

CV - ROBERTO HERNÁNDEZ PALOMARES

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RESEARCH POSITIONS

University of Waterloo Mathematics

January 2023 - Present

Postdoctoral Fellow

Texas A&M University Mathematics

August 2021 - December 2022

Visiting Assistant Professor

EDUCATION

Mathematics Department at The Ohio State University

August 2015 - May 2021

- Ph.D. degree awarded in May 2021.

- Master in Sciences obtained in 2018.

CIMAT/Universidad de Guanajuato, México

August 2010 - June 2015

Bachelor of Mathematics.

RESEACH INTERESTS

Operator algebras, subfactors, quantum groups, tensor categories and quantum information

RESEARCH PROJECTS AND PUBLICATIONS

K-Theoretic classification of inductive limit actions of fusion categories on AF C*-algebras

With Chen and C. Jones, *Commun. Math. Phys.* 405, 83 (2024). DOI: [10.1007/s00220-024-04969-w](https://doi.org/10.1007/s00220-024-04969-w)
[arXiv:2207.11854](https://arxiv.org/abs/2207.11854)

Dynein localization and pronuclear movement in the *C. elegans* zygote

With D. P. Ignacio, N. Kravtsova, J. Henry and A. T. Dawes. *Cytoskeleton Journal*, Article ID: CM21733, DOI: [10.1002/cm.21733](https://doi.org/10.1002/cm.21733) (2022), Contribution: Methodology, formal analysis.

Q-System Completion for C*-2-Categories

With Chen, C. Jones and Penneys, *J. Functional Analysis*, Vol 283, Issue 3, (2022), 109524, ISSN 0022-1236, DOI: [10.1016/j.jfa.2022.109524](https://doi.org/10.1016/j.jfa.2022.109524), MR4419534, [arXiv:2105.12010](https://arxiv.org/abs/2105.12010). We study a higher idempotent completion for C* 2-categories and show that C*-algebras are Q-system complete.

Realizations of Rigid C*-Tensor Categories as Bimodules over a GJS C*-algebra

With Hartglass. *J. Math. Phys.* 61 (2020), no. 8, 081703, 32 pp. DOI: [10.1063/5.0015294](https://doi.org/10.1063/5.0015294)
MR4139893, [arXiv:09821](https://arxiv.org/abs/09821). We show that every unitary tensor category acts on some C*-algebra, using the Gionnet-Jones-Shlyakhtenko construction.

Classifying Module Categories for Generalized TLJ *-2-Categories

With Ferrer. *Internat. J. Math.* 31 (2020), no. 4, 2050027, 30 pp.

DOI: [10.1142/S0129167X20500275](https://doi.org/10.1142/S0129167X20500275), MR4098904, [arXiv:1905.00471](https://arxiv.org/abs/1905.00471). We provide a complete classification of module categories over the generalized Temperley-Lieb-Jones \uparrow 2-categories.

••• Preprints:

Remarks on C*-discrete inclusions

With B. Nelson [arXiv:2409.18161](https://arxiv.org/abs/2409.18161) (under review) We study fundamental properties of C*-correspondences to show certain semicircular systems from free probability are discrete. We develop a Galois theory for C*-discrete inclusions, and show crossed products by free actions of tensor categories preserve simplicity.

Quantum graphs, subfactors and tensor categories I

With M. Brannan [arXiv:2409.01951](https://arxiv.org/abs/2409.01951) (under review) Applications of subfactors into quantum information, constructing and classifying quantum graphs from tensor categories.

Discrete inclusions of C^* -algebras

With B. Nelson [arXiv:2305.05072](https://arxiv.org/abs/2305.05072) (under review) We characterize when an inclusion of C^* -algebras is a crossed product by a unitary tensor category in terms of the abstract property of *discreteness/quasi-regularity*. These inclusions are thus characterized by a *standard invariant* akin to subfactors.

Inclusions of Operator Algebras from Tensor Categories: beyond irreducibility

With L. Hataishi (To appear soon) We compare the discrete property for subfactors with that of C^* -inclusions. We develop techniques to study discrete inclusions which are not irreducible.

Discrete inclusions from Cuntz-Pimsner algebras

With B. Nelson (To appear soon) We show cores of Cuntz algebras yield irreducible C^* -discrete inclusions, giving crossed products by quantum symmetries. We show when cores of Cuntz-Pimsner algebras are C^* -discrete.

