John Huerta

Curriculum Vitae

17th February 2022

Department of Mathematics
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Research interests

Mathematical physics via differential geometry and higher structures.

Employment

Research scientist, Department of Mathematics, Instituto Superior Técnico, University of Lisbon, December 2018–Present.

Postdoctoral fellow, Department of Mathematics, Instituto Superior Técnico, University of Lisbon, January 2013–November 2018.

Postdoctoral fellow, Department of Theoretical Physics and Mathematical Sciences Institute, the Australian National University, August 2011–December 2012.

Education

PhD in Mathematics, University of California, Riverside, June 2011.
Advisor: John Carlos Baez.

M.S. in Mathematics, University of California, Riverside, March 2008.

B.S. in Physics and Mathematics with Honors, Magna Cum Laude, Northern Arizona University, December 2002.

Honors and awards

Levi L. Conant Prize, American Mathematical Society, 2013, for the best expository paper published in either the *Notices* or *Bulletin* of the AMS.

Delivered the **2014 Levi L. Conant Lecture**, "Symmetry in Mathematics and Physics", 18 April 2014, Worcester Polytechnic Institute.

"The strangest numbers in string theory" selected for **The Best Writing on Mathematics 2012**, ed. M. Pitici, Princeton University Press.

Leibniz fellow, Oberwolfach, 2010.

Doctoral research fellow, University of California, 2008–2009.

Grants

Research fellowship, Portuguese Science Foundation, 2014–2020, SFRH/BPD/92915/2013. (Bolsa de investigação, Fundação para a Ciéncia e a Tecnologia.) Value: 107,640 EUR.

Member of the **Higher Structures and Applications** project funded by the Portuguese Science Foundation. Reference: PTDC/MAT-PUR/31089/2017. Duration: 01/07/2018 – 30/06/2021. Principal investigator: Roger Picken. Value: 239,784 EUR.

Member of the **Quantization and Kähler Geometry** project funded by the Portuguese Science Foundation. Reference: PTDC/MAT-GEO/3319/2014. Duration: 01/01/2016 – 31/12/2018. Principal investigator: João Pimentel Nunes. Value: 117,000 EUR.

Member of the **Geometry and Mathematical Physics** project funded by the Portuguese Science Foundation. Reference: EXCL/MAT-GEO/0222/2012. Duration: 01/05/2013 – 30/04/2016. Principal investigator: Miguel Abreu. Value: 326,000 EUR.

Invited research visits

Aspen Center for Physics, Aspen, 28 July–11 August 2019.

Perimeter Institute for Theoretical Physics, Waterloo, 17–28 June 2019.

Faculty of Algebra, Geometry and Topology, University of Málaga, 2–16 May 2017.

Mathematical Institute, University of Oxford, October 2016.

Max Planck Institute for Mathematics, Bonn, September 2016.

Mathematical Sciences Research Institute, Berkeley, 27–31 January 2014.

Institute of Mathematical Research, the University of Hong Kong, May 2013.

Conferences organized

1. **4th Mile High Conference on Nonassociative Mathematics**, University of Denver, 29 July–5 August 2017.
2. **Higher Structures Lisbon**, Instituto Superior Técnico, 24–27 July 2017.
3. **3rd Mile High Conference on Nonassociative Mathematics**, University of Denver, 12–16 August 2013.

Edited volumes

1. **Nonassociative mathematics and its applications**, proceedings of the 4th Mile High Conference on Nonassociative Mathematics, editor (with Murray Bremner, Scott Carter, Tony Evans, Jonathan Smith, and Petr Vojtěchský). *Contemporary Mathematics* **721**, American Mathematical Society, Providence, 2019.
2. **Proceedings of the 3rd Mile High Conference on Nonassociative Mathematics** editor (with Murray Bremner, Tony Evans, Michael Kinyon, and Petr Vojtěchský), published as a special volume of *Commentationes Mathematicae Universitatis Carolinae* **55** (2014), 267–420.

