

# Jonathan Bain

Department of Technology, Culture, and Society  
Tandon School of Engineering, New York University  
370 Jay Street, SC-1, Brooklyn, NY 11201

jon.bain@nyu.edu  
research.engineering.nyu.edu/~jbain  
2 Metrotech Center, 9th Fl., Rm929

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## EDUCATION

1998 **Ph.D.** History and Philosophy of Science, University of Pittsburgh, Pittsburgh, PA.  
1996 **M.S.** Physics, University of Pittsburgh  
1992 **M.A.** History and Philosophy of Science, University of Pittsburgh  
1989 **B.S.** Applied Mathematics/Physics, University of the Pacific, Stockton, CA. **Minor**, Philosophy

## AREA OF SPECIALIZATION

philosophy/foundations of physics; history & philosophy of science

## AREAS OF COMPETENCE

logic, social philosophy, epistemology, philosophy of mathematics, Whitehead, science and technology studies.

## EMPLOYMENT

2017–present **Professor**, Department of Technology, Culture and Society; Tandon School of Engineering, New York University (NYU-Tandon).  
2010–present **Affiliated Faculty**, Department of Philosophy, NYU.  
2005–2017 **Associate Professor**, Department of Technology, Culture and Society, NYU-Tandon.  
1999–2005 **Assistant Professor**, Department of Humanities and Social Sciences, Polytechnic University.<sup>†</sup>  
1998–1999 **Visiting Assistant Professor**, Department of Philosophy, University of California-Riverside.

## PUBLICATIONS

### Book:

*CPT Invariance and the Spin-Statistics Connection*, Oxford University Press (2016).

### Refereed Articles:

25. 'The RT Formula and its Discontents: Spacetime and Entanglement', *Synthese* 198 (2021), 11833–60.
24. 'Spacetime as a Quantum Error-Correcting Code?', *Studies in History and Philosophy of Modern Physics* 71 (2020), 26–36.
23. 'Why be Natural?', *Foundations of Physics* 49 (2019), 898–914.
22. 'Non-Locality in Intrinsic Topologically Ordered Systems', *Studies in History and Philosophy of Modern Physics* 66 (2019), 24–33.
21. 'Topological Order and Emergence', *Philosophica* 92 (2017), 77–112.
20. 'Emergence and Mechanism in the Fractional Quantum Hall Effect', *Studies in History and Philosophy of Modern Physics* 56 (2016), 27–38.
19. 'Pragmatists and Purists on CPT Invariance in Relativistic Quantum Field Theories', in U. Mäki, *et al.* (eds.) *Recent Developments in the Philosophy of Science: EPSA13 Helsinki*, Springer (2015), 227–42.

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<sup>†</sup> Polytechnic University became The Polytechnic Institute of New York University (NYU-Poly) in 2008. NYU-Poly became The Tandon School of Engineering, New York University (NYU-Tandon) in 2015.

