John Francis Robert Duncan — 2025 May 25

Contact information

Institute of Mathematics
Academia Sinica
Taipei, Taiwan.

jduncan@gate.sinica.edu.tw
https://sites.google.com/site/johnfrduncan/

Research interests

Moonshine, vertex algebra, finite simple groups, automorphic forms, arithmetic of algebraic varieties, conformal field theory, quantum gravity.

Appointments

Academia Sinica
Research Fellow, September 2021 - present.

Emory University
Adjunct Professor, September 2022 - present.
Associate Professor with tenure, September 2018 - August 2022.
Assistant Professor, July 2015 - August 2018.

Tokyo University, Japan
Project Associate Professor, May 2015 - August 2015.

Case Western Reserve University
Assistant Professor, October 2010 - June 2015.

King's College, Cambridge, U.K.
Junior Research Fellow, October 2009 - September 2010.

Harvard University
Benjamin Peirce Lecturer on Mathematics, July 2006 - June 2009.

Education

Yale University, New Haven CT, U.S.A.
Ph.D., mathematics, May 2006.
Dissertation Title: "Vertex Operators, and Three Sporadic Groups"
Advisor: Igor B. Frenkel (Yale University)

University of Auckland, Wellington, New Zealand
M.A., mathematics, with first class honors, May, 2000.
B.A., mathematics and economics, April, 1999.

Thesis

Vertex Operators, and Three Sporadic Groups; Yale University Ph.D. thesis.

Publications

1. **Super-moonshine for Conway's largest sporadic group**, *Duke Math. J.* **139** (2007), no. 2, 255-315. `arXiv:math/0502267`

2. **Arithmetic groups and the affine E8 Dynkin diagram**, *CRM Proceedings and Lecture Notes*, Volume 47, 2008. `arXiv:0810.1465`

3. **Extensions of the Virasoro algebra**, *Lie Theory and its Applications in Physics VII,* pp.431-438. Heron Press Ltd., Sofia, Bulgaria, 2008.

4. **Vertex operators and sporadic groups**, *Moonshine - The First Quarter Century and Beyond.* Cambridge University Press, 2010. `arXiv:0811.1306`

5. **Rademacher sums, moonshine and gravity**, with Igor B. Frenkel, *Communications in Number Theory and Physics* **5** (2011), no. 4, 849-976. `arXiv:0907.4529`

6. **An E8 correspondence for multiplicative eta-products**, with Christopher J. Cummins, *Canadian Mathematical Bulletin* **55** (2012), 67-72. `doi:10.4153/CMB-2011-068-9`

7. **On Rademacher Sums, the Largest Mathieu Group, and the Holographic Modularity of Moonshine**, with Miranda C. N. Cheng, *Communications in Number Theory and Physics* **6** (2012), no. 3, 697-758. `arXiv:1110.3859`

8. **The Largest Mathieu Group and (Mock) Automorphic Forms**, with Miranda C. N. Cheng, *String-Math 2011, Proceedings of Symposia in Pure Mathematics* **85** (2012). `arXiv:1201.4140`

9. **Mathieu Moonshine and $N = 2$ String Compactifications**, with Miranda C. N. Cheng, Xi Dong, Jeffrey A. Harvey, Shamit Kachru and Timm Wrase, *Journal of High Energy Physics* 09 (2013) 030. `arXiv:1306.4981`

10. **Umbral Moonshine**, with Miranda C. N. Cheng and Jeffrey A. Harvey, *Communications in Number Theory and Physics* **8** (2014), no. 2, 101-242. `arXiv:1204.2779`

11. **Rademacher Sums and Rademacher Series**, with Miranda C. N. Cheng, *Conformal Field Theory, Automorphic Forms and Related Topics, Contributions in Mathematical and Computational Sciences*, vol. 8, Springer, 2014, pp. 143-182. `arXiv:1210.3066`

12. **On the work of Igor Frenkel**, with Pavel Etingof, Ivan Ip, Mikhail Khovanov, Matvei Libine, Anthony Licata, Alistair Savage and Michael Schlosser, *Perspectives in Representation Theory, Contemporary Mathematics* **610** (2014).

13. **On the Discrete Groups of Mathieu Moonshine**, with Miranda C. N. Cheng, *Perspectives in Representation Theory, Contemporary Mathematics* **610** (2014). `arXiv:1212.0906`

14. **Umbral Moonshine and Linear Codes**, *RIMS Kôkyûroku* no. 1872 (2014).