Papers

1. **Bundle gerbes on supermanifolds**. Available as arXiv:2012.15813.
2. **Real ADE-equivariant (co)homotopy and Super M-branes** (with Hisham Sati and Urs Schreiber). *Comm. Math. Phys.* **371** (2019), 425–524. Also available as arXiv:1805.05987.
3. **How Space-Times Emerge from the Superpoint**, *Fortschr. Phys.* **67** (2019) 1910009. Also available as arXiv:1903.02822.
4. **M-theory from the superpoint** (with Urs Schreiber). *Lett. Math. Phys.* **108** (2018), 2695–2727. Also available as arXiv:1702.01774.
5. **Division algebras and supersymmetry IV**, *Adv. Theor. Math. Phys.* **21** (2017), 383–449. Also available as arXiv:1409.4361.
6. **The magic square of Lie groups: the 2×2 case** (with Tevian Dray and Joshua Kincaid), *Lett. Math. Phys.* **104** (2014), 1145–1168. Also available as arXiv:2009.00390.
7. **$\mathbf{G_2}$ and the rolling ball** (with John Baez), *Trans. Amer. Math. Soc.* **366** (2014), 5257–5293. Also available as arXiv:1205.2447.
8. **Division algebras and supersymmetry III**, *Adv. Theor. Math. Phys.* **16** (2012), 1485–1589. Also available as arXiv:1109.3574.
9. **Division Algebras, Supersymmetry and Higher Gauge Theory**. PhD thesis, UC Riverside. Available as arXiv:1106.3385.
10. **An invitation to higher gauge theory** (with John Baez), *Gen. Relativ. Gravit.* **43** (2011), 2335–2392. Also available as arXiv:1003.4485.
11. **Division algebras and supersymmetry II** (with John Baez), *Adv. Theor. Math. Phys.* **15** (2011), 1373–1410. Also available as arXiv:1003.3436.
12. **Division algebras and supersymmetry I** (with John Baez), in *Superstrings, Geometry, Topology, and C^*-algebras*, eds. R. Doran, et al., Proc. Symp. Pure Math. 81, AMS, Providence, 2010, pp. 65–80. Also available as arXiv:0909.0551.
13. **The algebra of grand unified theories** (with John Baez), *Bull. Amer. Math. Soc.* **47** (2010), 483–552. Winner of the **Levi L. Conant Prize, American Mathematical Society, 2013**. Also available as arXiv:0904.1556.

Popularizations

The strangest numbers in string theory (with John Baez), *Scientific American*, May 2011. Also available at `http://math.ucr.edu/home/baez/octonions/strangest.html`. Also in ***The Best Writing on Mathematics 2012***, ed. M. Pitici, Princeton U. Press, 2012, pp. 50–60.

Advising

Diogo Freire de Andrade, PhD 2021–2025, Insituto Superior Técnico.

Nino Scalbi, PhD 2019–2023, Insituto Superior Técnico. (Co-advised with Roger Picken.)

Diogo Freire de Andrade, MSc 2019–2021, Insituto Superior Técnico.

Hosana Ranaivomanana, PhD thesis examiner, Stellenbosch University, January 2022.

Kowshik Bettadapura, honours thesis examiner, Australian National University, November 2011.

Talks

Bundle gerbes on Lie supergroups, 19 November 2021, Geometry and Topology Seminar, University of Waterloo.

Bundle gerbes on Lie supergroups, 4 October 2021, *Pure Spinors, Superalgebras, and Holomorphic Twists*, University of Heidelberg.

Geometric quantization and the Borel–Weil theorem, minicourse, 6-17 September 2021, University of Bologna.

Bundle gerbes on Lie supergroups, 14 June 2021, RIND mathematical physics seminar (online).

The higher algebra of supersymmetry, 29 March 2021, *Octonions and the Standard Model*, the Perimeter Institute for Theoretical Physics (online).

Bundle gerbes on supermanifolds, 4 March 2021, Prague mathematical physics seminar (online).

Bundle gerbes on supermanifolds, 5 June 2020, TQFT club, University of Lisbon (online).

Bundle gerbes on supermanifolds, 7 May 2020, *SuperDay in Alessandria*, University of Eastern Piedmont (online).

Higher gauge theory on supermanifolds, 8 November 2019, Mathematical Physics Seminar, University of Lyon.

The equivariant brane bouquet, 22 May 2019, University of Málaga.

Division algebras and the brane bouquet, 15 February 2019, *Workshop on Geometric Structures in Mathematics and Physics*, University of Bologna.

Division algebras and supersymmetry, 14 February 2019, *Workshop on Geometric Structures in Mathematics and Physics*, University of Bologna.

Finite groups and brane intersections, 23 October 2018, *Regional Interdisciplinary Workshop on Geometry, Topology, and Physics*, New York University Abu Dhabi.

M-theory from the superpoint, 12 September 2018, Cosmology Seminar, the Albert Einstein Institute, Potsdam.

M-theory from the superpoint, 15 August 2018, *Higher Structures in M-theory*, University of Durham.

$\mathbf{G_2}$ and the rolling ball, 25 March 2018, Mathematics Colloquium, New York University Abu Dhabi.

Division algebras and supersymmetry, 24 March 2018, *SuperPhysmatics 2018*, New York University Abu Dhabi.

