

Personal data

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Website: <https://gorkamunoz.github.io/>

Languages: Spanish (Native), Catalan (Native), French (Proficient), English (Proficient)

Education

19/11/2020: **Phd in Photonics**, Institute of Photonic Sciences ICFO (Spain)

Thesis: Anomalous diffusion: from life to machines (cum laude)

01/09/2016: **Master in Photonics**, Universitat Politècnica de Catalunya UPC (Spain)

Thesis: Nonergodic Subdiffusion of a Random-walker from Interactions with Heterogeneous Partners (9/10)

15/07/2015: **Bachelor in Physics**, Universitat Autònoma de Barcelona UAB (Spain) and Université de Laval (Canada)

Thesis: Light propagation in nanowires: from theory to experiments (9/10)

Research experience

01/10/2021 - present: **Postdoctoral Researcher** at the Quantum Information and Computing group at Innsbruck University, led by Prof. Dr. Hans J. Briegel.

20/11/2020 - 31/09/2021: **Postdoctoral Researcher** at the Quantum Optics theory group at ICFO under the supervision of Prof. Dr. Maciej Lewenstein.

12/09/2016 - 19/11/2020: **LaCaixa PhD Fellow** at the Quantum Optics theory group at ICFO under the supervision of Prof. Dr. Maciej Lewenstein.

01/06/2015 - 01/07/2015: **SURF Summer Fellow** at the Institute of Physics and Complex Systems (IFISC) under the supervision of Prof. Dr. Roberta Zambrini.

01/06/2014 - 15/07/2015: **Undergraduate Researcher** in a joint project between the Quantum Optics group of the Universitat Autònoma de Barcelona (UAB) and the Institute of microelectronics of Barcelona (IMB-CNM), under the supervision of Dr. Verónica Ahufinger and Dr. Andreu Llobera.

Main areas of research

Anomalous diffusion: theory and phenomenological models

My PhD Thesis has been devoted to the study of a particular form of motion: anomalous diffusion. We developed models, both for classical and quantum systems, with which to understand which kind of properties, both from the moving particle and the environment lead to the appearance of such rich phenomena.

Machine learning and Physics

In recent years, I have been captivated by the potential Machine Learning techniques offer to the study of Physics. We have pioneered the use of such techniques to understand anomalous diffusion and developed the AnDI Challenge, a community project to further develop the field. Moreover I have also used ML to solve complex combinatorial problems of Quantum Information and have also studied how to use Physics to enhance Machine Learning algorithms.

Science beyond science

While I like the most fundamental approach to Physics, I also enjoy applying this knowledge to other fields and also to its dissemination. I have collaborated in projects related to the study of light pollution via a citizen science experiment and also helped create quantum inspired music. Moreover, I have participated in plenty of Outreach projects both for young students and the general public.

Publications

Objective comparison of methods to decode anomalous diffusion

G. Muñoz-Gil et al., [Nat. Commun. 12, 6253 \(2021\)](#).

I co-organized the scientific competition leading to this publication. I was in charge of the simulations and numerical analysis of the datasets used during the event. I also developed for this aim andi-datasets python package.

Unsupervised learning of anomalous diffusion data

G. Muñoz-Gil, G. Guigo i Corominas and M. Lewenstein, [J. Phys. A: Math. Theor. 54 504001 \(2021\)](#).

In this publication, we propose the use of unsupervised learning as an effective tool for the characterization of anomalous diffusion both in simulations and theory. This is the first time such techniques are used for such aims.

Applications of Quantum Randomness: From Rabi Oscillations to Fourier Axis Controlling the Musical Timbre

R. Yamada, S. Grandi, G. Muñoz-Gil, L. Barbiero, A. Aloy, M. Lewenstein, [IJMSTA 3 \(2\): 17-25 \(2021\)](#)

Efficient training of energy-based models via spin-glass control

G. Muñoz-Gil*, A. Pozas-Kerstjens*, M. A. Garcia-March, A. Acín, M. Lewenstein and P. R. Grzybowski (* equal contribution), [Mach. Learn.: Sci. Technol. 2 025026 \(2021\)](#)

Certificates of quantum many-body properties assisted by machine learning

B. Requena, G. Muñoz-Gil, M. Lewenstein, V. Dunjko, J. Tura, [arXiv:2103.03830](#)

Together with Dr. J. Tura, I conceived the core ideas of this project and proposed the resulting reinforcement learning (RL) method. Then, I supervised B. Requena in the development of the numerical tools needed to achieve the paper's results.

