

# Emilio Pisanty

POSTDOCTORAL RESEARCHER · STRONG-FIELD THEORY GROUP

Max Born Institute for Nonlinear Optics and Short-Pulse Spectroscopy, Berlin

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## Education

- **PhD in Controlled Quantum Dynamics**, Imperial College London, UK 2012-2016
- **MRes in Controlled Quantum Dynamics** with Distinction, Imperial College London, UK 2011-2012
- **Licenciatura en Física (BSc in Physics)** with Honours and 9.80/10 GPA, F. Ciencias, UNAM, Mexico 2006-2011

## Research Experience

### Max Born Institute for Nonlinear Optics and Short-Pulse Spectroscopy

Berlin

WISSENSCHAFTLICHE MITARBEITER · group leader: Olga Smirnova

2020 - present

- Settled the question on the existence optical skyrmions by providing explicit constructions

### ICFO – The Institute of Photonic Sciences

Barcelona

POSTDOCTORAL RESEARCHER · group leader: Maciej Lewenstein

2017 - 2020

- Discovered and characterized a novel type of optical polarization vortex with new symmetries and topologies of light
- Designed the first nonlinear optical polarization tomography experiment, in collaboration with experimentalists
- Developed novel methods, and advanced existing ones, to analyze strong-field interactions for atoms and solids
- Directed the development, as an MSc supervisor, of a fully-quantum-optical framework for high-harmonic generation
- Discovered a natural definition of the cutoff for high-order harmonic generation

### Max Born Institute for Nonlinear Optics and Short-Pulse Spectroscopy

Berlin

WISSENSCHAFTLICHE MITARBEITER · group leader: Misha Ivanov

2016 - 2017

- Designed a method to prevent the Lorentz-force suppression of high harmonics in the long-wavelength regime
- Implemented complex-trajectory methods on a rotating frame to understand the chirality of high-harmonic emission

### Imperial College London

London

POSTGRADUATE RESEARCHER · advisor: Misha Ivanov

2011 - 2016

PhD Thesis: Electron dynamics in complex space and complex time

MRes Thesis: Under-the-barrier electron-ion interaction during tunnel ionization

- Characterized the role of the complex-valued quantum orbits in semiclassical treatments of strong-field ionization
- Used analytical tools to describe kinematical origins for Zero-Energy Structures in above-threshold ionization
- Clarified the conservation of spin angular momentum in high-order harmonic generation

### Instituto de Ciencias Nucleares, UNAM

Mexico City

ESTUDIANTE ASOCIADO · advisor: Eduardo Nahmad-Achar

2010 - 2011

BSc Thesis: Generalized coherent states and the analytic structure of the annihilation operator

- Researched the quantum optics of field quadratures in a truncated photon basis, leading to a first-author undergraduate publication

## Awards and scholarships

- Cellex-ICFO-MPQ Postdoctoral Fellowship, 2018-2020
- Rector's Scholarship Fund Award, Imperial College London, 2012 - 2015
- Sir Peter Knight prize for MRes performance, Centre for Doctoral Training in Controlled Quantum Dynamics, Imperial College London, 2012
- Mexican National Council for Science and Technology (CONACYT) foreign scholarship, 2011 - 2016
- Mexican Secretary of Education (SEP) postgraduate complementary scholarship, 2011 - 2012
- Diploma for academic performance (second place of 283 by grade average), Facultad de Ciencias, Universidad Nacional Autónoma de México, 2011

## Professional experience

### TEACHING EXPERIENCE

- Co-supervised two MSc students, Javier Rivera Deán (thesis: *Quantum-optical analysis of high-order harmonic generation*) and Masudur Rahman (thesis: *Quantum simulations of attosecond physics*), Quantum Optics Theory group, ICFO, 2019
- Contributed to the supervision of one PhD student, Noslen Suárez (thesis: *Strong-field processes in atoms and polyatomic molecules*), Quantum Optics Theory group, ICFO, 2017

