

António F. Moreira dos Santos, Ph.D.

Neutron Scattering Scientist
Point of Contact - SNAP Beamline, SNS

Contact Information

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Links

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SCOPUS	https://www.scopus.com/authid/detail.uri?authorId=10538992200

Biographical Sketch

António M. dos Santos graduated in Materials Engineering from the Universidade Nova de Lisboa, Portugal. Following graduation, he worked in the Welding and Quality Institute. He obtained a PhD. in Materials Science at the University of California, Santa Barbara, as Fullbright scholar co-advised by Prof. A. K. Cheetham and Prof. F.F. Lange. His dissertation focus was the study of magneto-structural properties of functional maganites. This was followed by a Post-Doc at CICECO, at the University of Aveiro, Portugal where he worked on lanthanide phosphors and low dimensional magnetism. In 2007 he joined ORNL's Spallation Neutron Source as a post doc, working on structure – properties relationships of materials under pressure. He transitioned to permanent staff in Sep. 2012, as an instrument scientist at the SNAP beamline. As of January 2018, he serves as SNAP's point of contact. Antonio M. dos Santos conceived and advocated for the first major upgrade at the beamline and was its scientific lead through completion. He has chaired conference sessions at the American Crystallographic Association, the IUCr and the March Meeting of the APS, and has served as instructor on workshops on crystallography, sample environments for neutron scattering and related topics. He has co-authored over 85 peer-reviewed publications (h-index 20) and 2 books and book chapters. He is a frequent reviewer for works in condensed matter physics, material science and high-pressure research and is an Associated Editor for Am. Mineralogist.

Education

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|---|------|
| Ph.D. Materials Science Dept. U.C. Santa Barbara,
“Electrical and Magnetic Properties of Manganese Oxides with Perovskite-
Related Structures”, Advisor: Prof. Anthony K. Cheetham, FRS | 2002 |
| Post-Graduate Degree as European Welding Engineering
Instituto de Soldadura e Qualidade, Oeiras
(Institute of Welding and Quality) | 1996 |
| Undergraduate Degree in Materials Engineering
Faculdade de Ciências e Tecnologia Universidade Nova de Lisboa | 1994 |

Professional Experience

- Instrument Scientist at SNAP, at the Spallation Neutron Source,
Oak Ridge National Laboratory, TN, USA Nov 2009 -
Present
- Post-doctoral position in high pressure diffraction in the SNAP
instrument at the Spallation Neutron Source, Oak Ridge National
Laboratory, TN, USA May 2007- Oct
2009
- Post-Doctoral Fellowship from the Fundação Ciência e Tecnologia
Shared between Physics and Chemistry Dep. at Universidade de
Aveiro, Portugal Apr 2004-07
- Graduate Research Assistant for the Materials Department
University of California Santa Barbara, CA, USA 1996-02
- Teaching Assistant “Mat 10 - Materials in Society” Materials
Department University of California Santa Barbara, CA, USA Winter 99
- Research Assistant for the Polymers Group of the Materials Science
at the Faculdade de Ciências e Tecnologia/U.N.L., Portugal 1994-96
- Research Assistant for the New Materials Division of the Instituto
de Soldadura e Qualidade, Oeiras, Portugal 1994-96

Awards and Honors

- Fulbright Scholar Ph.D. program 1996-2002

- UCSB Vice-Chancellor Fellowships for Research in external laboratories:
 - Los Alamos National Laboratory Jan 2001
 - JNCASR Indian Institute of Science Nov1999 - Feb 2000
- Official Student Visitor Scholarship from the Los Alamos National Lab July-Oct. 2001

