CURRÍCULUM VITAE **Date:** 25/03/2023

1. PERSONAL DATA

JUAN RAMÓN MUÑOZ DE NOVA

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Born in Madrid, May 30, 1988

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2. EDUCATION

1 - Physics Degree, Universidad Complutense de Madrid, 2011.

2 - Master in Theoretical Physics, Universidad Complutense de Madrid, 2012.

3 - PhD Degree with European Honours, Summa Cum Laude, Universidad Complutense de Madrid, December 2015.

Title of the thesis: "Collective properties of quantum matter: from Hawking radiation analogues to quantum Hall effect in graphene".

Advisors: Ivar Zapata and Fernando Sols.

Referees: C. Westbrook and I. Carusotto.

Members of the jury: J. J. García-Ripoll, R. Parentani, C. Creffield, F. Guinea, and M. Á. Martín-Delgado.

3. PROFESSIONAL CAREER

Organization / University	Department	Professional category	Start date	Final date
Universidad Complutense de Madrid	Física de Materiales	Predoc Researcher (FPI Grant)	01/10/2011	09/12/2015
Technion – Institute of Technology of Israel	Physics Department	Postdoctoral Fellow	22/02/2016	30/05/2019
Universidad Complutense de Madrid	Física de Materiales	Postdoctoral Researcher	03/06/2019	31/10/2021
Universidad Complutense de Madrid	Física de Materiales	Marie Curie Fellowship/ UNA4CAREER Program/ Co-PI of HARBEA Project	15/11/2021	14/11/2024

4. CV SUMMARY

I graduated in Physics in 2011 at Universidad Complutense de Madrid (UCM), obtaining the Extraordinary Award of Undergraduate Achievements, with a grade of 9.66/10, and "Matrícula de Honor" in 39 courses, also qualifying among the best 750 students (top 1%) of the whole University. I obtained my Master's Degree in Fundamental Physics at UCM, with a grade of 9.83/10.

During my PhD (summa cum laude with European Honors), supervised by F. Sols and I. Zapata, I studied diverse phenomena, with the main focus on analogue Hawking radiation (HR) in Bose-Einstein condensates (BEC). I proposed and unified different criteria for the unambiguous experimental signature of HR, later implemented in its first preliminary observation by J. Steinhauer.

Several international collaborations were developed during my PhD. With I. Carusotto, I spent 5 months in the Pitaevskii Center on Bose-Einstein Condensation of Trento, studying the time evolution of a black-hole laser (BHL), finding that its final state is described by a phase diagram where it can reach an intriguing periodic state of continuous emission of solitons (CES). I made a 3-month stay at Harvard University, where I studied, under the supervision of E. Demler, the phase diagram of the quantum Hall (QH) state at the charge neutrality point in graphene. This study was later continued with I. Zapata, computing the collective modes of the different QH phases by applying a novel approach based on BEC techniques, and pioneeringly discovering QH states with two spontaneously broken symmetries. With D. Guéry-Odelin, a renowned BEC experimentalist, I designed a quasi-stationary analogue black hole by outcoupling a condensate through an optical lattice, also later computing its Hawking spectrum, which behaves as a low-pass filter. Finally, with J. Steinhauer, I explained the thermal decay of the density fringes induced by a short Bragg pulse in a Bose gas above the critical temperature.

As a result of the work developed during my PhD Thesis, I obtained a postdoctoral fellowship at the Technion with Steinhauer, the world-leading experimentalist in gravitational analogues. For several years, I focused exclusively on the design and theoretical analysis of an improved experimental setup, working in all fronts: analytical, numerical, and experimental. The investment was worth it: the resulting experiment provided the first conclusive observation of Hawking radiation (the first accepted by the whole community) and, for the very first time, the pioneering measurement of the Hawking temperature, another Holy Grail of Physics. This work was published in Nature with me as first author, the first article in Nature from this field since Hawking's original prediction 50 years ago. It was designed Highly-Cited Paper by Web Of Science. In addition, we observed for the first time the evolution of an analogue black hole, confirming the stationarity of Hawking radiation and reporting a novel mechanism of stimulated HR not predicted in the literature. This has been another landmark experiment, published in Nature Physics.

Using this expertise, I developed the HARBEA (HAwking Radiation BEyond the Analogue) project, of which I am Co-PI along with F. Sols, which earned me a Marie Skłodowska-Curie postdoctoral fellowship funded by the competitive UNA4CAREER program. This innovative project searches for applications and interdisciplinary exports of HR, finally a well-established effect after my work at the Technion, in contrast to the current trends still restricted to the gravitational analogy, demonstrating the potential for technological transfers of my research.