Geometric Measure of Arens Irregularity

With Hu, Maierhofer and Rao. https://www.fields.utoronto.ca/programs/scientific/14-15/summer-research14/mini-conf/final_report_18_ene_2015.pdf We provide necessary and sufficient conditions for two ultrafilters to commute under the Arens products and show these products are distinct for every discrete group.

••• Ongoing projects:

Quantum graphs, subfactors and tensor categories II

(Work in progress with M. Brannan) We develop a categorical framework for quantum graphs, affording the use of K -theoretic and subfactor invariants. Expanding on path spaces of quantum graphs, we study sub-shifts and their associated operator algebras.

Construction of highly-regular quantum graphs

(Work in progress from Outsourcing Math Research) We introduce and construct highly-regular quantum graphs, and study their interphase with spin models and tensor categories.

Complex Hadamard Matrices, Symmetries and Quantizations

(Work in progress with D. Gromada and M. Brannan) We study quantum symmetries of generalized Hadamard matrices and their associated quantum groups and representation categories.

PRESENTATIONS

••• Invited Talks:

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| 23: Quantum Symmetries Seminar, OSU, Columbus, OH USA | <i>Oct 2024</i> |
| Invited speaker. <i>Title: Quantum graphs, subfactors and tensor categories</i> | |
| 22: South Atlantic Noncommutative Geometry Seminar, U Buenos Aires, ARG | <i>Oct 2024</i> |
| Seminar speaker. <i>Title: Quantum graphs, subfactors and tensor categories</i> | |
| 21: Graph Theory Seminar UWaterloo, ON Ca | <i>Oct 2024</i> |
| Seminar speaker. <i>Title: Quantum graphs, subfactors and tensor categories</i> | |
| 20: Analysis Seminar, UWaterloo | <i>March 2024</i> |
| Seminar speaker. <i>Title: C^* Quantum Dynamics</i> | |
| 19: Math Physics & Operator Alg. seminar, Michigan State U, Lansing, MI, USA | <i>Jan 2024</i> |
| Invited speaker. <i>Title: C^* Quantum Dynamics</i> | |
| 18: C^* -Algebras and Tensor Categories, Fields Institute, Toronto, ON, CA | <i>Nov 2023</i> |
| ◇◇◇ Mini-Course Lecturer: <i>Actions of tensor categories on operator algebras</i> | |
| 17: Carleton-Ottawa Joint Analysis Seminar, Ottawa, ON, CA | <i>March 2023</i> |
| Invited speaker: <i>K-theoretic classif. of ind. lim. actions of fusion cats. on AF-algs</i> | |
| 16: Analysis Seminar University of Waterloo, Waterloo | <i>March 2023</i> |

