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.
Languages: Spanish (native), English (fluent)

HONORS AND GRANTS

- AMS-Simons Travel Grant   *July 2022 - June 2024*
- Presidential Fellowship granted by OSU   *Summer 2020 - Spring 2021*
- Doctoral Studies CONACyT Fellowship, Mexican Science Foundation   *Spring 2019 - Spring 2021*
- AMS MRC Quantum Symmetries: Subfactors and Fusion Categories   *Rhode Island, Summer 2018*
- OSU Mathematics Department Fellowship   *Columbus, OH, Spring 2018*
- RA: Modeling of Cell Polarization, supervised by Dr.Dawes (OSU)   *OH, Summer 2016*
- Universidad de Guanajuato Medal for Distinguished Students   *Gto, Mex, 2015*
- CIMAT Honors fellowship for undergraduate mathematics students *Gto, Mex, Aug 2010 - Aug 2015*
- Honorable Mention, International Mathematics Competition   *Blagoevgrad, Bulgaria, June 2014*
- Fields Institute Undergraduate Research Summer Program   *Toronto, ON, Ca, Summer 2014*

Recent and upcoming training activities:
- 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 University, Fall 2022*
- Topological quantum groups, tensor categories and subfactors   *University of 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*
- 2019 OSU Quantum Symmetries Summer Research Program   *Columbus OH, June 2019*

RESEACH INTERESTS

C*-algebras, von Neumann algebras, subfactors, quantum groups, tensor categories, quantum information, and quantum computation.

RESEARCH PROJECTS AND PUBLICATIONS

Discrete inclusions of C*-algebras
arXiv:2305.05072 (submitted) Joint with Brent Nelson (Michigan State U). We characterize abstractly when a unital inclusion of C*-algebras is *discrete/quasi-regular*. Equivalently, we show C*-discrete

inclusions are precisely *crossed products* by actions of unitary tensor categories. As such, this class of inclusions is characterized by a *standard invariant* akin to subfactors.

Dynein localization and pronuclear movement in the *C. elegans* zygote
Cytoskeleton Journal, Article ID: CM21733, `DOI: 10.1002/cm.21733` (2022), joint with David P. Ignacio, Natalia Kravtsova, John Henry and Adriana T. Dawes (OSU). Contribution: Methodology, formal analysis.

K-Theoretic classification of inductive limit actions of fusion categories on AF C*-algebras
`arXiv:2207.11854` (submitted) Joint with Quan Chen and Corey Jones (North Carolina State U). We define a computable K-theoretic invariant to classify inductive limit quantum symmetry actions on AF C*-algebras, generalizing the theory of (twisted) equivariant K-theory for finite group actions.

Q-System Completion for C*-2-Categories
Joint with Quan Chen, Corey Jones and David Penneys (Ohio State University), *J. Functional Analysis*, Vol 283, Issue 3, (2022), 109524, ISSN 0022-1236, `DOI: 10.1016/j.jfa.2022.109524`, `MR4419534`, `arXiv:2105.12010`. We define and study a higher unitary idempotent completion for C* 2-categories called Q-system completion. We show that the C* 2-category of C*-algebras is Q-system complete.

Realizations of Rigid C*-Tensor Categories as Bimodules over a GJS C*-algebra
Joint with Michael Hartglass (Santa Clara U). *J. Math. Phys.* **61** (2020), no. 8, 081703, 32 pp. `DOI: 10.1063/5.0015294 MR4139893`, `arXiv:09821`. Given a RC*TC, construct a monoidal embedding onto a subcategory of bimodules over a GJS C*-algebra. We also construct an embedding into the category of bi-finite bimodules over a free group factor recovering known embeddings.

Classifying Module Categories for Generalized TLJ $*$-2-Categories
Joint with Giovanni Ferrer, University of Puerto Rico Mayagüez. *Internat. J. Math.* **31** (2020), no. 4, 2050027, 30 pp. `DOI: 10.1142/S0129167X20500275`, `MR4098904`, `arXiv:1905.00471`. We provide a complete classification of generalized unitary fiber functors on generalized Temperley-Lieb-Jones categories into bigraded Hilbert spaces.

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

PhD Thesis: Quantum Symmetries for Quantum Spaces, directed by Prof. David Penneys
Constructing families of representations of RC*TC over bimodules over C*-algebras arising from groups or planar algebras. These representations can be interpreted as actions of a category over a C*-algebra, constituting examples of quantum symmetries.

Ongoing projects:
Quantum graphs, subfactors and tensor categories
Work in progress joint with Michael Brannan (U. Waterloo). Applications of subfactors into quantum information, producing and classifying quantum graphs from tensor categories.

Approximation properties for unitary tensor categories
Work in progress joint with Jason Crann (Carleton U). Investigating approximation properties of tensor categories and relating them to corresponding properties of inclusions of operator algebras.