18. 'Three Principles of Quantum Gravity in the Condensed Matter Approach', *Studies in History and Philosophy of Modern Physics* 46 (2014), 154–63.
17. 'Emergence in Effective Field Theories', *European Journal for Philosophy of Science* 3 (2013), 257–273.
16. 'CPT Invariance, the Spin-Statistics Connection, and the Ontology of Relativistic Quantum Field Theories', *Erkenntnis* 78 (2013), 797–821.
15. 'The Emergence of Spacetime in Condensed Matter Approaches to Quantum Gravity', *Studies in History and Philosophy of Modern Physics* 44 (2013), 338–45.
14. 'Category-Theoretic Structure and Radical Ontic Structural Realism', *Synthese* 190 (2013), 1621–35.
13. 'Effective Field Theories', in Batterman, B. (ed.) *The Oxford Handbook of Philosophy of Physics*, Oxford University Press (2013), 224–54.
12. 'Quantum Field Theories in Classical Spacetimes and Particles', *Studies in History and Philosophy of Modern Physics* 42 (2011), 98–106.
11. 'Relativity and Quantum Field Theory', in Petkov, V. (ed.) *Space, Time, and Spacetime - Physical and Philosophical Implications of Minkowski's Unification of Space and Time*, Springer (2010), 129–46.
10. 'Condensed Matter Physics and the Nature of Spacetime', in Dieks, D. (ed.) *The Ontology of Spacetime, Vol. 1*, Elsevier (2008), 301–29.
9. 'Spacetime Structuralism', in Dieks, D. (ed.) *The Ontology of Spacetime, Vol. 1*, Elsevier (2006), 37–66.
8. Essay review: Hättich, F., *Quantum Processes: A Whiteheadian Interpretation of Quantum Field Theory*, in *Studies in History and Philosophy of Modern Physics* 36 (2005), 680–90.
7. 'Theories of Newtonian Gravity and Empirical Indistinguishability', *Studies in History and Philosophy of Modern Physics* 35 (2004), 345–76.
6. 'Einstein Algebras and the Hole Argument', *Philosophy of Science* 70 (2003), 1073–85.
5. 'What Should Philosophers of Science Learn from the History of the Electron?', (with J. D. Norton) in Buchwald, J. & A. Warwick (eds.), *Histories of the Electron*, MIT Press (2001), 451–65.
4. 'Against Particle/Field Duality: Asymptotic Particle States and Interpolating Fields in Interacting QFT (or: Who's Afraid of Haag's Theorem?)', *Erkenntnis* 53 (2000), 375–406.
3. 'The Coordinate-Independent 2-component Spinor Formalism and the Conventionality of Simultaneity', *Studies in History and Philosophy of Modern Physics* 31 (2000), 201–26.
2. 'Weinberg on QFT: Demonstrative Induction and Underdetermination', *Synthese* 117 (1998), 1–30.
1. 'Whitehead's Theory of Gravity', *Studies in History and Philosophy of Modern Physics* 29 (1998), 547–74.

**Invited Reviews (not refereed):**

6. French, S. and J. Saatsi (ed.) *Scientific Realism and the Quantum*, in *Metascience* 29 (2020), 445–8.
5. Rickles, D. (ed.) *The Ashgate Companion to the Philosophy of Physics*, in *Metascience* 18 (2009), 485–9.
4. Healey, R. *Gauging What's Real: The Conceptual Foundations of Contemporary Gauge Theories*, in *Philosophy of Science* 75 (2008), 479–85.
3. Arabatzis, T. *Representing Electrons*, in *International Studies in Philosophy of Science* 20 (2006), 352–4.
2. Pesic, P., *Seeing Double: Shared Identities in Physics, Philosophy, and Literature*, in *ISIS* 93 (2002), 670–1.
1. Jammer, M., *Concepts of Mass in Contemporary Physics and Philosophy*, in *Physics Today* 53 (2000), 67–8.

**ERDOS NUMBER: 5**

Jonathan Bain → John D. Norton → Alexander Pruss → Richard Bradley Jr. → Svante Janson → Paul Erdos

**INVITED (\*) AND REFEREED PRESENTATIONS**

2022

- 'The QECC Interpretation of AdS/CFT', 'A Duality Between Topology and Entanglement? The RT Formula', 'A Duality Between Topology and Entanglement? ER=EPR, Parts I and II', *XXV International Summer School in Philosophy of Physics, Dualities Between Physics and Philosophy*, University of Urbino, Urbino, Italy, June 6-10.\*

2019

- 'Spacetime as a Quantum Error-Correcting Code?', *European Philosophy of Science Association*, University of Geneva, Geneva, Switzerland, Sept. 11–14.