Scientific Activities

- 2021 - Present – Associated Editor for American Mineralogist
- 2021 – Instructor at the National School on Neutron and X-ray Scattering
- 2018 - Present – Member in the High Pressure proposal review panel for the Advanced Photon Source, ANL.
- 2016 - Present – Representative of the Oak Ridge National Laboratory to the Consortium for Materials Properties Research in Earth Sciences (COMPRES)
- 2020 (cancelled) and 2021 – Co-organizer for Focus Session “Matter in Extreme Environments” at the 2021 March Meeting of the American Physical Society
- 2019 Chair of Workshop “Smaller, Deeper and Lighter: Advanced Neutron Techniques for the Geosciences”, Dec 8th, San Francisco California, USA
- 2019 Chair of Workshop “Total Scattering Measurements under high Pressure”, Oct 28-29, Oak Ridge, TN, USA
- 2018 Scientific Committee Member for the 56th EHPRG Meeting on High Pressure Science and Technology, Sep. 2nd-7th, Aveiro Portugal
- 2017 – Session Co-Chair in the 24th Congress of the IUCr, Aug. 2017, Hyderabad, India MS-049 In-Situ and In- Operando characterization of catalytic and functional materials
- 2013 – Chair of the Workshop on New Directions for High Pressure Neutron Research, Oak Ridge, Tennessee, USA
- 2013 - Chair for the Powder Diffraction Scientific Interest Group of the American Crystallography Association
- 2013 - Chair for the Transactions Symposium: Neutron & Synchrotron Sources: Role in Crystallography of the American Crystallography Association
- 2013 – Instructor at the National School on Neutron and X-ray Scattering
- 2012 - Chair of the session “In-Situ / Parametric Studies” of the American Crystallography Association Meeting
- 2012 – Instructor at the National School on Neutron and X-ray Scattering
- 2011 – Instructor at the National School on Neutron and X-ray Scattering

Projects and Proposals

Contributor: “Monte Carlo Ray Tracing Analysis of mixed samples”, LDRD – 2022-2024, P.I. Garrett Granroth
Starting Date: TBA

Consultant: Instabilidades de rede funcionais em perovskites naturalmente estruturadas
POCI-01-0145-FEDER-029454
PI: Armandina Lopes, U. Porto, Portugal
Starting Date: August 2018

Consultant: Strictive4Device - Micro and nanostructures with giant magnetostrictive effect: Production, optimization and applications in multifunctional devices
PTDC/CTM-NAN/115125/2009
PI: Joao Pedro Araujo, U. Porto, Portugal
Starting Date: August 2011

Consultant: MULTIFOX: Nanometric Probing and Modification of Multiferroic Oxides;
PTDC/FIS/105416/2008
PI: Vitor Amaral U.Aveiro, Portugal
Starting Date: Jan 2011

Consultant: Strictive4Device - Micro and nanostructures with giant magnetostrictive effect: Production, optimization and applications in multifunctional devices
PTDC/CTM-NAN/115125/2009
PI J. P. Araujo, U. Porto, Portugal
Starting date Oct 2010

Principal Investigator: Luminescent Lanthanide Silicate Synthesis, using Lanthanide complexes as Structure Directing Agents
May 2005-May 2007

Collaborator: Novel Multidimensional Lanthanide-Organic Frameworks: Hydrothermal Synthesis, Structural Characterization and Applications.
PI F.F. Paz, U. Aveiro, Portugal
May 2005-May 2008

Mentoring Activities

- **João Horta (U. Porto, Portugal) Fulbright Scholar** ORNL 2022
- **Chris Perrault (U.A.B.) External member PhD Committee** 2021
- **Ethan Deters (U. T. Knoxville) SULI student** ORNL 2019
- **Lucas Paixão (UFF, Brazil) External member PhD Committee** 2016
- **Lucas Paixão (UFF, Brazil)** ORNL 2015
- **Jeff Montgomery (U.A.B.) External member PhD Committee** 2016
- **Armandina Lopes (U. Porto, Portugal) Sabbatical/ FLAD** ORNL 2014
- **João Pedro Araújo (U. Porto, Portugal) Sabbatical/ FLAD** ORNL 2014
- **Sarah Thomas (U.A. B.) External member PhD Committee** 2016
- **Fábio Figueiras (U Aveiro, Portugal)** ORNL 2011
- **André Pereira (U. Porto, Portugal) Fullbright Scholar** ORNL 2009
- **Ana C. Coelho (U. Aveiro)** U. Aveiro 2004

Peer Reviewed Publications

85 Manuscripts – Cited 1701 times – h-index 20 (Retrieved from Scopus Oct. 2021)

Full list of publications is deposited on:

ORCID

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- <https://orcid.org/0000-0001-6900-0816>

SCOPUS

- **10538992200**
- <https://www.scopus.com/authid/detail.uri?authorId=10538992200>

In Press:

C. S. Perreault, Y. K. Vohra, A. M. dos Santos and J. J. Molaison; “*Magnetic Structure of antiferromagnetic high-pressure phases of dysprosium*”, J. Mag. Mag. Mat.

