Markus K. Oberthaler, and Stefan Floerchinger. “Curved and expanding spacetime geometries in Bose-Einstein condensates”. In: *Phys. Rev. A* 106 (May 2022), p. 033313.  DOI: 10.1103/PhysRevA.106.033313.
- 10 **Álvaro Parra-López** and Joakim Bergli. “Synchronization in two-level quantum systems”. In: *Phys. Rev. A* 101 (June 2020), p. 062104.  DOI: 10.1103/PhysRevA.101.062104.

Talks and conferences

Invited seminars

- 18/03/25  **Analogue expanding universes in BECs: Towards the observation of entangled pairs**
Journal club of the Cosmology, Relativity and Gravitation group
Held at the *University of Sheffield*, United Kingdom
- 20/02/25  **Materia oscura, o cómo la expansión del universo es capaz de crear partículas**
Seminarios de investigación en física fundamental y aplicada
Held at the *B&T Faculty of the Alfonso X el Sabio University*, Madrid, Spain
- 02/03/23  **Simulating gravitational production of Dark Matter in the lab**
Amsterdark seminars
Held at the *GRAPPA Institute of the University of Amsterdam*, Netherlands

Oral contributions to conferences

- 11/12/24  **Cosmological production of dark matter in the Universe and in the laboratory**
III IPARCOS Workshop
Held at the *Faculty of Physical Sciences of the Complutense University of Madrid*, Spain
- 03/12/24 - 05/12/24  **Towards probing entangled pairs in BEC analogue expanding universes**
JUGAR II Workshop
Held at the *Instituto de Estructura de la Materia-CSIC*, Madrid, Spain
- 19/11/24 - 21/11/24  **Spacetime dynamics as a dark matter production mechanism**
XVI CPAN Days
Held at the *Faculty of Physical Sciences of the Complutense University of Madrid*, Spain
- 22/07/24 - 26/07/24  **Influence of spatial curvature in particle production during the early universe**
Spanish and Portuguese Relativity Meeting EREP 2024
Held at the *Department of Physics of the University of Coimbra*, Portugal
- 21/05/23 - 03/06/23  **How Measurement Realizes Quantum Vacuum Ambiguities**
Analog Gravity in 2023
Held at the *Centro de Ciencias Pedro Pascual*, Benasque, Spain
- 24/05/23 - 26/05/23  **Scalar and vector dark matter production during inflation and reheating**
Quantum Field Theory in Curved Spacetime Workshop 2023
Held at the *Instituto de Astrofísica de Andalucía-CSIC*, Granada, Spain
- 12/12/22 - 15/12/22  **Oscillations and vacuum choice in slow-roll sourced particle production**
Madrid Winter Workshop 2022
Held at the *Faculty of Physical Sciences of the Complutense University of Madrid*, Spain
- 11/07/22 - 15/07/22  **Gravitational particle production in the laboratory**
XXXVIII Biennial of Physics of the Spanish Royal Society of Physics
Held at the *University of Murcia*, Spain
- 23/05/22 - 25/05/22  **Shedding light on Dark Matter using BECs**
19th MultiDark Consolider Workshop
Held at *La Cristalera*, Miraflores de la Sierra, Spain

Talks and conferences (continued)

Poster contributions to conferences

- 16/03/25 - 21/03/25 ♦ **Road to observing entangled pairs in BEC analog cosmological expansion**
QSimFP Community Workshop 2025
Held at the *University of Nottingham*, United Kingdom
- 18/02/24 - 21/02/24 ♦ **Switch-on and -off effects in particle production**
Emergent spacetime geometry - from quantum simulation to cosmology
Held at *Physikzentrum Bad Honnef*, Germany

Other talks

- 13/12/22 - 14/12/22 ♦ **Miniature Universes**
PhD Days
Held at the *Faculty of Physical Sciences of the Complutense University of Madrid*, Spain

Specialised Training

- 16/07/22 - 17/07/22 ♦ **IPARCOS Workshop**
Faculty of Physical Sciences of the Complutense University of Madrid, Spain
- 23/05/22 - 25/05/22 ♦ **Second EuCAPT Annual Symposium**
CERN (online), Geneva, Switzerland
- 23/05/22 - 27/05/22 ♦ **Quantum Field Theory in Curved Spacetimes Workshop 2022**
University of Granada (Online), Spain
- 04/05/22 - 06/05/22 ♦ **Iberian Cosmology Meeting IberiCOS 2022**
Institute of Space Science, Barcelona, Spain