- Designed and taught a course on Quantum Key Distribution for high-school students as part of the Barcelona International Youth Science Challenge, ICFO, 2019
- ICFO Theory Lectures series “Complex Analysis and Saddle-Point Methods for Strong-Field Physics and Beyond”, ICFO, 2018
- Postgraduate Teaching Assistant, Imperial College London. Tutorials and Professional Skills seminars for 1st and 2nd year physics: Vector Calculus, Electromagnetism, Quantum Mechanics, Optics, Atomic Physics; Mathematica course for MRes students, 2012 - 2016
- Teaching Assistant, Universidad Nacional Autónoma de México. Analytic Geometry, Linear Algebra and Introduction to Electromagnetism; 1st and 2nd year physics and mathematics, 2010 - 2011

## SOFTWARE

- ComplexFocus: Non-paraxial vector beams in Mathematica, a flexible and robust implementation of analytical solutions for describing tightly-focused laser beams
- LISSAFIRE: Lissajous-Figure Reconstruction for nonlinear polarization tomography of bichromatic fields
- RB-SFA: High Harmonic Generation in the Strong Field Approximation via Mathematica, a leading open-source implementation of the quantum-orbit and numerical-integration approaches to high-harmonic generation
- QuODD: Quantum-Orbits Dynamic Dashboard, for visualizing quantum orbits on complex time and complex space
- ARMSupport, an open-source implementation of Analytical  $R$ -Matrix theory for atomic and molecular strong-field photoionization

## SCIENCE COMMUNICATION

- Active contributor at Physics Stack Exchange, with  $\sim 2450$  posts reaching an estimated audience of 4 million views, 2012-present. Samples: Chirped Pulse Amplification; Unit realizations in the New SI; Oscillating charge in the hydrogen atom
- Presented outreach talks at high-school level as part of the *Matí de la Reserca* 2019
- On-site coordinator with the Lightyear Foundation for the establishment of the Lab\_13 Ghana practical-science teaching space, 2015
- Conducted practical-science education workshops in Ghana with the Lightyear Foundation, 2013
- Extensive science busking experience with Imperial College London and with the Lightyear Foundation, including the Green Man festival, the Big Bang Fair, and the Cheltenham Literature Festival; 2012-2016
- Presented outreach talks “Boat wakes”, 2012, and “Chirp”, 2014, Imperial College London

## PROFESSIONAL SERVICE

- Referee for *Sci. Rep.*, *J. Phys. B*, *Phys. Rev. Lett.*, *Mol. Phys.*, *New J. Phys.* and *Phys. Rev. A*, 2013-2019
- Student editor for the Centres for Doctoral Training Newsletter, Imperial College London, 2012
- Organizing committee, Summer School on Quantum Information, Computing and Control (QuICC) 2012

## ADDITIONAL EXPERIENCE


- Experience with web-based 3D figures and with 3D printing for visualization, communication and publication of complex geometrical concepts
- Experience with Wolfram Mathematica in both research, package development, and teaching roles
- Developed LaTeX article and poster templates; experience with git and mercurial for software and project management
- Black belt in Kung-fu Wu-shu, 1st and 2nd degree. Asociación Calmecac, Mexico City. 2006, 2008
- Bilingual in Spanish and English, intermediate-level German

## Publications

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23 publications (20 peer-reviewed) with h-index 12 (Google Scholar  ) / 8 (Web of Science) / 8 (Scopus).

Total citation count: 404 (Google Scholar  ) / 251 (Web of Science) / 248 (Scopus), cited in 186 (WOS) / 192 (Scopus) publications. Without self-citations: 191 citations over 148 publications (WOS).