T. Matsuoka, A. Haglund, R. Xue, J. S. Smith, M. Lang, A. M. dos Santos, and David Mandrus “*Pressure-Induced Insulator-Metal Transition in Two-Dimensional Mott Insulator NiPS₃*”, J. Phys. Soc. Japan

B.Pimentel, V. M. Andrade, V. G. de Paula, K. R. Pirota, F. Béron, M. A. Cardoso, J. N. Gonçalves, J. Amaral, A. M. Dos Santos, M. S. Reis “*Cubic to hexagonal tuning in Fe₂Mn(Si_{1-x}Ge_x) Heusler alloys*” J. Alloys and Comp.

Selected Publications:

S. P Vallone, A. N Tantillo, A. M Dos Santos, J. J Molaison, R. Kulmaczewski, A. Chapoy, P. Ahmadi, M. A Halcrow, K. G Sandeman “*Giant barocaloric effect at the spin crossover transition of a molecular crystal*” Advanced Materials 31(23), 1807334 (Jun 2019)

C. Perreault, Y. K Vohra, A. M dos Santos, J. J Molaison, R. Boehler “*Magnetic ordering in rare earth metal dysprosium revealed by neutron diffraction studies in a large-volume diamond anvil cell*” High Pressure Research 39(4) 588-597 (Oct 2019)

Malcolm Guthrie, Reinhard Boehler, Jamie J Molaison, Bianca Haberl, AM dos Santos, Christopher Tulk “*Structure and disorder in ice VII on the approach to hydrogen-bond symmetrization*” Phys. Rev. B, 99(18) 184112 (May 2019)

A. Sano-Furukawa, T. Hattori, K. Komatsu, H. Kagi, T. Nagai, J. J. Molaison, A. M. dos Santos, C. A. Tulk, “*Direct observation of symmetrization of hydrogen bond in delta-AIOOH under mantle conditions using neutron diffraction*” Sci. Reports **8** 15520 (2018)

A. M. dos Santos, J. J. Molaison, B. Haberl, L. Krishna, K. Page, M. Loguillo, X. P. Wang, “*The high-pressure gas capabilities at Oak Ridge National Laboratory's neutron facilities*” Rev. Sci. Instr. **89(9)** 092907 (2018)

B. R. Hester, A. M. dos Santos, J. J. Molaison, J. C. Hancock, A. P. Wilkinson, “*Synthesis of Defect Perovskites ($He_{2-x} \square_x$)(CaZr)F₆ by Inserting Helium into the Negative Thermal Expansion Material CaZrF₆*” J. of the Am. Chem. Soc. 139(38) 13284-13287 (2017)

A.-M. Schaeffer; W. Cai; E. Olejnik; J. J. Molaison; S. Sinogeikin; A. M. dos Santos; S. Deemyad; “*Boundaries for martensitic transition of Li-7 under pressure*”, Nature Comm. **6**, 8030(Aug 2015)

J. Cheng; K. E. Kweon; S. A. Larregola, Y. Ding; Y. Shirako; L. G. Marshall; Z. -Y. Li; X. Li; A. M. dos Santos; M. R. Suchomel; K. Matsubayashi; Y. Uwatoko; G. S. Hwang; J. B. Goodenough; J. -S. Zhou; “*Charge disproportionation and the pressure-induced insulator-metal transition in cubic perovskite PbCrO₃*”, PNAS : **112(6)** 1670-1674 (Feb 2015)

S. Haravifard ; A. Banerjee; J. van Wezel; D. M. Silevitch; A. M. dos Santos; J. C. Lang; E. Kermarrec; G. Srajer; B. D. Gaulin ; J. J. Molaison; H. A. Dabkowska; T. F. Rosenbaum; “*Emergence of long-range order in sheets of magnetic dimers*”, PNAS : **111(40)** 14372-14377 (Oct 2014)

R. Boehler; M. Guthrie; J. J. Molaison, A. M. dos Santos; S. Sinogeikin; S. Machida; N. Pradhan; C. A. Tulk “*Large-volume diamond cells for neutron diffraction above 90 GPa*”, High Pressure Res. **33(3)** 546-554 (2013)

A.M. Pereira, C. Magen, A.M. dos Santos, P.A. Algarabel, C. Ritter, L. Morellon, M.R. Ibarra, Y. Ren, J.B. Sousa, and J.P. Araujo “*Understanding the role played by Fe on the tuning of magnetocaloric effect in Tb₅Si₂Ge₂*”, Appl. Phys. Lett. **98(12)**, 122501 (2011);.

