CV date: 07/11/2025

PERSONAL INFORMATION

First name	Rafael		
Family name	Garcia Molina		
e-mail	rgm@um.es	https://webs.um.es/rgm	
Open Researcher and Contributor ID (ORCID)		0000-0001-8755-8709	

Current position

Position	Full Professor of Applied Physics		
Initial date	07/08/2008		
Institution	Universidad de Murcia		
Department/Center	Departamento de Física	Facultad de Química - Centro de Investigación en Óptica y Nanofísica (CIOyN)	
Country	Spain	Teleph. number	+34 868887389
Key words	Interaction of charged particles with matter; Electronic excitations in condensed matter; Hadrontherapy; Physics teaching and outreach		

Previous positions (research activity, interruptions)

Period	Position/Institution/Country/Interruption cause
1982-1983	No scientific activity due to Compulsory Military Service
1984-1987	Graduate Student / Universitatd'Alacant / Spain
1988-1988 (Jun)	Posdoctoral Student / Consejo Superior de Investigaciones Científicas (Madrid) / Spain
1988 (Jul)-1988 (Oct)	Posdoctoral Student / University of California at Irvine / USA
1988 (Nov)-1991	Associate Teacher of Applied Physics / Universidad de Murcia / Spain
1991-2008	Tenure Lecturer of Applied Physics / Universidad de Murcia / Spain
2008-to date	Full Professor of Applied Physics / Universidad de Murcia / Spain

Education

PhD, Licensed, Graduate	University/Country	Year
Licensed in Physics	Universitat de València / Spain	1980
PhD in Physics	Universitat de València / Spain	1987

CV SUMMARY

The topics in which I work are related to the interaction of charged particles (electrons, light ions and molecules) with condensed matter (solids and liquids), and to the excitation of electromagnetic modes in various geometries. To carry out these studies, I have used simulation codes and theoretical models, with the dielectric formalism as the main framework, but properly modified and improved when needed to account for effects not well described in the first Born approximation. One of my main achievements is the development of a methodology (MELF-GOS, Mermin Energy Loss Function – Generalized Oscillator Strength) to obtain a proper description of the electronic excitation spectrum of different materials, by separating the contributions due to the more loosely bound electrons from the ones in the inner-shells, which resulted in my most cited paper (Phys Rev A 58 (1998) 357; >200 cites). Another important output of my research was the development of a simulation code to describe in detail the propagation and dissociation of swift molecular clusters through thin targets, which is particularly useful for resolving molecular structures. More recently, my efforts have been addressed to analyse and simulate the energy deposited by swift ion beams in targets of biological interest (liquid water, DNA, protein…) due to its potential use in hadrontherapy to treat tumours. Especial attention has been paid to study the secondary electrons (and subsequent cascades) generated in the target by these ions, which are particularly effective in producing cell biodamage. The more recent work has improved the calculation of interaction probabilities for very-low energy electrons, which are considered to be the main responsible of DNA strand breaks production.

The results of this research have produced more than 150 scientific papers (in prestigious international journals and book chapters of well recognised publishers) and around 200 communications in international conferences (around 25 invited talks). All this research has

been done with the economic support of 30 projects obtained in public concurrence (being Principal and Co-Principal Researcher in 8 of them, which generated almost 400 k€).

Since the beginning of my career, a fruitful collaboration with researchers from different institutions has been maintained, namely with:

- R. H. Ritchie, Oak Ridge National Laboratory (Tennessee, USA)
- A. D. Boardman, University of Salford (Salford, United Kingdom)
- E. Louis, Universitat d'Alacant (Alacant, Spain)
- F. Guinea, Spanish National Research Council - CSIC (Madrid, Spain)
- A. A. Maradudin, University of California at Irvine (California, USA)
- N. R Arista, Centro Atómico Bariloche (Bariloche, Argentina)
- J. M. Fernández-Varea, Universitat de Barcelona (Barcelona, Spain)
- M. Behar and P. Grande, Universidade Federal de Rio Grande do Sul (Porto Alegre, Brasil)
- A. Solov'yov, MBN Research Center (Frankfurt, Germany)
- D. Emfietzoglou and I. Kyriakou, University of Ioannina (Ioannina, Greece)
- J. Valdés, Federico Santa María University (Valparaíso, Chile)
- M. Dapor and S. Taioli, European Center for Theoretical Studies in Nuclear Physics and Related Areas - ECT* (Trento, Italy)