- AS Maxwell, GSJ Armstrong, MF Ciappina, E Pisanty, Y Kang, AC Brown, M Lewenstein, C Figueira de Morisson Faria. Manipulating twisted electrons in strong-field ionization. *Faraday Discuss.* (2020), arXiv:2010.08355.
- A Chacón, D Kim, W Zhu, SP Kelly, A Dauphin, E Pisanty, AS Maxwell, A Picón, MF Ciappina, DE Kim, C Ticknor, A Saxena and M Lewenstein. Circular dichroism in high-order harmonic generation: Heralding topological phases and transitions in Chern insulators. *Phys. Rev. B* 102, 134115 (2020), arXiv:1807.01616, (citations:  17).
- M Lewenstein, MF Ciappina, E Pisanty, J Rivera-Dean, T Lamprou, P Tzallas The quantum nature of light in high harmonic generation. arXiv:2008.10221 (2020).
- E Pisanty, MF Ciappina and M Lewenstein. The imaginary part of the high-harmonic cutoff. *J. Phys. Photon.* 2, 034013 (2020), arXiv:2003.00277.
- AP Woźniak, M Lesiuk, DK Efimov, M Mandrysz, JS Prauzner-Bechcicki, M Ciappina, E Pisanty, J Zakrzewski, M Lewenstein, R Moszyński. A systematic construction of Gaussian basis sets for the description of laser field ionization and high-harmonic generation. arXiv:2007.10375 (2020).