Phase separation of tunable biomolecular condensates predicted by an interacting particle model

G. Muñoz-Gil, C. Romero-Aristizabal, N. Mateos, L. de Llobet Cucalon, M. Beato, M. Lewenstein, M. F. Garcia-Parajo, J. A. Torreno-Pina, [biorxiv:2020.09.09.289876](#)

I designed a theoretical model describing the appearance of phase separation in the cell nucleus. The model is able to predict the features observed by single particle tracking techniques in invivo systems. Moreover, we showcased the validity of the use of ML for characterizing the experimental observations.

The anomalous diffusion challenge: single trajectory characterisation as a competition

G. Muñoz-Gil, G. Volpe, M. A. García-March, R. Metzler, M. Lewenstein and C. Manzo, [SPIE 2020 Proceedings, 114691C \(2020\)](#)

Single trajectory characterization via machine learning

G. Muñoz-Gil, M. A. Garcia-March, C. Manzo, J. D. Martín-Guerrero, M. Lewenstein, [New Journal of Physics, 22\(1\), 013010 \(2020\) \(Publisher's Pick of 2020\)](#)

I conceived the main idea of this project, which is the first proposal for the characterization of anomalous diffusion by means of ML. The success of the proposal has translated into multiple collaborations with international theoretical and experimental groups.

Control of anomalous diffusion of a Bose polaron

C. Charalambous, M. A. García-March, G. Muñoz-Gil, P. R. Grzybowski, M. Lewenstein, [Quantum 4, 232 \(2020\)](#)

Diffusion through a network of compartments separated by partially transmitting boundaries

G. Muñoz-Gil, M.A. Garcia-March, C. Manzo, A. Celi, M. Lewenstein, [Frontiers in Physics 7, 31 \(2019\)](#)

Transient subdiffusion in Ising environments

G. Muñoz-Gil, C. Charalambous, M.A. García-March, M.F. García-Parajo, C. Manzo, M. Lewenstein and A. Celi, [Phys. Rev. E 96, 052140 \(2017\)](#)

Nonergodic subdiffusion from transient interactions with heterogeneous partners

C. Charalambous, G. Muñoz-Gil, A. Celi, M. F. Garcia-Parajo, M. Lewenstein, C. Manzo, and M. A. García-March, [Phys. Rev. E 95, 032403 \(2017\)](#)

Supervision experience

Master Thesis Supervision

Condensed matter meets deep learning: from spins to neurons, E. Piñol Jiménez (2020)

Master in Photonics, UPC-UAB-UB-ICFO, Barcelona (Spain)

Unsupervised learning of single trajectory characterization in anomalous diffusion, G. Guigó (2020)

Master of Multidisciplinary Research in Experimental Sciences, BIST-UPF, Barcelona (Spain)

Undergraduate Project Supervision

Using Quantum Machine Learning to Recognize Handwritten Numbers, J. Zingel (2019)

Barcelona Youth Summer Camp, ICFO, Barcelona (Spain). Winner of the '[New Zealand Future Scientist Prize 2020](#)' and the 'BIYSC project award 2019'.

Selected Conference Attendances

01/12/2021 - **ANDI Workshop** (Barcelona)

Organizer: event gathering the participants of the ANDI challenge as well as international leading experts of the field of anomalous diffusion.

03/10/2021 - **Venice meeting on Fluctuations in small complex systems V** (Venice)

Invited talk: Machine learning approaches to anomalous diffusion data.

24/08/2021 - **Summer School: Machine Learning in Quantum Physics and Chemistry** (Warsaw)

Tutor: Responsible for the practical sessions of the school.

01/08/2021 - **SPIE Photonics. Emerging Topics in Artificial Intelligence** (San Diego, virtual)

Invited talk: The anomalous diffusion challenge: Objective comparison of methods to decode anomalous diffusion.

29/06/2021 - **Workshop on Artificial Scientific discovery** (Erlangen, Germany, virtual)

Contributed poster: The AnDI challenge: objective comparison of methods to decode anomalous diffusion.

15/04/2021 - **Initial Training on Experimental Methods for Active Matter** (Gothenburg, virtual)

Assistant lecturer: 'Characterization of Ergodicity Breaking and Anomalous Diffusion from Single Trajectories'

03/08/2020 - **SPIE Photonics. Emerging Topics in Artificial Intelligence** (San Diego, virtual)

Invited talk: Single trajectory characterization as a competition

14/05/2020 - **Nordita Machine Learning Workshop** (Denmark, virtual)

Invited talk: Single trajectory characterization via Machine Learning: a community challenge approach

11/03/2020 - **09/09/2020** - **ANDI seminars** (virtual)

Organizer: Series of online talks on the topic of anomalous diffusion from leading experts of the field.