Besides my research in the subject of interaction of charged particles with matter, I have also devoted a substantial part of my time to improve and disseminate physics teaching methodologies, as well as to physics outreach, being the author of more than 60 papers and the presenter of almost 200 seminars and training courses in these topics (some of them as invited speaker in Switzerland, the Netherlands, Italy, Chile, Portugal, South Africa, United Kingdom, France, Mexico and Peru). I'm also co-author of 7 books, and a founder and regular contributor to "Physics Pills", a well acclaimed monthly section distributed among the members of the Teaching and Outreaching Division of the Spanish Royal Physics Society. I'm also a frequent collaborator in broadcasting programs (4 years in Longitud de Onda - Radio Clásica; 2 years in LaboratoriUM, Radio Televisión Murciana). All these activities have been recognised with several awards: Popularization of Science Prize (Association for Popularization of Science of Murcia Region 2014), Teaching and Dissemination of Physics Prize (Spanish Royal Physics Society 2016), 16 times in Physics/Science on Stage, University of Murcia Award to Science Outreach 2020.

As a result of all the above-mentioned activities, I have been advisor of 5 PhD Theses, whose authors are now professors at different universities (València, Alacant, Castilla-La Mancha, Murcia).

I'm Director of *Revista Española de Física* (ISSN: 0213-862X), the official journal of the Spanish Royal Physics Society (RSEF), Associate Editor of *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias* (ISSN 1697-011X), Associate editor of *Frontiers in Materials* (ISSN: 2296-8016), and member of the Scientific Board of *Revista Eletrônica Ludus Scientiae* (ISSN 2527-2624). Since 2017 I'm a full member of the Academy of Sciences of the Region of Murcia.

Besides reviewing papers for well reputed journals (Phys. Rev. A, B, E, Lett; Sci. Rep.; J. App. Phys.; New. J. Phys.; Radiat. Res.; Phys. Med. Biol....), during 2015-16 I was member of the Panel of Experts of the ACADEMIA Program for the accreditation of tenure lecturers in Spain.

RELEVANT MERITS

Relevant publications (last 10 years)

Among my publications of the last 10 years, I have selected the following papers, which are most related to the research lines that I have been developing lately and that have a greater projection in my future research:

- F. Matias, N. E. Koval, P. de Vera, R. Garcia-Molina, I. Abril, J. M. B. Shorto, H. Yoriyaz, J. J. N. Pereira, T. F. Silva, M. H. Tabacniks, M. Vos, and P. L. Grande, Stopping cross-section for protons across different phases of water, *Physical Review Letters* 135 (2025) 148003.
- F. Cheng, P. de Vera, R. Garcia-Molina, Assessing electronic excitation spectra of chromium, palladium, and samarium from their stopping quantities, *Physical Review B* 110 (2024) 235134.
- P. de Vera, S. Taioli, P. E. Trevisanutto, M. Dapor, I. Abril, S. Simonucci, R. Garcia-Molina, 2022, Energy deposition around swift carbon-ion tracks in liquid water, *International Journal of Molecular Sciences* 23 (2022) 6121.