Here emerges my other main line of research: quantum information (QI) at the LHC. I performed (with Y. Afik, member of ATLAS at the LHC) the first study of entanglement in top quarks, also proposing the first protocol for quantum tomography in a high-energy collider. This led to the first observation of entanglement in quarks by ATLAS, in turn also the highest-energy entanglement observation ever, which I co-authored as a Short-Term Associate (STA). A STA from outside High-Energy Physics (HEP) is extremely rare, and thus a huge honor. I also proposed the use of discord and steering as New Physics Witnesses to unambiguously signal the presence of New Physics, a work published in Physical Review Letters. This pioneering line of research of QI in HEP (QIHEP) is of huge impact and it has already become a whole topic of research by itself, as can be seen by the celebration of dedicated congresses and by the high rate of citations of my works. It was also selected as one of the highlights of 2023 by Nature Reviews Physics.

Within another line of research of the HARBEA project, I extended my previous study on the CES state and found that the long-time phase diagram of a black-hole laser is universal. In fact, I have proven that the CES state is something even deeper: it is a spontaneous Floquet state, a novel paradigm of quantum matter that behaves as a Floquet state without the need of external driving, providing a specific realization of a continuous time crystal. My study on spontaneous Floquet states has led me to propose the concept of Floquet Thermodynamics, which applies the conventional tools of Thermodynamics in stationary systems to Floquet systems. Moreover, I have shown that spontaneous Floquet states possess a temporal Nambu-Goldstone mode, whose amplitude provides a unique and tangible realization of a time operator in Quantum Mechanics. I have also shown that a black-hole laser behaves as a quantum amplifier, with potential applications in atomtronics and quantum technologies.

I have published 17 research articles, 1 conference note with ATLAS and 2 preprints, including 1 in Nature, 1 in Nature Physics, 1 in PRL and 1 in Quantum. I have attended to 19 congresses and workshops, delivering 17 talks, presenting 3 posters, being chairman of 1 session, moderator of 1 expert panel, and member of 1 expert panel. Among them, I have been invited speaker to the FQMT conference, invited keynote speaker at the workshop on "Quantum Observables in High-Energy Colliders" at the Galileo Galilei Institute, I have attended the March Meeting, and I have been invited as a panel expert at Oxford. In total, I have given 29 talks including seminars as invited speaker by prestigious institutions such as the Max-Planck Institute, the LPT at Paris-Saclay, or CERN. Regarding outreach, my research has been covered worldwide in more than 50 interviews and/or articles in the mass media, both national and international, and in social media, with more than 5 million views on Youtube.

I am a Lecturer 80 hrs/year of several Physics and Mathematics courses for Physics and Engineering Degrees. I have supervised 10 Bachelor Theses (TFG) and 3 Master Theses. I was member of the PhD Committee of Abdellah Tnourji from Clermont-Ferrand University. I have peer-reviewed for Nature Communications, Physical Review Letters, PRX Quantum, Quantum Science & Technology, Physics Letters B, Physical Review A, B & D, New Journal of Physics, Annalen der Physik, International Journal of Modern Physics B, or Universe. I am a Member of Real Sociedad Española de Física (RSEF).

In summary, I am a physicist with a unique expertise in the world, combining theoretical and numerical skills with a strongly marked interdisciplinarity, along with direct participation in state-of-the-art experiments, such as those of Jeff Steinhauer on analogue gravity, or those of ATLAS at the LHC.

5. LIST OF PUBLICATIONS

1 - **J. R. M. de Nova**, F. Sols, and I. Zapata, *Violation of Cauchy-Schwarz inequalities by spontaneous Hawking radiation in resonant boson structures*. 8 pages. **Physical Review A 89, 043808 (2014).** Link

2 - **J. R. M. de Nova**, D. Guéry-Odelin, F. Sols, and I. Zapata, *Birth of a quasi-stationary black hole in a Bose-Einstein condensate*. 35 pages. **New Journal of Physics 16, 123033 (2014).** Link

3 - **J. R. M. de Nova**, F. Sols, and I. Zapata, *Entanglement and violation of classical inequalities in the Hawking radiation of flowing atom condensates*. 18 pages. **New Journal of Physics 17, 105003 (2015).** Link