PRESENTATIONS, SEMINAR TALKS AND ADDITIONAL TRAINING

Presentations:
39: Conference on C*-Algebras and Tensor Categories, Fields Inst., Toronto, ON, CA   *Nov 2023*
    Mini-course speaker: *Actions of tensor categories on operator algebras*
38: Canadian Operator Symposium 2023, Western University, London, ON, CA   *May 2023*

Contributed talk: *Discrete inclusions of C*-algebras*

37: Great Plains Operator Theory Symposium, OSU, Columbus, OH, USA *May 2023*
Contributed talk: *Discrete inclusions of C*-algebras*

36: Non-Commutative Geometry and Operator Algebras, Vanderbilt, Nashville, TN, USA *May 2023*
Contributed talk: *Discrete inclusions of C*-algebras*

35: Carleton-Ottawa Joint Analysis Seminar, Ottawa, ON, CA *March 2023*
Invited speaker: *K-theoretic classitf. of ind. lim. actions of fusion cats. on AF-algs*

34: Analysis Seminar University of Waterloo, Waterloo, ON CA *March 2023*
Seminar speaker: *K-theoretic classif. of ind. lim. actions of fusion cats. on AF-algs*

33: Polish-German workshop: quantum gps, graphs & symms., Saarlandes U, Germany *Nov 2022*
Contributed talk: *Quantum symmetries for operator algs*

32: Quantum Symmetries Seminar, OSU, Columbus, OH, USA *Nov 2022*
Remote seminar speaker: *Discrete inclusions of C*-algebras*

31: Malý Seminar, Karlin Univeristy, Prague, Czech Rep *Nov 2022*
Invited speaker: *Unitary tensor categories and their actions*

30: NCG&T Sem, Inst. of Math. of the Czech Academy of Sciences, Prague, Czech Rep *Nov 2022*
Invited speaker: *K-theoretic classif. of ind. lim. actions of fusion cats. on AF-algebras*

29: Operator algebras Seminar, KU Leuven, Belgium *Oct 2022*
Invited speaker: *K-theoretic classif. of ind. lim. actions of fusion cats. on AF-algebras*

28: 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*

27: 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*

26: Quantum Groups Seminar, University of Copenhagen *June 2022*
Remote speaker: *Q-systems and higher unitary idempotent completion for C*-algs*

25: Topological Quantum Groups, C*-Tensor Categories, and Subfactors, U. Waterloo *May 2022*
Contributed talk: *Q-system completion for C* 2-categories*

24: Mathematics Colloquium, Universidad Autónoma de Yucatán-CIMAT, México *May 2022*
Remote speaker: *Qué son los espacios no-conmutativos y sus simetrías cuánticas*

23: AMS Join Mathematics Meeting: Skein Theory and Quantum Algebra Section *April 2022*
Remote contributed talk: *Q-System Completion for C*-algebras*

22: Jr. Student Seminar, Universidad de Guanajuato, México *March 2022*
Remote seminar speaker: *Simetrías cuánticas y espacios cuánticos*

21: ASUERAU C*-seminar, Arizona State University, AZ, USA *Feb 2022*
Remote speaker: *Applications of subfactor and categorical techniques to C*-algebras*

20: Analysis Seminar, University of Waterloo *Feb 2022*
Remote speaker: *C*-algs, Q-systems and higher idempotent completion for C* 2-cats.*

19: Algebra and Combinatorics Seminar, Texas A&M University, College St, TX, USA *Oct 2021*
Seminar speaker: *Q-systems and higher idempotent completion for C* 2-categories*

18: Young Mathematicians Conference in C*-algs, Münster University, Münster, Germany *Aug 2021*
Contributed talk: *Q-system completion for C*-Algebras*

17: Great Plains Operator Theory Symposium 2021 *May 2021*
Remote contributed talk: *C*-algebras, right correspondences, and Q-systems*

16: Category Theory Seminar, Universidad Nacional Autónoma de México *March 2021*
Remote seminar speaker: *UTC actions on C*-algebras*

15: IPAM: Actions of Tensor Categories on C*-algebras, Los Angeles, CA, USA
Remote contributed talk: *Actions of UTCs on GJS C*-algebras* *Jan 2021*

14: AMS Joint Mathematics Meeting: Advances in Operator Algebra *Jan 2021*
Remote contributed talk: *Representations of unitary categories on C*-algebras*

13: AMS Joint Mathematics Meeting: Hopf Algebras and Tensor Categories *Jan 2021*
Remote cont. talk: *Classifying module categories for generalized TLJ ∗-2-categories*

12: Subfactors seminar, Vanderbilt University *Sep 2020*

Remote seminar speaker: *Representations of RC*TCs over GJS C*-algebras*

11: OSU-Oxford Meeting   *May 2020*
    Remote contributed talk: *Realizations of RC*TC and Hilbertification*