The teleparallel trick, 8 March 2018, *Geilo Winter School: Geometry, Analysis, Physics*, Geilo, Norway.

Teleparallel supergravity as a higher gauge theory, 2 March 2018, *Workshop on Higher Gauge Theory*, University of Leeds.

M-theory from the superpoint (poster presentation), 27–30 November 2017, *Young Researchers in String Mathematics*, Max Planck Institute for Mathematics, Bonn.

The higher symmetry group of string theory, 16 November 2017, Mathematical Physics Seminar, University of Warsaw.

Octonionic windows on physics—a discussion, 3 August 2017, *4th Mile High Conference on Nonassociative Mathematics*, University of Denver.

$\mathbf{G_2}$ and the rolling ball, 1 June 2017, Geometric Analysis Seminar, Free University of Berlin.

M-theory from the superpoint, 30 May 2017, Quantum Fields and Strings Seminar, University of Surrey.

$\mathbf{G_2}$ and the rolling ball, 11 May 2017, Geometry and Topology Seminar, University of Málaga.

L_∞-algebras, cohomology, and physics, 4 May 2017, Geometry and Topology Seminar, University of Málaga.

L_∞-algebras, central extensions, and physics, 29 April 2017, Geometry and Topology Seminar, University of Porto.

M-theory from the superpoint, 18 January 2017, *Iberian Strings 2017*, Instituto Superior Técnico, Lisbon.

M-theory from the superpoint, 18 November 2016, *Métodos Categóricos y Homotópicos en Álgebra, Geometría y Topología*, University of La Rioja.

L_∞-algebras, cohomology, and physics, 17 October 2016, Topology Seminar, University of Oxford.

M-theory from the superpoint, 11 July 2016, *Advances in Quantum Gravity 2016*, Topos House, San Francisco.

Division algebras and supersymmetry, 24 November 2015, *Advances in Quantum Gravity 2015*, Los Angeles.

Trigroups and M-theory, 11 June 2015, joint meeting of the AMS–EMS–SPM, University of Porto.

The Octonions, 28 January 2015, Grupo de Física Matemática, University of Lisbon.

Trigroups and M-theory, 2 September 2014, *XXIII International Fall Workshop on Geometry and Physics*, University of Granada.

$\mathbf{G_2}$ and the rolling ball, 16 July 2014, *Encontro Nacional Sociedade Portuguesa de Matemática 2014*, New University of Lisbon.

Trigroups and M-theory, 10 May 2014, *Algebra and Representation Theory in the North (40th ARTIN meeting)*, University of Sheffield.

Symmetry in mathematics and physics, 18 April 2014, *Levi L. Conant Lecture*, Worcester Polytechnic Institute.

What can higher categories do for physics? 12 March 2014, Mathematics seminar, New University of Lisbon.

$\mathbf{G_2}$ and the rolling ball, 13 August 2013, *3rd Mile High Conference in Nonassociative Mathematics*, University of Denver.

The functor of points for supermanifolds, 8 July 2013, University of Hamburg.

$\mathbf{G_2}$ and the rolling ball, 4 July 2013, University of Hamburg.

$\mathbf{G_2}$ and the rolling ball, May 2013, Institute for Mathematical Research, the University of Hong Kong.

Minicourse on higher gauge theory, May 2013, Institute for Mathematical Research, the University of Hong Kong.

The categorified Poincaré supergroup, 25 March 2013, *94th Peripatetic Seminar on Sheaves and Logic*, University of Sheffield.

The categorified Poincaré superalgebra, 10 January 2013, *AMS Special Session on Lie Algebras, Algebraic Transformation Groups, and Representation Theory*, Joint Mathematics Meeting 2013, San Diego.

$\mathbf{G_2}$ and the rolling ball, 12 October 2012, University of Melbourne.

Superstrings, higher gauge theory and division algebras, 6 December 2011, TQFT seminar, Instituto Superior Técnico, Lisbon.

A higher supergroup for string theory, 2 December 2011, *Higher Structures 2011*, University of Göttingen.

Superstrings, higher gauge theory and division algebras, 23 November 2011, theoretical physics seminar, University of Erlangen–Nürnberg.

A categorified supergroup for string theory, 19 October 2011, Australian category theory seminar, Macquarie University.

$\mathbf{G_2}$, the split octonions, and the rolling ball, 18 October 2011, geometry seminar, University of Sydney.

A higher supergroup for string theory, 5 September 2011, *Group-valued moment maps with applications to mathematics and physics*, Institute for Geometry and Applications, University of Adelaide.