4 - **J. R. M. de Nova**, I. Zapata, and F. Sols, *Violation of classical inequalities by resonant Hawking radiation in a sonic black hole*. 13 pages. **Physica Scripta 2015, 014035 (2015)**. Link

5 - **J. R. M. de Nova**, S. Finazzi, and I. Carusotto, *Time-dependent study of a black-hole laser in a flowing atomic condensate*. 15 pages. **Physical Review A 94, 043616 (2016).** Link

6 - **J. R. M. de Nova** and I. Zapata, *Symmetry characterization of the collective modes of the phase diagram of the ν=0 quantum Hall state in graphene: Mean-field phase diagram and spontaneously broken symmetries.* 36 pages. **Physical Review B 95, 165427 (2017).** Link

7- Jeff Steinhauer and **Juan Ramón Muñoz de Nova**, *Self-amplifying Hawking radiation and its background: A numerical study*. 7 pages. **Physical Review A 95, 033604 (2017).** Link

8 - **J. R. M. de Nova**, F. Sols, and I. Zapata, *Quantum transport in the black-hole configuration of an atom condensate outcoupled through an optical lattice*. 21 pages. **Annalen der Physik 529, 1600385 (2017).** Link

9 - **Juan Ramón Muñoz de Nova**, *Non-linear stationary solutions in realistic models for analog black-hole lasers*. 33 pages. **Universe 3, 54 (2017).** Link

10 - **Juan Ramón Muñoz de Nova**, Katrine Golubkov, Victor I. Kolobov, and Jeff Steinhauer, *Observation of thermal Hawking radiation and its temperature in an analogue black hole*. 5 pages. **Nature 569, 688 (2019).** Link

11 - Victor I. Kolobov, Katrine Golubkov, **Juan Ramón Muñoz de Nova**, and Jeff Steinhauer, *Observation of stationary spontaneous Hawking radiation and the time evolution of an analogue black hole*. 8 pages. **Nature Physics 17, 362 (2021).** Link

12 - **J. R. M. de Nova**, P. F. Palacios, I. Carusotto, and F. Sols, *Long time universality of black hole lasers*. 15 pages. **New Journal of Physics 23, 023040 (2021).** Link

13 - Yoav Afik and **Juan Ramón Muñoz de Nova**, *Entanglement and quantum tomography with top quarks at the LHC*. 23 pages. **The European Physical Journal Plus 136, 907 (2021).** Link

14 - **J. R. M. de Nova** and F. Sols, *Continuous-time crystal from a spontaneous many-body Floquet state*. 18 pages. **Physical Review A 105, 043302 (2022).** Link

15 - Yoav Afik and **Juan Ramón Muñoz de Nova**, *Quantum information with top quarks in QCD*. 36 pages. **Quantum 6, 820 (2022).** Link

16 - Yoav Afik and **Juan Ramón Muñoz de Nova**, *Quantum Discord and Steering in Top Quarks at the LHC*. 6 pages. **Physical Review Letters 130, 221801 (2023).** Link

17 - **Juan Ramón Muñoz de Nova** and Fernando Sols, *The BHL-BCL crossover: from nonlinear to linear quantum amplification*. 22 pages. **Physical Review Research 5, 043282 (2023).** Link

18 – The ATLAS Collaboration. *Observation of quantum entanglement in top-quark pair production using pp collisions of $\sqrt{s}$=13 TeV using the ATLAS detector.* **ATLAS-CONF-2023-069 (2023).** Link

19 – The ATLAS Collaboration. O*bservation of quantum entanglement in top-quark pairs using the ATLAS detector*. 45 pages. **arXiv:2311.07288 (2023). Submitted to Nature.** Link

20 – **Juan Ramón Muñoz de Nova** and Fernando Sols, *Simultaneous symmetry breaking in spontaneous Floquet states: Floquet-Nambu-Goldstone modes, Floquet thermodynamics, and the time operator*. 28 pages. **arXiv:2402.10784 (2024).** Link

6. AWARDS

- Extraordinary Award of Undergraduate Achievements (best academic qualifications in the Physics Department, Universidad Complutense de Madrid), 2011.

- Among the best 750 qualifications in Universidad Complutense de Madrid (>80000 students).

- Ref. 10 was designed “Highly-cited paper” by Web of Science (2022).