A. M. dos Santos, P. Brandão, A. Fitch, M. S. Reis, V. S. Amaral, J. Rocha, "Synthesis, crystal structure and magnetic characterization of $\text{Na}_2\text{Cu}_5(\text{Si}_2\text{O}_7)_2$: An inorganic ferrimagnetic chain", J. of Solid State Chem. **180(1)** 15–20. (2007)

A. M. dos Santos, V. S. Amaral, P. Brandão, F. A. A. Paz, J. Rocha, L. P. Ferreira, M. Godinho, O. Volkova, and A. Vasiliev, "Singlet ground state determined by isolated Cu^{2+} chain topology in microporous $\text{Na}_2\text{Cu}_2\text{Si}_4\text{O}_{11}\cdot 2\text{H}_2\text{O}$ and $\text{Na}_2\text{Cu}_2\text{Si}_4\text{O}_{11}$ ", Phys. Rev. B, **72(9)**, 092403, (2005)

A. M. dos Santos, A. K. Cheetham, T. Atou, Y. Syono, Y. Yamaguchi, K. Ohoyama, H. Chiba, and C. N. R. Rao, "Orbital Ordering as the Determinant for Ferromagnetism in Biferroic BiMnO_3 ", Phys. Rev. B, **66(6)**, 064425-064425-4, (2002).

A. M. dos Santos, S. Parashar, A. R. Raju, A. K. Cheetham, and C.N.R.Rao, "Evidence for the occurrence of Magnetoferroelectricity in BiMnO_3 ", Solid State Commun., **122(1-2)**, 49-52, (2002)

Books and Invited Contributions

Books

Neutron Diffraction (Chapter)
ASM Handbook Vol. 10 Materials Characterization
António M dos Santos, Melanie Kirkham, Christina Hoffmann
ISBN 978-1-62708-213-6
Publication date 2019

Magnetismo Molecular (in Portuguese)
M. S. Reis and A. Moreira dos Santos,
Publisher” Livraria da Fisica, São Paulo, Brazil
Number of pages 192
Edition code 1ED. 2010
ISBN 9788578610791

Invited Articles

ÍMÃS MOLECULARES - Rumo aos Limites da Miniaturização (in Portuguese)
M. S. Reis and A. Moreira dos Santos,
Ciência Hoje vol 45 n 275

Thesis

Ph.D. Dissertation: Electrical and magnetic properties of manganates with perovskite-related structure, **2002**, University of California at Santa Barbara.

Conference Presentations

Oral Presentations

- 2021 March Meeting of the American Physical Society March 15th -19th 2021 (Virtual): Neutron Scattering Research on Quantum Materials under Pressure
- **Invited** TMS 2020 Annual Meeting February 23-27, San Diego, California, USA, “Giant Barocaloric Effect at the Spin Crossover Transition of a Molecular Crystal”
- **Invited** 27th AIRAPT – August 4th-9th 2019 Rio de Janeiro, Brasil, “High Pressure Neutron Science at the SNS – Current and Future Prospects”
- **Invited:** 24th Congress of the IUCr, Hyderabad, India , Aug. 2017 “Emerging Challenges in high Pressure Neutron Scattering”
- **Invited:** Strategy Meeting for High Pressure Spallation Science, July 2017 Lund, Sweden “Prospects for single-crystal studies under high pressure”
- **Invited:** Rare Earths 2016, Sapporo, Japan: “Neutron Scattering at High Pressure: A unique tool in Rare Earth Research”
- **Invited:** Research at High Pressure Gordon Conference, Holderness School, NH, “Recent Advances in Neutron Scattering Under Pressure”
- 2015 AIRAPT-25th & EHPRG-53rd Meeting, Madrid Spain High Pressure neutron diffraction on magnetic systems
- 64th Annual Denver X-ray Conference, Denver, Colorado
Invited - Successes and Challenges of High Pressure Neutron Powder Diffraction
- 2014 Magnetism and Magnetic Materials 2014 High Pressure Studies on Magnetic Materials - Highlights from the SNAP Instrument at the SNS
- 2014 American Crystallographic Association, Albuquerque, NM
Invited - Advances in Neutron High Pressure Research at the Spallation Neutron Source
- 2013 American Crystallographic Association Meeting Honolulu, HI Neutron scattering under high pressure: SNAP-Recent results and future directions