A higher supergroup for string theory, 9 April 2011, *Special Session on Physically Inspired Higher Homotopy Algebra*, AMS Spring Eastern Sectional Meeting, College of the Holy Cross, Worcester.

A categorified supergroup for string theory, 12 February 2011, *Workshop on Higher Gauge Theory, TQFT and Quantum Gravity*, Instituto Superior Técnico, Lisbon.

Minicourse on higher gauge theory, 7–8 February 2011, *School on Higher Gauge Theory, TQFT and Quantum Gravity*, Instituto Superior Técnico, Lisbon.

Division algebra technology for supersymmetry, 7 November 2010, *Special Session on Quasigroups, Loops, and Nonassociative Division Algebras*, AMS Fall Central Sectional Meeting, University of Notre Dame.

L_∞-superalgebras for the superstring and 2-brane, 5 November 2010, *Special Session on Topology, Geometry and Physics*, AMS Fall Central Sectional Meeting, University of Notre Dame.

L_∞-superalgebras for the superstring and 2-brane, 4 November 2010, the geometry and physics seminar, Northwestern University.

Introducing division algebras and spinors: a pretalk, 4 November 2010, the geometry and physics seminar, Northwestern University.

Introducing the quaternions, 27 September 2010, mathematics colloquium, Fullerton College.

Lie n-algebras, supersymmetry and division algebras: in brief, 7 June 2010, *Quantum Fields and Strings: Categorical Aspects*, Mathematisches Forschungsinstitut Oberwolfach.

Supersymmetry, division algebras and Lie n-algebras, 3 June 2010, *Higher Structures in Topology and Geometry IV*, University of Göttingen.

Supersymmetry, division algebras and Lie n-algebras, 20 April 2010, the Claremont topology seminar, Claremont–McKenna College.

The quaternions, 21 May 2010, mathematics and physics colloquium, California State University, Stanislaus.

Division algebras and supermembranes, 7 November 2009, *Special Session on Research Conducted by Students*, AMS Fall Western Sectional Meeting, University of California, Riverside.

Supersymmetry and division algebras, 22 June 2009, *2nd Mile High Conference in Nonassociative Mathematics*, University of Denver.

Teaching Experience

As a Lecturer: University of Lisbon, the Australian National University, and University of California, Riverside.

Graduate Level:
Algebraic and Geometric Methods in Engineering and Physics, Masters-level course, First Semester 2021–2022, University of Lisbon.

Description: This course is meant to serve as a bridge for students in the mathematics masters program who did not study mathematics as undergraduates. Topics include group theory, cryptography, representations and character theory, and a taste of manifolds and Lie groups.

Geometry and Gauge Theory, PhD-level course, Second Semester 2020–2021, University of Lisbon.

Geometry and Gauge Theory, PhD-level course, Second Semester 2017–2018, University of Lisbon.

Description: This was a PhD-level course in mathematical physics, taught in collaboration with a senior lecturer. I wrote and delivered half the lectures, and I designed and marked half the homework sets.

Undergraduate Level:
Linear algebra, Second Semester 2012, the Australian National University.

Score on student evaluation survey: 4/5.

Select quote from student comments:

John was able to convey concepts to us in the simplest way he saw fit, which meant that the concepts learned were always clearer and described in normal english. Drawings and visualisations help a heap with linear algebra. John's concern for a quiet class and for individual student concerns was great.

Honours linear algebra, Second Semester 2012, the Australian National University.

Score on student evaluation survey: 4/5.

Select quote from student comments:

Although last semester I didn't quite enjoy Linear Algebra because I thought that it wasn't very abstract and only consisted of row reduction, this semester I realised how wrong I was and how interesting Linear Algebra is, and this was thanks to the lecturer who taught the subject with a very different perspective to the way in which it was taught in MATH1115.

Introductory calculus, Summer 2007, University of California, Riverside.

Score on student evaluation survey: 4.9/5.

Select quote from student comments:

Great class, John. I understood every bit of the material, and that's more than I could say for my last 9C professor. Your examples were clear and easy to follow. Thanks for everything.

As a Teaching Assistant: University of California, Riverside, 2005–2011, except the 2008–2009 academic year while on a research fellowship:

Over 400 classroom hours.

Subjects taught: *College Algebra*; *Precalculus*; *Calculus*; *Business Calculus*; *Vector Calculus*; *Discrete Mathematics*; *Differential Equations*; *Linear Algebra*; *Set Theory*; *Advanced Calculus*; *Complex Variables*; *Modern Algebra*.

Service

Committee work

Postdoctoral search for the project *Higher Structures and Applications*, May 2019, University of Lisbon.

References

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Professor of Mathematics

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Stephen Roberts (*teaching reference*)
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