- Seminar speaker: *K-theoretic classif. of ind. lim. actions of fusion cats. on AF-algs*
- 15:** Quantum Symmetries Seminar, **OSU** Nov 2022
 Remote seminar speaker: *Discrete inclusions of C^* -algebras*
- 14:** Malý Seminar, **Karlin Univeristy, Prague, Czech Rep** Nov 2022
 Invited speaker: *Unitary tensor categories and their actions*
- 13:** NCG&T Sem, **Inst. of Math. Czech Academy of Sciences, Prague** Nov 2022
 Invited speaker: *K-theoretic classif. of ind. lim. actions of fusion cats. on AF-algebras*
- 12:** Operator algebras Seminar, **KU Leuven, Belgium** Oct 2022
 Invited speaker: *K-theoretic classif. of ind. lim. actions of fusion cats. on AF-algebras*
- 11:** Functional Analysis Seminar, **Inst. of Mathematics, University of Oxford, UK** Sep 2022
 Invited speaker: *K-theoretic classif. of ind. lim. actions of fusion cats. on AF-algebras*
- 10:** Quantum Groups Seminar, **University of Copenhagen, Denmark** June 2022
 Remote speaker: *Q-systems and higher unitary idempotent completion for C^* -algs*
- 9:** Mathematics Colloquium, **U. Autónoma de Yucatán-CIMAT, México** May 2022
Remote colloquium: *Qué son los espacios no-conmutativos y sus simetrías cuánticas*
- 8:** Jr. Student Seminar, **Universidad de Guanajuato, México** March 2022
 Remote speaker: *Simetrías cuánticas y espacios cuánticos*
- 7:** ASUERAU C^* -seminar, **Arizona State University, AZ, USA** Feb 2022
 Remote speaker: *Applications of subfactor and categorical techniques to C^* -algebras*
- 6:** Analysis Seminar, **U Waterloo** Feb 2022
 Remote speaker: *C^* -algs, Q-systems and higher idempotent completion for C^* 2-cats.*
- 5:** Alg & Combinatorics Seminar, **Texas A&M University, College St, TX, USA** Oct 2021
 Seminar speaker: *Q-systems and higher idempotent completion for C^* 2-categories*
- 4:** Category Theory Seminar, **Universidad Nacional Autónoma de México** March 2021
 Remote seminar speaker: *UTC actions on C^* -algebras*
- 3:** Algebra seminar, **Indiana U, Bloomington IN, USA** Nov 2020
 Remote seminar speaker: *Classifying module categories for generalized TLJ $*$ -2-categories*
- 2:** Brazos Analysis Seminar, **Texas A&M** Nov 2020
 Remote speaker: *Realizing unitary tensor categories over GJS C^* -algebras*
- 1:** Subfactors seminar, **Vanderbilt, Nashville TN, USA** Sep 2020
 Remote seminar speaker: *Representations of RC^*TCs over GJS C^* -algebras*
- ◇◇◇ **Invited Research Visits:**
- 5:** Research Visitor, **Michigan State University, Lansing, MI USA** Jan 2024
- 4:** Participant: Subfactors and Fusion (2-)Categories Workshop, **Banff, AB Canada** Dec 2023
- 3:** Research Visitor, **Carleton University, Ottawa, Canada** March 2023
- 2:** Visiting Researcher **Saarland University, Germany** Sep-Dec 2022
- 1:** Research Visitor, Mathematical Institute, **University of Oxford, UK** Aug 2022
- **Contributed Talks:**
- 24:** Workshop on Quantum Graphs **Saarland University, Germany** Feb 2025
 Contributed talk: *Higher regularity in quantum graphs*
- 23:** Canadian Operator Symposium 2023, **Western University, London, ON, CA** May 2023
 Contributed talk: *Discrete inclusions of C^* -algebras*
- 22:** Great Plains Operator Theory Symposium, **OSU, Columbus, OH, USA** May 2023
 Contributed talk: *Discrete inclusions of C^* -algebras*
- 21:** Non-Commutative Geom. & Op. Algs., **Vanderbilt, Nashville, TN, USA** May 2023
 Contributed talk: *Discrete inclusions of C^* -algebras*
- 20:** Polish-German Workshop: quantum gps, graphs & symms, **Saarland U** Nov 2022
 Contributed talk: *Quantum symmetries for operator algebras*
- 19:** Operator Algebras: Subfactors, K-theory, CFT, **Cardiff University, Wales, UK** Aug 2022
 Contributed talk: *K-theoretic classif. of ind. lim. actions of fusion cats. on AF-algs*
- 18:** Topological Quantum Groups, Tensor Categories, and Subfactors, **U. of Waterloo** May 2022