Teaching Experience

- 2024 - 2025 ♦ **Cosmology (24 hours)**
Complutense University of Madrid, Spain
Laboratory and problem sessions of the Cosmology course of the 4th year of the Bachelor's in Physics
- 2023 - 2024 ♦ **Cosmology (48 hours)**
Complutense University of Madrid, Spain
Laboratory and problem sessions of the Cosmology course of the 4th year of the Bachelor's in Physics
- 2022 - 2023 ♦ **Cosmology (18 hours)**
Complutense University of Madrid, Spain
Laboratory sessions of the Cosmology course of the 4th year of the Bachelor's in Physics
- ♦ **General Physics (24 hours)**
Complutense University of Madrid, Spain
Laboratory sessions of the General Physics course of the 1st year of the Bachelor's in Chemistry

Student supervision

Master's Thesis

- 2024-2025 ♦ **Guillermo Gutiérrez Baquero (ongoing)**
Complutense University of Madrid, Spain
Co-supervised with José A. R. Cembranos and Luis J. Garay
Thesis title: "Gravitational particle production in cosmological scenarios"

Student supervision (continued)

- 2023-2024 ♦ **Javier Ortega del Río**
Complutense University of Madrid, Spain
Co-supervised with José A. R. Cembranos and Luis J. Garay
Thesis title: "Gravitational production of dark matter"

Bachelor's Thesis

- 2024-2025 ♦ **Paula Gregori Motto (ongoing)**
Complutense University of Madrid, Spain
Co-supervised with Luis J. Garay
Thesis title: "Quantum fields in curved spacetimes"
- 2023-2024 ♦ **Saúl Baltasar Jimenez**
Complutense University of Madrid, Spain
Co-supervised with Luis J. Garay and Mercedes Martín-Benito
Thesis title: "Vacuum Entanglement in Quantum Field Theory"
- 2023-2024 ♦ **Lucía Velez Tartajo**
Complutense University of Madrid, Spain
Co-supervised with Luis J. Garay
Thesis title: "Quantum fields in curved spacetimes"

Other Studies

- Sep 2009 – Jun 2015 ♦ **Professional Music Degree, Specialisation in Percussion**
Conservatorio de Música Jaime López, Molina de Segura, Spain
- Sep 2009 – Apr 2013 ♦ **Kumon Math Program**
Kumon Murcia - La Vega, Murcia, Spain

Other Scientific Activities

Committees

- 19/11/24 – 21/11/24 ♦ **Local Organising Committee of the XVI CPAN Days**
Faculty of Physical Sciences of the Complutense University of Madrid, Spain
- 12/12/22 – 15/12/22 ♦ **Local Organising Committee of the Madrid Winter Workshop 2022**
Faculty of Physical Sciences of the Complutense University of Madrid, Spain

Additional Research Experience

- Sep 2020 – Oct 2021 ♦ **Internal student at the Quantum fields, fluids and information group**
Institute for Theoretical Physics, Heidelberg University, Heidelberg, Germany
Supervisor: Prof. Stefan Floerchinger
- Apr 2019 ♦ **Building and testing of Multi-gap Resistive Plate Chambers (MRPCs)**
Extreme Energy Events laboratory, CERN, Geneva, Switzerland
Supervisor: Prof. Farid Ould-Saada
- Aug 2018 – Jun 2019 ♦ **Internal student at the Condensed Matter group of the Department of Physics**
University of Oslo, Norway
Supervisor: Prof. Joakim Bergli
- Sep 2017 – Jun 2018 ♦ **Internal student at the Department of Physics**
Faculty of Chemistry, Murcia, Spain
Supervisors: Prof. Miguel Ortuño Ortín and Prof. Rafael García Molina

Skills

Languages ◇ Spanish: Mother tongue

◇ English: *First Certificate in English (FCE)*. Pass at Grade A (C1 level). Cambridge ESOL (2018)

Programming ◇ Mathematica, Python, FORTRAN, R

Other software ◇ Windows, Linux, \LaTeX , MS Office, GIMP, gnuplot