15. **Umbral Moonshine and the Niemeier Lattices**, with Miranda C. N. Cheng and Jeffrey A. Harvey, *Research in the Mathematical Sciences* (2014) 1:3. `arXiv:1307.5793`

16. **Mock Modular Mathieu Moonshine Modules**, with Miranda C. N. Cheng, Xi Dong, Sarah Harrison, Shamit Kachru and Timm Wrase, *Research in the Mathematical Sciences* (2015) 2:13. `arXiv:1406.5502`

17. **The Moonshine Module for Conway's Group**, with Sander Mack-Crane, *Forum of Mathematics, Sigma* **3** (2015). `arXiv:1409.3829`

18. **Maass-Jacobi Poincaré Series and Mathieu Moonshine**, with Kathrin Bringmann and Larry Rolen, *Advances in Mathematics* **281** (2015), 248-278. `arXiv:1409.4124`

19. **Moonshine**, with Michael Griffin and Ken Ono, *Research in the Mathematical Sciences* (2015) 2:11. `arXiv:1411.6571`

20. **Proof of the Umbral Moonshine Conjecture**, with Michael Griffin and Ken Ono, *Research in the Mathematical Sciences* (2015) 2:16. `arXiv:1503.01472`

21. **The Jack Daniels Problem**, with Ken Ono, *Journal of Number Theory* **161**, April 2016, 230-239. `arXiv:1411.5354`

22. **Derived Equivalences of K3 Surfaces and Twined Elliptic Genera**, with Sander Mack-Crane, *Research in the Mathematical Sciences* (2016) 3:1. `arXiv:1506.06198`

23. **The Umbral Moonshine Module for the Unique Unimodular Niemeier Root System**, with Jeffrey A. Harvey, *Algebra and Number Theory* **11** (2017) no. 3, 505-535. `arXiv:1412.8191`

24. **Equivariant K3 Invariants**, with Miranda C. N. Cheng, Sarah Harrison and Shamit Kachru, *Communications in Number Theory and Physics* **11** (2017), no. 1. `arXiv:1508:02047`

25. **Pariah moonshine**, with Michael H. Mertens and Ken Ono, *Nature Communications* 8(1) (2017). `arXiv:1709.08867`

26. **Self-Dual Vertex Operator Superalgebras and Superconformal Field Theory**, with Thomas Creutzig and Wolfgang Riedler, *J. Phys. A: Math. Theor.* **51** (2018) 034001. `arXiv:1704.03678`

27. **Weight One Jacobi Forms and Umbral Moonshine**, with Miranda C. N. Cheng and Jeffrey A. Harvey, *J. Phys. A: Math. Theor.* **51** (2018) 104002. `arXiv:1703.03968`

28. **Attractive Strings and Five-Branes, Skew-Holomorphic Jacobi Forms and Moonshine**, with Miranda C. N. Cheng, Sarah M. Harrison, Jeffrey A. Harvey, Shamit Kachru and Brandon C. Rayhaun, *J. High Energy Physics* (2018), Art. 130. `arXiv:1708.07523`

29. **Super vertex algebras, meromorphic Jacobi forms and umbral moonshine**, with Andrew O'Desky, *J. Algebra* **515** (2018), 389-407. `arXiv:1705.09333`

30. **O'Nan Moonshine and Arithmetic**, with Michael H. Mertens and Ken Ono, *American Journal of Mathematics* **143** (2021), no. 4, 1115-1159. `arXiv:1702.03516`

31. **From the Monster to Thompson to O'Nan**, In: **Proceedings of the Conference on Vertex Operator Algebras, Number Theory and Related Topics**, edited by Mathew Krauel, Michael Tuite and Gaywalee Yamskulna, *Contemporary Mathematics* **753** (2020). American Mathematical Society. `arXiv:1909.09684`

32. **Meromorphic Jacobi Forms of Half-Integral Index and Umbral Moonshine Modules**, with Miranda C. N. Cheng, *Communications in Mathematical Physics* **370** (2019), no. 3, 759-780. `arXiv:1707.01336`

33. **Modular Forms on the Double Half-Plane**, with David A. McGady, *International Journal of Number Theory* **16** (2020), no. 09, 1989-2003. `arXiv:1806.09875`

34. **A Short Introduction to the Algebra, Geometry, Number Theory and Physics of Moonshine**, In: **Partition Functions and Automorphic Forms**, edited by V. Gritsenko and V. Spiridonov, *Moscow Lectures* **5** (2020). Springer, Cham.

35. **Optimal Mock Jacobi Theta Functions**, with Miranda C. N. Cheng, *Advances in Mathematics* **372** (2020) 107284. `arXiv:1605.04480`

36. **Vertex operator superalgebra/sigma model correspondences: The four-torus case**, with Vassilis Anagiannis, Miranda C. N. Cheng, and Roberto Volpato, *Progress of Theoretical and Experimental Physics* **2021** (2021), no. 8, 08B102. `arXiv:2009.00186`.

37. **Class Numbers, Cyclic Simple Groups and Arithmetic**, with Miranda C. N. Cheng and Michael H. Mertens. *Journal of the London Mathematical Society* **108** (2023), Issue 1, 238-272. `arXiv:2204.00775`

38. **Modular Products and Modules for Finite Groups**, with Jeffrey A. Harvey and Brandon C. Rayhaun, *Algebras and Representation Theory* **27** (2024), 115-159. `arXiv:2202.08271`

39. **Class Numbers, Congruent Numbers and Umbral Moonshine**, with Miranda C. N. Cheng and Michael H. Mertens. *Journal of Number Theory* **277**, December 2025, 201-235. `arXiv:2306.16414`.