- S Mitra, S Biswas, J Schötz, E Pisanty, B Förg, GA Kavuri, C Burger, W Okell, M Högnér, I Pupeza, V Pervak, M Lewenstein, P Wnuk and MF Kling. Suppression of individual peaks in two-colour high harmonic generation *J. Phys. B: At. Mol. Opt. Phys.* 53, 134004 (2020), arXiv:2007.15450 (citations: WOS 1).
- J Schoetz, Z Wang, E Pisanty, M Lewenstein, MF Kling and MF Ciappina. Perspective on Petahertz Electronics and Attosecond Nanoscopy. *ACS Photonics* 6, 3057 (2019), arXiv:1912.08574 (citations:  $\mathfrak{F}$  3 / WOS 2 / Scopus 2).
- K Amini, J Biegert, F Calegari, A Chacón, MF Ciappina, A Dauphin, DK Efimov, C Figueira de Morisson Faria, K Giergiel, P Gniewek, AS Landsman, M Lesiuk, M Mandrysz, AS Maxwell, R Moszyński, L Ortmann, JA Pérez-Hernández, A Picón, E Pisanty, J Prauzner-Bechcicki, K Sacha, N Suárez, A Zair, J Zakrzewski and M Lewenstein. Symphony on Strong Field Approximation. *Rep. Prog. Phys.* 82, 116001 (2019), arXiv:1812.11447 (citations:  $\mathfrak{F}$  30 / WOS 12 / Scopus 11).
- L Rego, KM Dorney, NJ Brooks, Q Nguyen, C-T Liao, J San Román, DE Couch, A Liu, E Pisanty, M Lewenstein, L Plaja, HC Kapteyn, MM Murnane and C Hernández-García. Generation of extreme-ultraviolet beams with time-varying orbital angular momentum. *Science* 364, aaw9486 (2019), arXiv:1901.10942 (citations:  $\mathfrak{F}$  55 / WOS 30 / Scopus 28).
- ★ E Pisanty, GJ Machado, V Vicuña-Hernández, A Picón, A Celi, JP Torres and M Lewenstein. Knotting fractional-order knots with the polarization state of light. *Nature Photon.* 13, 569 (2019), arXiv:1808.05193 (citations:  $\mathfrak{F}$  13 / WOS 9 / Scopus 10).
- ★ E Pisanty, L Rego, J San Román, A Picón, KM Dorney, HC Kapteyn, MM Murnane, L Plaja, M Lewenstein and C Hernández-García. Conservation of torus-knot angular momentum in high-order harmonic generation. *Phys. Rev. Lett.* 122, 203201 (2019), arXiv:1810.06503 (citations:  $\mathfrak{F}$  12 / WOS 7 / Scopus 5).
- VE Nefedova, MF Ciappina, O Finke, M Albrecht, J Vábek, M Kozlová, N Suárez, E Pisanty, M Lewenstein and J Nejd. Determination of the spectral variation origin in high-order harmonic generation in noble gases. *Phys. Rev. A* 98, 033414 (2018), arXiv:1806.03974 (citations:  $\mathfrak{F}$  8 / WOS 4 / Scopus 5).
- E Pisanty, D Hickstein, BR Galloway, CG Durfee, HC Kapteyn, MM Murnane and M Ivanov. High harmonic interferometry of the Lorentz force in strong mid-infrared laser fields. *New J. Phys.* 20, 053036 (2018), arXiv:1606.01931 (citations:  $\mathfrak{F}$  13 / WOS 5 / Scopus 6).
- N Suárez, A Chacón, E Pisanty, L Ortmann, AS Landsman, A Picón, J Biegert, M Lewenstein and MF Ciappina. Above-threshold ionization in multicenter molecules: the role of the initial state. *Phys. Rev. A* 97, 033415 (2018), arXiv:1709.04366 (citations:  $\mathfrak{F}$  7 / WOS 5 / Scopus 5).
- Á Jiménez-Galán, N Zhavoronkov, D Ayuso, F Morales, S Patchkovskii, M Schloz, E Pisanty, O Smirnova and M Ivanov. Control of attosecond light polarization in two-color bi-circular fields. *Phys. Rev. A* 97, 023409 (2017), arXiv:1805.02250 (citations:  $\mathfrak{F}$  32 / WOS 24 / Scopus 23).
- E Pisanty and Á Jiménez-Galán. Strong-field approximation in a rotating frame: high-order harmonic emission from  $p$  states in bicircular fields. *Phys. Rev. A* 96, 063401 (2017), arXiv:1709.00397 (citations:  $\mathfrak{F}$  19 / WOS 14 / Scopus 15).
- BR Galloway, D Popmintchev, E Pisanty, DD Hickstein, MM Murnane, HC Kapteyn and T Popmintchev. Lorentz drift compensation in high harmonic generation in the soft and hard X-ray regions of the spectrum. *Opt. Express* 24, 21818 (2016) (citations:  $\mathfrak{F}$  14 / WOS 8 / Scopus 8).
- E Pisanty and M Ivanov. Kinematic origin for near-zero energy structures in mid-IR strong field ionization. *J. Phys. B: At. Mol. Opt. Phys.* 49, 105601 (2016) (citations:  $\mathfrak{F}$  3 / WOS 2 / Scopus 3).
- ★ E Pisanty and M Ivanov. Slalom in complex time: emergence of low-energy structures in tunnel ionization via complex time contours. *Phys. Rev. A* 94, 043408 (2016), arXiv:1507.00011 (citations:  $\mathfrak{F}$  34 / WOS 25 / Scopus 25).
- ★ E Pisanty, S Sukiasyan and M Ivanov. Spin conservation in high-order-harmonic generation using bicircular fields. *Phys. Rev. A* 90, 043829 (2014), arXiv:1404.6242 (citations:  $\mathfrak{F}$  80 / WOS 66 / Scopus 68).
- M Ivanov and E Pisanty. High-harmonic generation: Taking control of polarization. *Nature Photon.* 8, 501 (2014) (News & Views) (citations:  $\mathfrak{F}$  37 / WOS 29 / Scopus 27).
- E Pisanty and M Ivanov. Momentum transfers in correlation-assisted tunnelling. *Phys. Rev. A* 89, 043416 (2014), arXiv:1307.4765 (citations:  $\mathfrak{F}$  9 / WOS 7 / Scopus 6).
- E Pisanty and E Nahmad-Achar. On the spectrum of field quadratures for a finite number of photons. *J. Phys. A: Math. Theor.* 45, 395303 (2012), arXiv:1109.5724 (citations:  $\mathfrak{F}$  2 / WOS 1 / Scopus 1).

## Presentations

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### ORAL

- *Ab-initio* vs analytical methods. Invited ‘battle’ round-table discussion, Quantum Battles in Attoscience, online, 2020.
- Conservation of Torus-Knot Angular Momentum in High-Harmonic Generation Driven by Fields with Spin-Orbit Mixing. Contributed talk, DAMOP 2020, online, 2020.
- Creating and multiplying knotted topologies in the polarization state of light. Invited talk, International Workshop on Atomic Physics, MPI-PKS, 2019.
- Conservation of Torus-Knot Angular Momentum in High-Harmonic Generation Driven by Fields with Spin-Orbit Mixing. Accepted talk, USTS 2019 Meeting, Madrid, 2019.
- Knotted topologies in the polarization state of bichromatic light. Accepted talk, ICOAM, 2019.
- Knotting fractional-order knots with light’s polarization. ICFO Day Research Talk, 2017; Contributed talk, QUTIF Young Researcher meeting, 2018; Invited Seminar, MPQ, CEA-Saclay, UCL, King’s College London, Imperial College London,

Lund University, 2018-2020.