- Contributed talk: *Q-system completion for C^* 2-categories*
- 17: AMS JMM:** Skein Theory and Quantum Algebra Section *April 2022*
 Remote contributed talk: *Q-System Completion for C^* -algebras*
- 16: Young Mathematicians Conference in C^* -algs, Münster U., Münster, Germany** *Aug 2021*
 Contributed talk: *Q-system completion for C^* -Algebras*
- 15: Great Plains Operator Theory Symposium 2021** *May 2021*
 Remote contributed talk: *C^* -algebras, right correspondences, and Q-systems*
- 14: Actions of Tensor Categories on C^* -algebras, IPAM, Los Angeles, CA, USA**
 Remote contributed talk: *Actions of UTCs on GJS C^* -algebras* *Jan 2021*
- 13: AMS JMM:** Advances in Operator Algebra *Jan 2021*
 Remote contributed talk: *Representations of unitary categories on C^* -algebras*
- 12: AMS JMM:** Hopf Algebras and Tensor Categories *Jan 2021*
 Remote cont. talk: *Classifying module categories for generalized TLJ $*$ -2-categories*
- 11: OSU-Oxford Meeting** *May 2020*
 Remote contributed talk: *Realizations of RC^*TC and Hilbertification*
- 10: Hayes Graduate Forum, OSU Columbus, OH, USA** *Feb 2020*
 Poster presentation: *Quantum symmetries of quantum spaces*
- 9: Quasy-Con, University of Illinois, Urbana-Champaign, IL, USA** *Nov 2019*
 Contributed talk: *Realizing RC^*T categories as bimodules over C^* -algebras*
- 8: QAQT Student Seminar, OSU Cbus, OH** *Oct 2019*
 Seminar speaker: *Unitary modules for the generalized TLJ $*$ -2-categories*
- 7: CIMPA School: Quantum Symmetries, U. de los Andes, Bogotá, Colombia** *July 2019*
 Poster presentation: *Classifying Module Categories for TLJ $*$ -2-Categories*
- 6: OSU QAQT Seminar, OSU, Cbus, OH** *March 2019*
 Seminar speaker: *Computing the fusion algebra of a subfactor*
- 5: Quantum Algebra & Quantum Topology Student Seminar, OSU Cbus, OH** *Oct 2018*
 Seminar speaker: *Radon-Nikodym theorem in von Neumann Algebras*
- 4: Non-Commutative Geom Op Algs Seminar, OSU, Cbus, OH** *Summer 2018*
 Seminar speaker: *Representing some RC^*TC over Hilbert C^* -Bimodules*
- 3: Non-Commutative Geom Op Algs Seminar, OSU, Cbus, OH** *Spring 2018*
 Seminar speaker: *Uniqueness of Separable Hyperfinite II_1 Factor*
- 2: Non-Commutative Geom Op Algs Seminar, OSU, Cbus OH** *Fall 2017*
 Seminar speaker: *Measuring Geometric Arens Irregularity*
- 1: Quantum Algebra & Quantum Topology Seminar, OSU, Cbus, OH** *Spring 2017*
 Seminar speaker: *Index Rigidity Theorem: Quantized and Continuum Spectra*

HONORS AND GRANTS

Distinctions:

- Newton Inst: School on quantum groups, qu. info and op. algs. (£800) *Cambridge, UK - Nov 2024*
- $\diamond\diamond\diamond$ **Fields Inst. Mini-course lecturer:** C^* -Algs and Tensor Cats. *Toronto - Nov 2023*
- AMS-Simons Travel Grant (\$5,000USD) *July 2022 - June 2024*
- PhD **OSU's Presidential Fellowship** (~\$66,000USD) *Summer 2020 - Spring 2021*
- PhD CONACyT Fellowship, Mexican Science Council *Spring 2019 - Spring 2021*
- AMS MRC Quantum Symmetries: Subfactors and Fusion Categories *Rhode Island, Summer 2018*
- OSU Mathematics Department Fellowship (~\$30,000USD) *Columbus, OH, Spring 2018*
- Modeling of Cell Polarization RA (OSU) (~\$4,000USD) *Columbus, Summer 2016*
- Universidad de Guanajuato Medal for Distinguished Students *Gto, Mex, 2015*
- CIMAT Honors Math Undergraduate Fellowship (~\$10,000USD) *Gto, Mex, Aug 2010 - Aug 2015*
- Honorable Mention: International Mathematics Competition *Blagoevgrad, Bulgaria, June 2014*
- Fields Institute Undergrad Research Summer Program (~\$6,000USD) *Toronto, Can, Summer 2014*

Recent and upcoming sponsored training activities:

- Workshop on quantum graphs *Saarland U, Germany Feb 2025*
- School on quantum groups, qu. info and op. algebras *I. Newton Inst. Cambridge, UK Nov 2024*
- Classification of C*-Algebras and Dynamics *Oberwolfach, Germany May 2024*
- Subfactors and Fusion (2-)Categories Workshop *Banff Research Station, Dec 2023*
- Twinned Conference on C*-Algebras and Tensor Categories *Fields Institute, Toronto, Nov 2023*
- Focus Semester in Quantum Information *Saarland U, Fall 2022*
- Topological quantum groups, tensor categories and subfactors *Waterloo, May 2022*
- Tensor categories and topological quantum field theories *MSRI, Berkeley, CA, Spring Sem 2020*
- CIMPA Research School: Quantum Symmetries *Bogotá, Colombia, July 2019*
- OSU Quantum Symmetries Summer Research Program *Columbus OH, June 2019*
- Subfactors: planar algs, quantum symms, & random matrices *MSRI, Berkeley, CA June 2017*

ACADEMIC SERVICES AND OUTREACH

Technical reviewer:

- Communications in Mathematical Physics
- Bulletin of the London Mathematical Society
- Journal of Mathematical Physics
- Journal of Operator Theory
- Proceedings of the American Mathematical Society
- Communications in Algebra

Outsourcing Math Research: ([OMR Website](#))

Mentoring and sponsoring young researchers based in underdeveloped countries:

- Research mentor for 3 Mexican, 1 Colombian & 1 Costa Rican student *Summer 2024*
- Sponsored and supervised UGto, Mexican undergrad researcher Héctor Zepeda *Spring 2023*
- Sponsored and supervised UGto undergraduate researcher Violeta Martínez Escamilla *Summer 2022*
- Sponsored and supervised UGto undergraduate researcher José Barrientos López *Summer 2022*

Research Experience for Undergraduates:

- Mentor for undergraduate researchers at U Waterloo, joint with Michael Brannan *Summer 2023*
Project: "Quantum graphs with no classical symmetries"
- Mentor for undergraduate Giovanni Ferrer (U. of Puerto Rico) *Summer 2018 and 2019*

OSU Directed Reading Program:

- Mentored physics undergraduate Ian de la Cruz on Classical Mechanics *Spring 2019*

Physics Institute UGto Physics Sundays:

- Guiding experiments with students from public elementary and middle-schools *Fall 2014*

Organization:

- Member of organizing committee: Harmonic Analysis on Tensor Categories Seminar *Fall 2023*
- Member of organizing committee: OSU Mathematics Department Colloquium *Fall 2020 - Sp 2021*
- Organizer: Quantum Symmetries Student Seminar ([QSSS Website](#)) *Fall 2018 - Sp 2021*

Administrative:

- Presided Math Undergraduate Students Org., UGto, MX *Fall 2014 - Spring 2015*

TEACHING AND STUDENT SUPERVISION

Theses directed:

- Pure Mathematics Master's thesis adviser for Violeta Martínez Escamilla *Summer 23-Spring 24*
CIMAT, Gto, Mexico
- Pure Mathematics Master's thesis adviser for José Barrientos López *Summer 23-Spring 24*
CIMAT, Gto, Mexico

- UW-EPFL Mathematics Bachelor's thesis adviser for Laurent Costa
École Polytechnique Fédérale de Lausanne, Switzerland

Spring 24

Leading Lecturer Positions:

8-	PMath/AMath 331 Applied Real Analysis (~ 95 students), U Waterloo, CA	<i>Fall 2024</i>
7-	Math 135 Algebra for Honours Mathematics (~ 60 students), UW	<i>Winter 2024</i>
6-	PMath 451/651 Measure and Integration (~ 15 students), UW	<i>Fall 2023</i>
5-	PMath 343 Intro to Math of Quantum Info (~ 20 students), UW	<i>Winter 2023</i>
4-	Math 308 Differential Equations Sec 504 (~ 65 students), Texas A&M, USA	<i>Spring 2022</i>
3-	Math 308 Differential Equations Sec 505 (~ 65 students), TAMU	<i>Spring 2022</i>
2-	Math 251 Engineering Mathematics III Sec 520 (~ 100 students), TAMU	<i>Fall 2021</i>
1-	Math 251 Engineering Mathematics III Sec 521 (~ 100 students), TAMU	<i>Fall 2021</i>

Teaching Assistant Positions:

11-	1156 Calculus for students in the Biological Sciences (~ 65 students), OSU, USA	<i>Fall 2019</i>
9-	1156 Calculus for students in the Biological Sciences (~ 65 students), OSU	<i>Fall 2018</i>
8-	2568 Linear Algebra grader, OSU	<i>Fall 2017</i>
7-	1152 Calculus II (~ 65 students), OSU	<i>Spring 2017</i>
6-	1156 Calculus for students in the Biological Sciences (~ 65 students), OSU	<i>Fall 2016</i>
5-	1172 Engineering mathematics (~ 65 students), OSU	<i>Spring 2016</i>
4-	1151 Calculus I (~ 65 students), OSU	<i>Fall 2015</i>
3-	Complex Variables (~ 20 honors students), UGto, MX	<i>Fall 2014</i>
2-	Vector Calculus (~ 25 honors students), UGto	<i>Spring 2014</i>
1-	Abstract Algebra I (~ 25 honors students), UGto	<i>Fall 2013</i>