

Álvaro Parra-López, Physicist

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🏠 Álvaro Parra-López (Scholar)

📄 Álvaro Parra-López (INSPIRE)

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Personal Details

- ◇ **Born:** 02/12/97
- ◇ **Nationality:** Spanish
- ◇ **Gender:** male (he/him/his)
- ◇ **Address:** Fysikkbygningen, Office Ø442, Sem Sælands vei 24, 0371 Oslo, Norway

Current Position

- Oct 2025 –
- ◇ **Postdoctoral Researcher - Ramón Areces Fellow**
Department of Physics, Theoretical Physics Section, University of Oslo, Norway
Postdoc advisor: Prof. Torsten Bringmann

Previous Positions

- Mar 2025 – Sep 2025
- ◇ **Postdoctoral Researcher**
Institute of Theoretical Physics UAM/CSIC, Autonomous University of Madrid, Spain
Postdoc advisor: Prof. Alejandro Bermúdez Carballo
- Dec 2024 – Mar 2025
- ◇ **Postdoctoral Researcher - Formación de Profesorado Universitario (FPU) Fellow**
Department of Theoretical Physics and IPARCOS, Complutense University of Madrid, Spain
Postdoc advisor: Prof. José A. R. Cembranos and Prof. Luis J. Garay
- Oct 2021 – Dec 2024
- ◇ **Predocctoral Researcher - Formación de Profesorado Universitario (FPU) Fellow**
Department of Theoretical Physics and IPARCOS, Complutense University of Madrid, Spain
Supervisors: Prof. José A. R. Cembranos and Prof. Luis J. Garay

Education

- Oct 2021 – Dec 2024
- ◇ **PhD in Physics**
Complutense University of Madrid, Spain
PhD thesis: "Cosmological production of dark matter in the Universe and in the laboratory"
Supervisors: Prof. José A. R. Cembranos and Prof. Luis J. Garay
Defense date: 13/12/2024
Calification: *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 (maximum grade in 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 (University of Oslo)
Overall mark obtained: 9.11 (scale from 0 to 10)
Award for the Outstanding Graduate of the Year (21/11/2019)

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

Funding and Grants

- 2025 ♦ **Ramón Areces Postdoctoral Fellowship (1+1 years)**, Ramón Areces Foundation
Private funding for developing a research project in Prof. Bringmann's group at the University of Oslo, as a post-doctoral fellow
- 2023 ♦ **FPU Fellowship Mobility Grant**, Spanish Ministry of Science, Innovation and Universities (MICIU)
Grant for financing the stay in Prof. Agulló's group at Louisiana State University
- 2021 ♦ **Formación de Profesorado Universitario (FPU) Predoctoral Fellowship**, Spanish Ministry of Science, Innovation and Universities (MICIU)

Awards and Achievements

- 2023 ♦ **Top 10 Breakthroughs of the Year 2023 for Nature study**, Physics World
- 2019 ♦ **Award of the Outsantind Graduate of the Year**, University of Murcia
- 2018 ♦ **Erasmus+ Fellowship**, European Union

Research Publications

- 1 *Jose A.R. Cembranos, Luis J. Garay, and **Álvaro Parra-López**. "Influence of spatial curvature in particle production". *In preparation* (2026)
- 2 *Jose A. R. Cembranos, Luis J. Garay, **Álvaro Parra-López**, and Javier Ortega del Río. "Estimation of gravitational production uncertainties". In: *JCAP* 01 (Jan. 2026), p. 003. [DOI: 10.1088/1475-7516/2026/01/003](https://doi.org/10.1088/1475-7516/2026/01/003)
- 3 *Álvaro Álvarez-Domínguez and **Álvaro Parra-López**. "Relevance of on and off transitions in quantum pair production experiments". In: *Phys. Rev. D* 112 (Oct. 2025), p. 085028. [DOI: 10.1103/rjgn-fp9j](https://doi.org/10.1103/rjgn-fp9j)
- 4 *Ivan Agullo, Adria 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](https://doi.org/10.1103/PhysRevD.110.125023)
- 5 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](https://doi.org/10.1103/PhysRevD.110.123523)
- 6 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](https://doi.org/10.1103/PhysRevLett.133.260201)
- 7 *Jose A.R. Cembranos, Luis J. Garay, **Álvaro Parra-López**, and Jose M. Sánchez Velázquez. "Vector dark matter production during inflation and reheating". In: *JCAP* 2024.02 (Feb. 2024), p. 013. [DOI: 10.1088/1475-7516/2024/02/013](https://doi.org/10.1088/1475-7516/2024/02/013)
- 8 *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](https://doi.org/10.1103/PhysRevD.108.065008)
- 9 *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: *JCAP* 2023.08 (Aug. 2023), p. 060. ISSN: 1475-7516. [DOI: 10.1088/1475-7516/2023/08/060](https://doi.org/10.1088/1475-7516/2023/08/060)
- 10 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](https://doi.org/10.1038/s41586-022-05313-9)
- 11 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](https://doi.org/10.1103/PhysRevD.105.105020)

- 12 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](#)
- 13 **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](#)

The authors are listed in alphabetical order in the publications marked with an asterisk ^{*}.

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

- 15/12/25 - 17/12/25 ◇ **From Analogue Spacetimes to Relativistic Quantum Information**
When Quantum Field Theory Meets Quantum Information
Held at the *University Carlos III of Madrid*, Spain
- 08/07/25 - 11/07/25 ◇ **Bose-Einstein condensates as Relativistic Quantum Information simulators**
QTYR 2025: Quantum technologies for Young Researchers Workshop
Held at the *Instituto de Química Física Blas Cabrera (IQF-CSIC)*, Madrid, Spain
- ◇ **Analog Spacetimes and Relativistic Quantum Information in Bose-Einstein Condensates**
QuIST IX
Held at the *Instituto de Ciencias Materiales (ICMM-CSIC)*, Madrid, Spain
- 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

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

- 2025-2027 ◇ **Edvard Aasen (ongoing)**
University of Oslo, Norway
Co-supervised with Torsten Bringmann and Marcos M. Flores
Thesis title: "Cosmological gravitational particle production of Dark Matter"
- ◇ **Sander Svartbekk Sandvik (ongoing)**
University of Oslo, Norway
Co-supervised with Torsten Bringmann and Marcos M. Flores
Thesis title: "Gravitational Particle Production during Inflation"
- 2025-2026 ◇ **Elena Sánchez Barrero (ongoing)**
Complutense University of Madrid, Spain
Co-supervised with José A. R. Cembranos and Luis J. Garay
Thesis title: "Perturbative and Non-Perturbative Approaches to Dark Matter Production During Inflation"
- 2024-2025 ◇ **Guillermo Gutiérrez Baquero (now in industry)**
Complutense University of Madrid, Spain
Co-supervised with José A. R. Cembranos and Luis J. Garay
Thesis title: "Gravitational particle production in cosmological scenarios"
- 2023-2024 ◇ **Javier Ortega del Río (now PhD student at University of the Basque Country with Prof. Mariam Bouhmadi-López)**
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 (now MSc student at Utrecht University)**
Complutense University of Madrid, Spain
Co-supervised with Luis J. Garay and José de Ramón Rivera
Thesis title: "Quantum fields in curved spacetimes"

Student supervision (continued)

- ◇ **Saúl Baltasar Jimenez (now PhD student at Illinois University)**
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 (now MSc student at STRONG group with Prof. Cardoso)**
Complutense University of Madrid, Spain
Co-supervised with Luis J. Garay
Thesis title: "Quantum fields in curved spacetimes"

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

Referee Activities

- ◇ **Journal of High Energy Physics**

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