7. FELLOWSHIPS, CONTRACTS AND GRANTS

1 - Collaboration grant with Group “Física Teórica de la Materia Condensada” of Universidad Complutense de Madrid (2010-2011).

2 - FPI/2011 grant from the Spanish Ministry of Education and Science with Group “Física Teórica de la Materia Condensada” of Universidad Complutense de Madrid (2011-2015).

3 - Post-doctoral fellowship at the Technion - Institute of Technology of Israel (2016-2019).

4 - Post-doctoral contract at Universidad Complutense de Madrid (2019-2021).

5 - Post-doctoral Marie-Curie fellowship, UNA4CAREER Program, co-PI of HARBEA project (2021-2024). Budget: 35532 €.

8. INTERNATIONAL COLLABORATIONS

1 - Iacopo Carusotto – Topic: Non-linear regime of black-hole lasers. Affiliation: BEC Center, Universita’ di Trento, Italy.

2 - Eugene Demler – Topic: Integer quantum Hall states in graphene. Affiliation: ETH, Zürich, Switzerlard.

3 - David Guéry-Odelin – Topic: Analogue scenarios in outcoupled Bose-Einstein condensates. Affiliation: Université Toulouse, France.

4 - Jeff Steinhauer – Topic: Experimental characterization of Hawking radiation and gravitational analogues. Affiliation: Physics Faculty, Technion, Israel.

5 - Yoav Afik – Topic: Quantum information with top quarks. Affiliation: Physics Department, CERN.

6 - Johan Christensen – Topic: Gravitational analogues in acoustic metamaterials. Affiliation: Carlos III, Madrid, Spain.

7 – Top Working Group of the ATLAS Collaboration – Topic: Entanglement detection at the LHC. Affiliation: LHC, CERN.

8 – Abner Soffer, Yevgeny Kats & David Uzan – Topic: Quantum information in quarks. Affiliation: Tel-Aviv and Ben-Gurion University, Israel.

9. TEACHING

1 - Teaching Assistant, Solid State Physics, Physics Degree (2012-2015).

2 - Teaching Assistant, General Physics Laboratory, Chemistry and Chemical Engineering Degree (2013-2014).

3 - Lecturer, General Physics Laboratory, Materials and Chemical Engineering Degree (2019-2020).

4 - Lecturer, Mechanics Laboratory, Physics Degree (2020-2021).

5 - Lecturer, Mathematics I, Materials Engineering Degree (2022-2024).

10. SUPERVISION

1 - Direction of 10 Bachelor Theses (TFG-Trabajo de Fin de Grado): Pablo Fernández Palacios (2019-2020), Alfonso García Sánchez (2020-2021), Pablo Moles Matías (2020-2021), Ángel Rodríguez Alcaraz (2020-2021), Manuel Fernández Alcoba (2020-2021), Rodrigo Jiménez Guerrero (2022-2023), José Gutiérrez Madejón (2022-2023), Jorge del Arco Martín (2023-2024), Francisco Felipe Pérez (2023-2024), Gonzalo Alonso Reíllo (2023-2024).

2 - Direction of 3 Master Theses: Pablo Fernández Palacios (2020-2021), Pedro Alcázar Guerrero (2020-2021), Andrés Blanco Alonso (2021-2022).

11. COMMITEES

1 –Bachelor Thesis Committee (Universidad Complutense de Madrid, June-July 2022).

2 – PhD Committee of Abdellah Tnourji (Clermont-Ferrand, November, 2022).

12. VISITING STAYS

1 - 5 month stay at BEC Center of Trento with I. Carusotto and S. Finazzi (2013). Supported by the FPI Grant.

2 - 3 month stay at Harvard University in Cambridge, USA with Prof. E. Demler (2014). Supported by the FPI Grant.

13. SCIENTIFIC CONGRESSES

1 - V Encuentro de Gases Cuánticos, Madrid, Spain. January 2013. Invited Talk: *Hawking Radiation in quantum gases*.

2 - FQMT 2013, Prague. July 2013. Contributed Poster: *Violation of Cauchy- Schwarz inequalities by spontaneous Hawking radiation in resonant boson structures*.

3 - Analogue-Gravity Workshop, Haifa, Israel. June 2018. Invited Talk: *Numerical simulation of the Hawking emission in an experimental black hole*.

4 - QFC 19, Pisa. October 2019. Contributed Talk: *Measurement of the emission of Hawking radiation with the Hawking temperature in an analogue black hole*.