- 2013 AIRAPT, Seattle, WA
Magneto-Structural coupling in compressed Manganese Oxide
- 2012 Fall Materials Research Society, Boston, MA
Recent Results at SNAP, the High Pressure Diffractometer at the SNS
- 2011 American Crystallographic Association Meeting, New Orleans, LA
Structural and Magnetic Properties of Cobalt Oxide under Pressure
- 2010 IUCr High Pressure Commission Meeting, Gatlinburg TN
Structural and Magnetic Properties of Cobalt Oxide under Pressure
- 2009 American Crystallographic Association, Toronto, Canada
Structure and Characterization of two Novel Aluminum Borohydride Amines
- 2009 Joint Meeting of the American Geophysical Union, Toronto, Canada
Combined Neutron and X-Ray Diffraction Studies on H/D Isotope Effects in
Brukite
- 2009 International Conference on Neutron Scattering, Knoxville, TN
High-Pressure Neutron Diffraction on Hydrogenated and Deuterated Brukite.
- 2006, International conference on f-Elements, Wroclaw Poland
Novel Luminescent Materials Based on a Eu(III) Complexes with
benzoyltrifluoroacetone and Bidentate Heterocyclic Amines
- 2006 III Joint European Magnetic Symposia, San Sebastian, Spain
Homometallic Ferrimagnetism in a New Copper Chain Compound $\text{Na}_2\text{Cu}_5\text{Si}_4\text{O}_{14}$
- 2005 American Physical Society March Meeting, Los Angeles
 $\text{Na}_2\text{Cu}_2\text{Si}_4\text{O}_{11}\cdot\text{H}_2\text{O}$: A new $S=1/2$ chain material with Microporous Structure

Poster Presentations

- 2019 American Geophysical Society Fall Meeting 9th – 13th December 2019 San Francisco, Ca “Neutron scattering: Towards a better understanding of planetary chemistry(s)”
- 2018 56th EHPRG Meeting Sep 2nd-7th Aveiro Portugal, “Insights on Quantum Materials using High Pressure Neutron Scattering”
- 2015 COMPRES yearly Meeting
Opportunities for Geosciences using High Pressure Neutron Scattering

- 2012 “Research at High Pressure” Gordon Conference
Overview of the Current Capabilities and future developments at the SNAP high pressure beamline
- 2010 “Research at High Pressure” Gordon Conference
Effect of Isotopic Substitution in the Compressibility of Brucite
- 2010 Goldshmidt Conference
Combined high-pressure neutron and X-ray diffraction study of H-D substitution effects on brucite
- 2008 Conference of the International Union of Crystallography
The Structure of Type I Semiconducting Clathrates under Pressure
- 2008 Gordon Conference, Research at High Pressure
Structural Characterization of Cobalt Oxide under High Pressure
- 2008 Conference of the American Crystallographic Association, Knoxville, TN
Magnetic Structural Changes of Cobalt Oxide under High Pressure
- 2008 Int. Workshop on Synthesis of Functional Oxide Materials, UCSB, CA
SNAP - The High Pressure Beamline at SNS
- 2006 European Conference on Molecular Magnetism, Tomar, Portugal
Novel inorganic compounds as low-dimension magnetic materials
- 2006 International Conference on Magnetism, Kyoto, Japan
Homometallic Ferrimagnetism in a New Copper Chain Compound $\text{Na}_2\text{Cu}_5\text{Si}_4\text{O}_{14}$
- 2005 III International Materials Symposium , Aveiro, Portugal
Photoluminescence of Stoichiometric Lanthanide Silicates $\text{Na}_5\text{LnSi}_4\text{O}_{12}$, Ln=Eu, Tb.
- 2002 Gordon Conference in Solid State Chemistry
“First Experimental Observation of Coexistence of Ferroelectricity and Ferromagnetism: BiMnO_3 ” - Selected for oral presentation