- Haces de luz con nudos de polarización. Invited Seminar, University of Salamanca, 2017; Invited Seminar, ICN-UNAM, 2018.
- Slalom in complex time: semiclassical trajectories in strong-field ionization and their analytical continuations. BIRS Workshop on Mathematical and Numerical Methods for Time-Dependent Quantum Mechanics, Oaxaca; Invited Seminar, ICN-UNAM, 2017.
- Strong-field dynamics with a 360° view. Symfonia Grant Meeting, Warsaw, 2017.
- High-harmonic interferometry of the Lorentz force in strong mid-IR laser fields. QUTIF Young Researcher Meeting, Göttingen, 2016.
- Complex trajectories for quantum orbits. Invited seminar, Rostock University, 2016.
- Polarization effects in non-collinear bicircular HHG. Max-Born Institute seminar, 2016.
- Electron dynamics in complex time and complex space. ICFO invited seminar, 2016.
- Probing non-dipole effects in HHG using noncollinear beams. XLIC Meeting, Belgium, 2016.
- Complex time contours in tunnel ionization and low-energy structures. APS March Meeting, San Antonio, 2015.
- Spin conservation in bicircular HHG. 1st XLIC WG1 meeting, UCL, 2014.
- Spin conservation in bicircular HHG: a photon exchange model. 5th TaDEM, ICF-UNAM, 2014.
- The role of correlations in tunnel ionization. Invited seminar, Azpuru-Guzik group, Harvard University, 2013.
- Momentum transfers in correlation-assisted tunnel ionization. 3rd AQuA Student Congress, Imperial College, 2013.
- Interactions during the tunnel effect. II Symposium of CONACYT Scholars and Ex-scholars in Europe, Strasbourg, 2012.

## POSTER

- The imaginary part of the high-order harmonic cutoff. DAMOP 2020, online, 2020.
- Conservation of torus-knot angular momentum in high-harmonic generation driven by fields with spin-orbit mixing. ATTO2019, Szeged, 2019.
- Creating and multiplying knots in the polarization state of light. ICAP, Barcelona, 2018.
- Conservation of torus-knot angular momentum in high-harmonic generation. GRC Multiphoton Processes, Providence, 2018.
- Anatomy of high-order harmonic emission from  $p$  states in bicircular fields. ICOMP 14, Budapest, 2017.
- Recovering high-harmonic emission from Lorentz-force effects using noncollinear counter-rotating beams. International Workshop on Atomic Physics, MPI-PKS, 2016.
- Slalom in complex time: dealing with the imaginary position of a quantum orbit. ATTO2015, Saint-Sauveur, 2015; 3rd XLIC General Meeting, Debrecen, 2015; International Workshop on Atomic Physics, MPI-PKS, 2015; QUTIF Research School, Rostock, 2016.
- Spin transfer in bicircular HHG: a photon exchange model. CORINF 2014 Summer School, Cargèse, 2014; GRC Multiphoton Processes, Waltham, 2014; Quantum Optics VII, Mar del Plata, 2014.
- Angular distributions for correlation-assisted tunnelling. ICOLS 2013, Berkeley; GRC Quantum Control of Light and Matter, Mount Holyoke College; ATTO2013, Paris, 2013.
- Channel jumping inside a tunnel ionization barrier. ATTOFEL Winter School, Bormio, 2013.
- Under-the-barrier electron-ion interaction during tunnel ionization. QuICC 2012, Aberystwyth, 2012.
- Quadrature (pseudo)eigenstates for finite photon numbers. QuICC 2012. Aberystwyth, 2012.
- Analytical Structure of the Annihilation Operator. IV Annual Meeting of the Quantum Information Division (DICU), Quéré-taro, 2011.