5 - Cold Atoms Workshop, Online. October 2020. Invited Talk: *Stationarity and thermality of spontaneous Hawking radiation and beyond: Observing the time evolution of an analogue black hole.*

6 - Cold Atoms Workshop, Granada. November 2021. Invited Talk: *Continuous time crystal from a spontaneous many-body Floquet state.*

7 - March Meeting 2022, Chicago. March 2022. Contributed talk: *Quantum information with top quarks at the LHC.*

8 - FQMT 2022, Prague. August 2022. Invited talk: *Quantum information with top quarks at the LHC* + Invited poster: *Continuous time crystal from a spontaneous many-body Floquet state.*

9 - Workshop on Quantum Information with Top quarks and Higgs bosons, University of Glasgow, Online. November 2022. Invited talk: *Quantum information with top quarks.*

10 - Cold Atoms Workshop, Madrid. November 2022. Invited talk: *The BHL vs. BCL problem.*

11 - Foundational tests of quantum mechanics at the LHC, Oxford. March 2023. Invited expert for the Panel Session: *Loopholes and interpretations: What would these measurements imply?.*

12 - Quantum Entanglement in High-Energy Physics 2023, Jagiellonian University, Krakow. May 2023. Invited talk: *Quantum information with top quarks at the LHC.*

13 – Analogue Gravity in 2023, Benasque. May 2023. Contributed talk: *The BHL vs. BCL puzzle*. Chairman of 1st June Afternoon Session.

14 – Quantum simulation of gravitational problems on condensed matter analog models, Trento. June 2023. Contributed talk in collaboration with Fernando Sols for the special event in the memory of Renaud Parentani: *From black holes to lasers and time crystals: In memory of Renaud Parentani.*

15 - Time Crystals Conference 2023, Krakow. September 2023. Contributed poster: *Continuous time crystal from a spontaneous many-body Floquet state.*

16 - 12th International Workshop on the CKM Unitarity Triangle, Santiago de Compostela. September 2023. Invited talk: *Quantum information with top quarks.*

17 - Quantum Observables for Collider Physics, Firenze. November 2023. Invited keynote talk: *Quantum information with top quarks.* Moderator of "Theoretical Challenges" Panel.

18 – Cold Atoms Workshop Barcelona 2024, Barcelona. January 2024. Invited talk: *Multiple symmetry breaking in spontaneous Floquet states.*

19 – Emergent Spacetime Geometry Workshop, Bad Honnef. February 2024. Invited talk: *Stationary spontaneous Hawking radiation and beyond: Observing the time evolution of an analogue black hole.*

20 – PITT PACC Workshop: Exploring Quantum Mechanics in High Energy Physics, Pittsburgh. March 2024. Invited talk: *Quantum Mechanics in Field Theory: Quantum? Field Theory.*

14. TALKS AND SEMINARS

1 - LPT, Orsay, Paris. March 2015. Invited Talk: *Time-dependent study of a black-hole laser in a Bose-Einstein condensate*.

2 - Technion Retreat 2018, Israel. February 2018. Contributed Talk: *Hawking radiation in analogue black holes in Bose-Einstein Condensates*.

3 - Quantum Information Seminar. Technion, Haifa, Israel. March 2018. Invited Talk: *Hawking radiation.*

4 - BOOST 2020, Online. July 2020. Online webinar (along with Yoav Afik): *Quantum information and entanglement with top quarks at the LHC.*

5 - Top Spin Correlation ATLAS meeting. November 2020. Invited Talk: *Quantum Tomography with Top Quarks at the LHC.*

6 - Top Properties and Mass ATLAS meeting. November 2020. Invited Talk: *Quantum Tomography and Entanglement with Top Quarks at the LHC.*

7 - Max Planck Institute, Garching, July 2021. Invited Talk: *Continuous time crystal from a spontaneous many-body Floquet state.*

8 - ATLAS Top WG Plenary Meeting. October 2021. Invited Talk: *Entanglement and quantum tomography with top quarks at the LHC.*

9 - Universidad Carlos III, Leganés. November 2021. Invited Talk: *Analogue gravity.*

10 - Instituto de Física Teórica, Universidad Autónoma de Madrid. January 2022. Invited Talk: *Entanglement and quantum tomography with top quarks at the LHC.*

11 - Quantum Café, Online. March 2022. Invited Talk: *Quantum information with top quarks.*

12 - Top Properties and Mass ATLAS meeting. November 2022. Invited Talk: *Entanglement and quantum tomography with top quarks at the LHC.*

15. OUTREACH AND MEDIA IMPACT [SELECTION]

1 - *A un paso de demostrar la radiación de Hawking, "One step away of detecting Hawking radiation".* Cadena SER Link ABC Link La Sexta Link etc (2016).