Invited Oral Presentations

- AGU Workshop “Smaller, Deeper and Lighter: Advanced Neutron Techniques for the Geosciences”, San Francisco California , USA Dec 2019
 “Sample environments for neutron scattering”
- Workshop “Total Scattering Measurements under high Pressure”, Oak Ridge, TN, USA Oct 2019
 “Total scattering measurements at SNAP 2.0”
- IFIMUP, Porto University Jun 2019
 “Condensed Matter Research at the ORNL’s Neutron Sources”
- Brooklyn College, City University of New York April 2019
 “An illustrated guide to high pressure research at the Spallation Neutron Source”
- HiPSEC, U. Nevada Las Vegas Sep. 2017
 “The Reach of High-Pressure Research in the Spallation Neutron Source”
- Fluminense Federal University, Niteroi, Brazil Sep. 2016
 “Neutron scattering at high pressure: Present capabilities and future directions”
- National Center for Physics Research, Rio de Janeiro, Brazil Sep. 2016
 “Neutron scattering at high pressure: Present capabilities and future directions”
- Institute of Solid State Physics, University of Tokyo, Japan, Jun. 2016
 “High Pressure at the SNS: Past, Present and Future”
- U. Utah Condensed Matter Seminar Mar. 2015
 Neutron scattering at high pressure: Present capabilities and future directions
- U. Utah Condensed Matter Seminar Mar. 2015
 Neutron scattering at high pressure: Present capabilities and future directions
- U. Hawaii, Manoa, HIGP Seminar Nov. 2014
 Neutron scattering at high pressure: Present capabilities and future directions

- ORNL - Neutron and Nano User Meeting
Neutron High Pressure Technology Aug. 2013
- U. Alabama, Birmingham Physics Colloquium
Frontiers of Neutron Research under Extreme Conditions: SNAP
Research on Solid State Physics, Chemistry and Geophysics Sep. 2012
- Berea College, KY
Seeing the World through Neutrons: From new energy resources
to the core of the earth Feb. 2009
- U. Tennessee, Knoxville
Invited Lecture for the Engineering Department: “Structure and
Properties of Perovskites Sep 2008
- Inst. Chem Research, Kyoto Univ.
High-Pressure Studies of Crystalline and Amorphous Ge Based
Clathrates Aug 2008
- J-Park, Tokai-Japan.
High-Pressure Studies of Crystalline and Amorphous Ge Based
Clathrates Aug 2008
- MRL, U.C. Santa Barbara
Structure-properties relationships in Metal Oxides: Magnetic and
optical implications Aug 2007
- LNS, Paul Scherrer Institute, Switzerland,
Structure-properties relationship: Magnetic and Optical
Implications Jan 2007
- Physics Department, Faculdade de Ciências, Universidade de
Lisboa, Portugal, “Magnetic Structure of BiMnO₃” Nov 2002
- Physics Dep., U. of Santiago, Santiago de Chile, Chile
“Magnetic and Dielectric Properties of BiMnO₃” May 2002

Internships

- Workshop on JANA - Incommensurate Crystal Structures Jul 2009
- Workshop on Magnetic Structure Determination from Neutron Powder Diffraction Data Nov 2005
- LANSCE Los Alamos National Laboratory, New Mexico Jul-Sep 2001
- JNCASR Bangalore, India Nov 1999 - Mar. 2000
- Rietveld Method Short Course, Georgia Institute of Technology Jun 98
- Resiquímica- a Hoechst company March-July - 1993

Certifications

- European Welding Engineer 1996
- European Corporate Training Credential 2005

Scientific Expertise

- Powder diffraction analysis of x-ray and neutron scattering, including crystal structure determination and refinement and magnetic structure determination.
- Considerable experience in solid state chemistry synthesis both in powder form and through solution precursor routes.
- High pressure techniques for neutrons x-rays and magnetization measurements.
- Thin films deposition on single crystal substrates through a variety of techniques (such as spin coating and nebulized spray pyrolysis).
- Materials characterization techniques such as scanning electron microscopy, electrical and dielectric characterization, magnetic measurements (SQUID measurements) etc.
- Photoluminescence optical properties of oxide materials, both in steady state (emission and excitation spectra) and lifetimes of excited states.
- Working knowledge of program languages Python, C and Wolfram Mathematica

Languages

Language	Conversation	Reading	Writing
Portuguese (Native Speaker)	Mastery	Mastery	Mastery
English	Mastery	Mastery	Mastery
Spanish	Advanced	Advanced	Basic
French	Medium	Advanced	Basic