01/12/2019 - [NEURIPS, Machine Learning for the Physical Sciences Workshop](#) (Vancouver)
Poster: RAPID – Training Boltzmann Machines without sampling.

20/09/2019 - [Active matter and artificial intelligence](#) (Lausanne)
Contributed talk: Machine learning cracks statistical averages.

03/09/2019 - [Physics Challenges for Machine Learning and Network Science](#) (London)
Poster: RAPID – Training Boltzmann Machines without sampling.

12/05/2019 - [New Trends in Statistical Physics](#) (Sitges, Spain)
Contributed talk: Machine learning cracks statistical averages.

02/08/2018 - [31st Marian Smoluchowski Symposium on Statistical Physics](#) (Zakopane, Poland)
Contributed talk: Confinement as sole cause of Anomalous diffusion.

22/07/2018 - [International conference in atomic physics \(ICAP\)](#) (Barcelona)
Poster: Diffusion through compartmentalized environments.

09/07/2018 - [Unsolved problem on noise](#) (Gdansk, Poland)
Contributed talk: Scale-dependent anomalous diffusion in spatially disordered environments.

Other (selected) activities

July 2019-2021 - Co-organizer of the [Barcelona International Youth Summer Camp](#) (BIYSC)
Participated as an organizer and teacher of the ICFO branch of the BIYSC. In particular, I helped to organize the whole program and imparted lectures on simulations of quantum cryptography algorithms.

01/09/2020 - Co-founder of [Quantum Barcelona](#)
We are a team of *quantum* enthusiasts organizing activities for the dissemination of topics related to the quantum sciences. Due to the pandemic, we limited our activities to spotlight talks from experts in the field, most of them working in successful companies working on quantum hardware and software.

04/10/2020 - Organizer of the course ‘Quantum Programming with IBM Qiskit’, Thinktic, Logroño (Spain).
Organized and taught an extended course (20 h.) about quantum computation and quantum machine learning implemented in the IBM library, Qiskit. The course is aimed at people with little to no knowledge on quantum physics and covers the basics of Machine Learning and Quantum Physics as well as their implementation on IBM quantum computers.

Prizes and Grants

02/2021 - [NJP’s best of 2020 selection](#)
The paper ‘Single trajectory characterization via machine learning’ was shortlisted by the editorial board of New Journal of Physics (NJP) among the most the most cited and downloaded papers from NJP in 2020

09/2016 - [La Caixa - Severo Ochoa PhD fellowship grant](#).
Grant awarded to pursue a PhD program at the Institute of Photonic Science (ICFO).

04/2016 - [UPC Collaboration Grant](#)
Grant awarded to collaborate with the coordinators of the Master in Photonics (UPC) on organization tasks.

07/2015 - [SURF Summer Fellowship](#), IFISC–UIB, Palma de Mallorca.
Grant awarded to work with Prof. R. Zambrini on the study of quantum optomechanical oscillators.

10/2014 - UAB Collaboration Grant, UAB, Barcelona.

Grant awarded to collaborate with 'Dinamització comunitària de la UAB', promoting and organizing all kinds of activities for the students of the Science Faculty and my university. I also worked on the improvement of the exchange programs of the UAB.

10/2012 - UAB Collaboration Grant, UAB, Barcelona.

Grant awarded to collaborate with 'Àmbit de Participació de la UAB', creating platforms for students' representation in the Science Faculty, and promoting the participation of students in university activities.

Selected transferable skills courses

05/2020 - BIST Leadership in action 2021

Twelve hours course aimed at developing skills for the successful self-management and development to progress in a professional career.

10/2019 - Supervising Master's Research projects

Six hours workshop aimed at developing supervision skills to meet the needs of a master's students during the progress of their Master thesis.

04/2018 - Becoming a Scientific Writer: Putting Why? before How?

Six hours workshop aimed at helping publishing scientists develop a more impartial, analytical view of scientific writing, to better understand their readers as the focus for their scientific communication, and to make them more efficient writers and editors.

02/2017 - Effective oral presentation

Eight hours workshop aimed at developing skills to prepare and deliver an oral presentation and convey a direct and effective message.