Preprints

An Overview of Penumbral Moonshine, with Jeffrey A. Harvey and Brandon C. Rayhaun. `arXiv:2109.09756`.

Two New Avatars of Moonshine for the Thompson Group, with Jeffrey A. Harvey and Brandon C. Rayhaun. `arXiv:2202.08277`.

Recent Talks

2025 Waseda Number Theory Workshop, Waseda University, Tokyo, Japan, March 2025.

2024 Workshop on Number Theory and Algebra, Institute for Basic Science, Daejeon, Korea. February 2024.

Physical Mathematics and Beyond, Korea Institute for Advanced Study; Seoul, Korea. February 2024.

Mathematics Department Seminar, Stanford University; Stanford, CA, U.S.A. January 2024.

AMS Special Session on Mock Modular forms, Physics, and Applications, Joint Mathematics Meetings; San Francisco, U.S.A. January 2024.

Mathematics Department Colloquium, Tsukuba University; Tsukuba, Japan. November 2023.

Harish-Chandra Centenary Celebrations, Harish-Chandra Research Institute; Prayagraj, Uttar Pradesh, India. October 2023.

Mathematics Department Colloquium, National Taiwan Normal University; Taipei, Taiwan. October 2023.

Teaching Awards

Glennan Fellow, Case Western Reserve University, July 2014 to June 2015.

Theodore M. Focke Professorial Fellow, Case Western Reserve University, July 2013 to June 2015.

Nominated for the 2014 Bruce Jackson, MD, Award for Excellence in Undergraduate Mentoring, Case Western Reserve University.

Nominated for the 2014 Carl F. Wittke Award for Excellence in Undergraduate Teaching, Case Western Reserve University.

Nominated for the 2012 Diekhoff Award for Graduate Student Teaching, Case Western Reserve University.

Harvard University Certificates of Distinction in Teaching, Spring 2008 and Spring 2009.

Advising

Postdoctorate

- Rajat Gupta (Academia Sinica, 2022).

Graduate

- Maryam Khaqan (Ph.D., Emory, 2021).
- Lea Beneish (Ph.D., Emory, 2020).
- Victor Manuel-Aricheta (Ph.D., Emory, 2019).
- Paul Bruno (Ph.D., Case Western Reserve, 2016).

Undergraduate

- Jason Kraynak, Summer 2021 - Fall 2021 (Emory University, research project).
- David Dai, Fall 2020 (Emory, research project).
- Eric Zhu, Fall 2020 - Spring 2021 (Georgia Tech, research project).
- George Buck, Spring 2020 - Summer 2020 (Emory, research project).
- Qiyu Zhang, Fall 2019 - Spring 2020 (Emory, honors thesis).
- Ryan Chen, Summer 2018 (REU at Emory).
- Nate Gillman, Summer 2018 (REU at Emory).
- Xavier Gonzalez, Summer 2018 (REU at Emory).
- Samuel Marks, Summer 2018 (REU at Emory).
- Matthew Schoenbauer, Summer 2018 (REU at Emory).
- Matthew Tyler, Summer 2018 (REU at Emory).
- Paul Vienhage, Fall 2017 - Spring 2018 (Emory, honors thesis).
- Morad Hassan, Fall 2017 - Spring 2018 (Emory, honors thesis).
- Robert Dicks, Spring 2017 - Spring 2018 (Emory, honors thesis).
- Roger Van Peski, Summer 2017 (REU at Emory).
- Neekon Vafa, Summer 2017 (REU at Emory).
- Xavier Gonzalez, Summer 2017 (REU at Emory).
- Samuel DeHority, Summer 2017 (REU at Emory).
- Morad Hassan, Fall 2016 - Spring 2017 (Emory, research project).
- Zhong Zheng, Fall 2014 - Spring 2015 (Case Western Reserve, senior capstone project).
- David Buzinski, Spring 2014 - Fall 2014 (Case Western Reserve, research project).
- Michelle Bergeron, Fall 2013 - Spring 2014 (Case Western Reserve, senior capstone project).
- Brendon Dosch, Fall 2013 - Spring 2014 (Case Western Reserve, senior capstone project).
- Andrew O'Desky, Fall 2013 - Spring 2014 (Case Western Reserve, senior capstone project).
- Zhouyang Zhang, Fall 2013 - Spring 2014 (Case Western Reserve, senior capstone project).
- Brendon Dosch, Summer 2013 (Case Western Reserve, research project).
- Andrew O'Desky, Summer 2013 (Case Western Reserve, research project).
- Sander Mack-Crane, Fall 2012 - Spring 2014 (Case Western Reserve, research projects).
- Charles Clum, Fall 2012 - Spring 2013 (Case Western Reserve, senior capstone project).
- William Eisenmenger, Fall 2010 - Spring 2011 (Case Western Reserve, senior capstone project).
- Rebekah Wadsworth, Fall 2010 - Spring 2011 (Case Western Reserve, senior capstone project).
- Samuel Lichtenstein, Summer 2008 (Harvard, research project).
- Tien Anh Nguyen, Fall 2006 - Spring 2007 (Harvard, senior thesis).