2018

- 'Why be Natural?', *Philosophy of Science Association*, Seattle, WA, Nov. 1–4.
- Commentary, *Norton For Everyone?*, University of Pittsburgh, Pittsburgh, PA, Oct. 26–28.\*
- 'Non-Locality in Intrinsic Topologically Ordered Systems', *American Philosophical Association-Pacific Division*, San Diego, CA, March 28–April 1.
- 'Why be Natural?', *Naturalness, Hierarchy, and Fine-Tuning*, RTWH Aachen University, Aachen, Germany, Feb. 28–March 1.\*

2017

- 'Non-Locality in Intrinsic Topologically Ordered Systems', *European Philosophy of Science Association*, University of Exeter, Exeter, U.K., Sept. 6–9. (Accepted for presentation but could not attend.)
- 'Category-Theoretic Radical Ontic Structural Realism', *Rutgers Workshop on Structural Realism and Metaphysics of Science*, Rutgers University, New Brunswick, NJ, May 18–19.\*

2016

- 'What Explains the Spin-Statistics Connection?', *Metro-Area Philosophy of Science Group*, New York University, New York, NY, Dec. 9.\*
- 'Emergence and Mechanism in the Fractional Quantum Hall Effect', *18th U.K. and European Meeting on the Foundations of Physics*, London School of Economics, London, U.K., July 16–18.
- 'Emergence and Mechanism in the Fractional Quantum Hall Effect', *British Society for Philosophy of Science Annual Conference*, Cardiff University, Cardiff, U.K., July 7–8.
- 'What Explains the Spin-Statistics Connection?', *Society for Exact Philosophy*, University of Miami, Coral Gables, FL, May 6–8.
- 'What Explains the Spin-Statistics Connection?', *American Philosophical Association-Pacific Division*, San Francisco, CA, March 30–April 3.

2015

- 'What Explains the Spin-Statistics Connection?', *European Philosophy of Science Association*, Heinrich Heine University, Dusseldorf, Germany, Sept. 23–26.
- Comments on Kerry McKenzie's 'Fundamentality as Structuralist Resource', *First Annual Conference of the Society for the Metaphysics of Science*, Rutgers University, Newark, NJ, Sept. 17–18.\*

2014

- 'Pragmatists and Purists on CPT Invariance in Relativistic Quantum Field Theory', *Philosophy of Science Association*, Chicago, IL, Nov. 6–9.
- 'What Explains the Spin-Statistics Connection?', *British Society for Philosophy of Science Annual Conference*, University of Cambridge, Cambridge, U.K., July 10–11.
- 'Pragmatists and Purists on CPT Invariance in Relativistic Quantum Field Theory', *Society for Exact Philosophy*, California Institute of Technology, Pasadena, CA, June 22–24.

2013

- 'Three Principles of Quantum Gravity in the Condensed Matter Approach', *Beyond Spacetime*, University of Illinois, Chicago, IL, September 27–29.
- 'Pragmatists and Purists on CPT Invariance in Relativistic Quantum Field Theory', *European Philosophy of Science Association Conference*, University of Helsinki, Helsinki, Finland, August 28–31.
- 'Pragmatists and Purists on CPT Invariance in Relativistic Quantum Field Theory', *17th U.K. and European Meeting on the Foundations of Physics*, Ludwig-Maximilians University, Munich, Germany, July 29–31.
- 'Pragmatists and Purists on CPT Invariance in Relativistic Quantum Field Theory', *British Society for Philosophy of Science Annual Conference*, University of Exeter, Exeter, U.K., July 4–5.

2012

- 'The Emergence of Spacetime in Condensed Matter Approaches to Quantum Gravity', *Reflections on Space, Time & Their Quantum Nature*, Max Planck Institute for Gravitational Physics, Potsdam, Germany, Nov. 26–28.\*
- 'Emergence in Effective Field Theories', *Philosophy of Science Association*, San Diego, CA, Nov. 15–17.
- 'Emergence in Effective Field Theories', *Society for Exact Philosophy*, Ohio State, Columbus, OH, Oct. 11–15.
- 'Principles of Quantum Gravity in the Condensed Matter Approach', *British Society for Philosophy of Science Annual Conference*, University of Stirling, Stirling, U.K., July 5–6.