- P. de Vera, I. Abril, R. Garcia-Molina, Electronic cross section, stopping power and energy loss straggling of metals for swift protons, alpha particles and electrons, *Frontiers in Materials* 10 (2023) 124951
- A. Pedrielli, P. de Vera, P. E. Trevisanutto, N. M. Pugno, R. Garcia-Molina, I. Abril, S. Taioli, M. Dapor, Electronic excitation spectra of cerium oxides: from ab initio dielectric response functions to Monte Carlo charge transport simulations, *Physical Chemistry Chemical Physics* 23 (2021) 19173.
- S. Taioli, P. E. Trevisanutto, P. de Vera, S. Simonucci, I. Abril, R. Garcia-Molina, M. Dapor, Relative role of the physical mechanisms on complex biodamage induced by carbon irradiation, *Journal of Physical Chemistry Letters* 12 (2021) 487.
- P. de Vera, I. Abril, R. Garcia-Molina, Excitation and ionisation cross-sections in condensed-phase biomaterials by electrons down to very low energy: application to liquid water and genetic building blocks, *Physical Chemistry Chemical Physics* 23 (2021) 5079.
- P. de Vera, M. Azzolini, G. Sushko, I. Abril, R. Garcia-Molina, M. Dapor, I. A. Solov'yov, A. V. Solov'yov, Multiscale simulation of the focused electron beam induced deposition process, *Scientific Reports* 10 (2020) 20827.
- P. de Vera, R. Garcia-Molina, Electron inelastic mean free paths in condensed matter down to a few electronvolts, *Journal of Physical Chemistry C* 123 (2019) 2075.
- P. de Vera, I. Abril, R. Garcia-Molina, Energy spectra of protons and generated secondary electrons around the Bragg peak in materials of interest in hadron therapy, *Radiation Research* 190 (2018) 282.
- M. Dapor, I. Abril, P. de Vera, R. Garcia-Molina, Energy deposition around swift proton tracks in polymethylmethacrylate: How much and how far, *Physical Review B* 96 (2017) 064113.
- R. C. Fadanelli, M. Behar, L. C. C. M. Nagamine, M. Vos, N. R. Arista, C. D. Nascimento, R. Garcia-Molina, I. Abril, Energy loss function of solids assessed by ion beam energy-loss measurements: Practical application to Ta_2O_5, *Journal of Physical Chemistry C* 119 (2015) 20561.
- P. de Vera, R. Garcia-Molina, I. Abril, Angular and energy distributions of electrons produced in arbitrary biomaterials by proton impact, *Physical Review Letters* 114 (2015) 018101.

Research projects (last 10 years; PI=Principal Investigator)

My role in each project appears at the beginning of each item.

- **PI** Generation, transport and effects of electrons in condensed matter; Ministerio de Economía y Competitividad (FIS2014-58849-P); 2014; 01.01.2015 – 31.12.2018; 36300 €.
- **co-PI** Numerical simulations of complex interacting systems - Excellence Research Group; Seneca Foundation – Agency of Science and Technology of the Region of Murcia (19907/GERM/15); 2015; Co-PI Miguel Ortuño (Universidad de Murcia); 01.01.2016 – 31.12.2021; 250000 €.
- **PI** Interaction of low energy electrons with nanosystems; Ministerio de Ciencia, Innovación y Universidades (PGC2018-096788-B-I00); 2018; 01.01.2019 – 30.09.2022; 34848 €.
- **Researcher** Dose estimation in hadrontherapy - Grupos de Investigación Consolidables de la Generalitat Valenciana; Generalitat Valenciana (AICO/2019/070); 2019; PI Carlos Lacasta Llácer (CSIC-Valencia); 01.01.2019 – 31.12.2020; 39957 €.
- **Researcher** High-Z ceramic oxide nanosystems for mediated proton cancer therapy; Fondazione Caritro (Trento, Italy); 2019; PI Maurizio Dapor (ECT* Trento, Italy); 01.10.2019 – 30.09.2021; 50000 €.
- **co-PI** Nanoscale biodamage induced by swift ions: towards a dete¡ailed modelling and simulation - Ministerio de Ciencia e Innovación (PID2021-122866NB-I00); 2022; co-PI Pablo de Vera; 01.09.2022 – 31.08.2026; 42350 €.
- **co-PI** Energetic particles against cancer: Detailed simulations for a better use; Fundación Séneca - Agencia de Ciencia y Tecnología de la Región de Murcia (22081/PI/22); 2023; co-PI Pablo de Vera; 01.01.2023 – 31.12.2026; 33220 €.