2 - Interview for *Principio de Incertidumbre* of Canal Extremadura radio (2016). Link

3 - *Cómo fabricar un agujero negro, "How to make a black-hole"*. Muy Interesante (2016). Link.

4 - *Stephen Hawking was right: 'Black hole' created in a lab confirms the late physicist's predictions on radiation, scientists say*. Daily Mail (2019). Link

5 - *In a first, scientists took the temperature of a sonic black hole*. Science News. Top 3 of 2019. Link

6 - *Quantum simulation of black-hole radiation*. Nature News & Views (2019). Link

7 - *How to make a black hole in a science lab*. Gizmodo (2019). Link

8 - *How Scientists Are Making 'Sonic' Black Holes in a Lab.* YouTube. (>150k views) (2019). Link

9 – *Hawking-Strahlung-experimenteller Nachweis in Bose-Einstein-Kondensat*. YouTube. (>50k views) (2019). Link

10 – *Building Black Holes in the Lab.* YouTube. (>500k views) (2020). Link

11 – *The life of an analogue black hole.* Nature News & Views (2021). Link

12 – *Researchers observe stationary Hawking radiation in an analog black hole.* Phys.org (2021). Link

13 – *Black hole conjured up in a lab does the same weird things Stephen Hawking thought it would do*. Syfy Wire (2021). Link

14 – *Black Hole Experiment Using Sound Creates Intriguing Phenomena.* YouTube. (>120k views) (2021). Link

15 – *Reacciones a la primera imagen del agujero negro supermasivo en el centro de la Vía Láctea "Reactions to the first image of the supermassive black hole at the center of the Milky Way".* Science Media Centre (2022). Link

16 – *Una imagen confirma la existencia de un agujero negro supermasivo en el centro de nuestra galaxia, "Image confirms the existence of a supermassive black hole at the center of our galaxy".* El Diario (2022). Link

17 – *97,000 Sonic Black Hole Experiments Revealed Something "Impossible" | Black Holes Part 2.* YouTube. (>900k views) (2022). Link

18 – *Why Black Hole Environments Are a Lot More Complicated Than We Thought.* YouTube. (>3M views) (2022). Link

19 - *Investigadores de la Complutense se acercan a "la nueva física" de la mecánica cuántica, "Complutense researchers get closer to the 'new physics' of quantum mechanics"*. La Vanguardia (2023). Link

20 - *Más cerca de la nueva física con dos propiedades de la mecánica cuántica, "Closer to new physics with two properties of quantum mechanics"*. Monthly Bulletin of RSEF (2023).

21 - *Highest-energy observation of quantum entanglement*. CERN Courier (2023). Link

22 - *Large Hadron Collider turned into world's biggest quantum experiment*. New Scientist (2023). Link

23 – *Quantum entanglement observed in top quarks*. Physics World (2023). Link

24 – *Scientist measure entanglement at the LHC*. Symmetry Magazine (2023). Link

25 – *Entanglement between a pair of top quarks*. Editors' picks 2023, Research Highlights, Nature Reviews Physics (2024). Link

26 – *Un modelo teórico demuestra el efecto amplificador cuántico de los agujeros negros, "A theoretical model proves the quantum amplification effect of black holes".* Madri+d (2024). Link

16. REFEREE

- Referee for International Journal of Modern Physics B, Universe, New Journal of Physics, Annalen der Physik, Physical Review A, B & D, Quantum Science & Technology, Physics Letters B, PRX Quantum, Physical Review Letters, Nature Communications.

17. MEMBERSHIP OF SCIENTIFIC SOCIETIES AND INTERNATIONAL COLLABORATIONS

- Associated member of Real Sociedad Española de Física (RSEF) since 2020.

- Short Term Associate (STA) of the ATLAS collaboration at the LHC (2021-2024).

18. NON-ACADEMIC PROFESSIONAL EXPERIENCE

1 - Sales representative. APNG. 2 months (2008).

2 - Sales representative. Global Success. 3 months (2009).

3 - Promoted to sales leader. Supervisor of a group of 4 people. Global Success. 4 months (2009).

4 - Experience as secretary and personal tutor.