2011

- 'Concepts of Emergence Appropriate for Effective Field Theories', *Emergence and Effective Field Theories*, Perimeter Institute for Theoretical Physics, Waterloo, Canada, Oct. 26–28.\*
- 'CPT Invariance, the Spin-Statistics Connection, and the Ontology of Relativistic Quantum Field Theories', *European Philosophy of Science Association Conference*, Athens, Greece, Oct. 5–8.
- 'CPT Invariance, the Spin-Statistics Connection, and the Ontology of Relativistic Quantum Field Theories', *27th Boulder Conference on the History & Philosophy of Science*, University of Colorado, Boulder, CO, Sept. 23–25.
- 'CPT Invariance, the Spin-Statistics Connection, and the Ontology of Relativistic Quantum Field Theories', *British Society for Philosophy of Science Annual Conference*, University of Sussex, Brighton, U.K., July 7–8. (Accepted for presentation but could not attend.)

2010

- 'Category-Theoretic Structure and Radical Ontic Structural Realism', *Structure and Identity*, University of Bristol, Bristol, UK, July 23–25.
- 'Interpreting Effective Field Theories', *British Society for Philosophy of Science Annual Conference*, University of Dublin, Dublin, Ireland, July 8–9.
- 'Interpreting Effective Field Theories', *16th U.K. and European Meeting on the Foundations of Physics*, University of Aberdeen, Aberdeen, UK, July 5–7.

2009

- 'Motivating Structural Realist Interpretations of Spacetime', *Metaphysics of Science*, University of Melbourne, Melbourne, Australia, July 2–5.
- 'Intertheoretic Implications of Non-Relativistic Quantum Field Theories', *Workshop on the Philosophy of Quantum Field Theory*, University of Western Ontario, London, Canada, April 24–26.\*

2008

- 'Motivating Structural Realist Interpretations of Spacetime', *Studia Logica International Conference: Logic and the Foundations of Physics (Trends6)*, Brussels, Belgium, Dec. 11–12.
- 'Quantum Field Theories in Classical Spacetimes and Particles', *Philosophy of Science Association 2008*, Pittsburgh, PA, Nov. 6–8.
- 'The Spin-Statistics Theorem and Non-Relativistic Quantum Field Theories', *Theoretical and Experimental Aspects of the Spin-Statistics Connection and Related Symmetries (Spin-Stat2008)*, Istituto Nazionale di Fisica Nucleare Sezione di Trieste, Trieste, Italy, Oct. 21–25. (Accepted for presentation but could not attend.)
- 'Quantum Field Theories in Classical Spacetimes and Particles', *British Society for Philosophy of Science Annual Conference*, University of St. Andrews, St. Andrews, UK, July 10–11.
- 'Relativity and Quantum Field Theory', *3rd International Conference on the Ontology of Spacetime*, Concordia University, Montreal, Canada, June 13–15.

2007

- 'Condensed Matter Physics, Emergent Spacetime, and Structural Realism', *15th U.K. and European Meeting on the Foundations of Physics*, University of Leeds, Leeds, UK, March 29–31.

2006

- 'Condensed Matter Physics and the Nature of Spacetime', *2nd International Conference on the Ontology of Spacetime*, Concordia University, Montreal, Canada, June 9–11.

- 'Emergent Spacetime and Structural Realism', *Society for Exact Philosophy*, UCSD, La Jolla, CA, May 18–21.

2005

- 'Reductionism and Emergentism in Contemporary Physics', Othmer Institute for Interdisciplinary Studies, Polytechnic University, Brooklyn, NY, Oct.\*
- 'Conceptual Foundations of Quantum Information Theory', Othmer Institute for Interdisciplinary Studies, Polytechnic University, Brooklyn, NY, Feb.\*

2004

- 'Spacetime Structuralism', *1st International Conference on the Ontology of Spacetime*, Concordia University, Montreal, Canada, May 11–14.