10: OSU's Hayes Graduate Forum, 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: OSU: QAQT Student Seminar, Columbus, OH, USA   *Oct 2019*
    Seminar speaker: *Unitary modules for the generalized TLJ *-2-categories*

7: CIMPA Research School: Quantum Symmetries, U. de los Andes, Bogotá, Colombia   *July 2019*
    Poster presentation: *Classifying Module Categories for TLJ ∗-2-Categories*

6: OSU QAQT Seminar   *March 2019*
    Seminar speaker: *Computing the fusion algebra of a subfactor*

5: OSU Quantum Algebra & Quantum Topology Student Seminar, Columbus, OH   *Oct 2018*
    Seminar speaker: *Radon-Nikodym theorem in von Neumann Algebras*

4: OSU NCGOA Seminar   *Summer 2018*
    Seminar speaker: *Representing some RC*TC over Hilbert C*-Bimodules*

3: OSU NCGOA Seminar   *Spring 2018*
    Seminar speaker: *Uniqueness of Separable Hyperfinite* II_1 *Factor*

2: OSU Non-Commutative Geometry & Operator Algebra Seminar, OH, USA   *Fall 2017*
    Seminar speaker: *Measuring Geometric Arens Irergularity*

1: OSU: Quantum Algebra & Quantum Topology Seminar, Columbus, OH, USA   *Spring 2017*
    Seminar speaker: Index Rigidity Theorem: Quantized and Continuum Spectra

Invited Research Visits:
- Research Visitor, Carleton University, Ottawa, Canada   *March 2023*
- Visiting Researcher to Saarland University, Germany   *Sep-Dec 2022*
- Mathematical Institute, University of Oxford, United Kingdom   *Aug 2022*

Undergraduate Thesis:
Semi-Riemannian Geometry and its Applications to Relativity   *Fall 2014 - Spring 2015*
Programming languages: C, Python, GAP.

ACADEMIC SERVICES

Outsourcing Math Research:
Mentoring and sponsoring undergraduate researchers based in underdeveloped countries:
- Sponsored and supervised UGto, Mex undergraduate researcher Héctor Zepeda   *Spring 2023*
- Sponsored and supervised UGto undergraduate researcher Violeta Martínez Escamilla   *Summer 2022*
- Sponsored and supervised UGto undergraduate researcher José Manuel Barrientos   *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: OSU Mathematics Department Colloquium: *Fall 2020 - Sp 2021*
- Organizer: Quantum Symmetries Student Seminar [(QSSS Website)](QSSS Website)   *Fall 2018 - Sp 2021*

Administrative:

- Directing the Mathematics Undergraduate Students Organization   *Fall 2014 - Spring 2015*
at the University of Guanajuato

TEACHING AND ADVISING

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

Leading Lecturer Positions:
6- PMath 451/651 Measure and Integration, U Waterloo, CA   *Fall 2023*
5- PMath 343 Intro to Math of Quantum Info ($\sim$ 20 students), U Waterloo, CA   *Winter 2023*
4- Math 308 Differential Equations Sec 504 ($\sim$ 65 students), Texas A&M, USA   *Spring 2022*
3- Math 308 Differential Equations Sec 505 ($\sim$ 65 students), Texas A&M, USA   *Spring 2022*
2- Math 251 Engineering Mathematics III Sec 520 ($\sim$ 100 students), Texas A&M, USA   *Fall 2021*
1- Math 251 Engineering Mathematics III Sec 521 ($\sim$ 100 students), Texas A&M , USA   *Fall 2021*

Teaching Assistant Positions:
11- 1156 Calculus for students in the Biological Sciences ($\sim$ 65 students), OSU, USA   *Fall 2019*
10- 1148 College Algebra ($\sim$ 65 students), OSU, USA   *Spring 2019*
9- 1156 Calculus for students in the Biological Sciences ($\sim$ 65 students), OSU, USA   *Fall 2018*
8- 2568 Linear Algebra grader, OSU, USA   *Fall 2017*
7- 1152 Calculus II ($\sim$ 65 students), OSU, USA   *Spring 2017*
6- 1156 Calculus for students in the Biological Sciences ($\sim$ 65 students), OSU, USA   *Fall 2016*
5- 1172 Engineering mathematics ($\sim$ 65 students), OSU, USA   *Spring 2016*
4- 1151 Calculus I ($\sim$ 65 students), OSU, USA   *Fall 2015*
3- Complex Variables ($\sim$ 20 honors students), UGto, MX   *Fall 2014*
2- Vector Calculus ($\sim$ 25 honors students), UGto, MX   *Spring 2014*
1- Abstract Algebra I ($\sim$ 25 honors students), UGto, MX   *Fall 2013*