2003

- 'How to be a Semantic Realist With Respect to Yang-Mills Gauge Theories', Department of Philosophy, University of Minnesota, Minneapolis, MN, Feb.\*

2002

- 'Einstein Algebras and the Hole Argument', *Philosophy of Science Association*, Milwaukee, WI, Nov. 7–9.
- 'How to be a Semantic Realist With Respect to Yang-Mills Gauge Theories', *Probing the Boundaries of Mathematics and Physics*, Department of Mathematics, University of Pittsburgh, Pittsburgh, PA, Oct.\*
- 'Philosophy and Physics: Tachyons, Causality, and Special Relativity', Interdisciplinary Physics Group, Polytechnic University, Brooklyn, NY, March.\*

1999

- 'Weinberg on QFT: Demonstrative Induction and Underdetermination', Department of Humanities and Social Sciences, Polytechnic University, Brooklyn, NY, March.\*

#### REFEREING AND REVIEWING

- External reviewer, PhD thesis, Department of Philosophy, University of Sydney, January 2014.
- Journal referee for:  
*Philosophy of Science*; *Studies in History and Philosophy of Modern Physics*; *British Journal for Philosophy of Science*; *European Journal for Philosophy of Science*; *European Philosophy of Science Association Proceedings*; *Erkenntnis*; *Synthese*; *International Studies in the Philosophy of Science*; *HOPOS: The Journal of the International Society for the History of Philosophy of Science*; *Foundations of Physics*; *Journal for General Philosophy of Science*; *Philosophy Compass*; *Nous*.
- Referee (book chapter) for Wiley & Sons; Elsevier Press.
- Grant reviewer for National Science Foundation (NSF); Social Sciences and Humanities Research Council of Canada (SSHRC); French National Research Agency (ANR); Fonds de recherche du Québec (FRQ).
- Book proposal reviewer for Cambridge University Press; Oxford University Press; Bloomsbury Publishing; Broadview Press; Longman Publishers; Imperial College Press.
- Book manuscript reviewer for Oxford University Press; Elsevier Press; SUNY Press.
- Article reviewer for *Mathematical Reviews*.

#### AWARDS AND FELLOWSHIPS

- Othmer Junior Faculty Fellowship, Othmer Institute for Interdisciplinary Studies, Polytechnic University, 2004–2006 (\$10,000).

#### UNIVERSITY SERVICE

- Tenure and Promotion Committee, NYU-Tandon, 2019-present.
- Steering Committee, Cross-School Minor in Science and Society, NYU, 2014–present.
- Undergraduate Curriculum and Standards Committee, NYU-Tandon, 2008–17.
- Development Committee, Cross-School Minor in Science and Society, NYU, 2010–12.

- Middle States Accreditation Working Group II, NYU-Tandon, 2010–12.
- Non-Engineering Freshman Curriculum Committee, NYU-Tandon, 2008.
- Graduate Curriculum and Standards Committee, Polytechnic Univ./NYU-Tandon, 2002–08.
- Chair, Institutional Review Board, Polytechnic Univ., 2001–07.
- Honors College mentor, Polytechnic Univ., 2004–06.
- Development Committee, Polytechnic Nanotechnology Initiative, Polytechnic Univ., 2004.
- Quality Learning Environment Team, Polytechnic Univ., 2001–04.
- Development Committee, Undergraduate Program in Interdisciplinary Physics, Polytechnic Univ., 2001.

## DEPARTMENTAL SERVICE

- Search Committee, Dibner Chair in History & Philosophy of Technology & Science, NYU-Tandon, 2018-19.
- Search Committee, Industry Assistant Professor of Ethics & Engineering, NYU-Tandon, 2018-19.
- Search Committee, Industry Assistant Professor of Science & Technology Studies, NYU-Tandon, 2016–17.
- Executive Committee, Dept. of Technology, Culture & Society, NYU-Tandon, 2010–17.
- Strategic Planning Committee, Dept. of Technology, Culture & Society, NYU-Tandon, 2015.
- Co-Director, Science and Technology Studies program, NYU-Tandon, 2010–15.
- Curriculum Committee, NYU-Tandon, 2006–11.
- Advisor, Undergraduate Program in Science & Technology Studies, NYU-Tandon, 2008–09.
- Development Committee, Undergrad Program in Science & Technology Studies, Polytechnic Univ., 2006–07.
- Search Committee, Dibner Chair in History & Philosophy of Technology & Science, Polytechnic Univ., 2005–07.
- Development Committee, Undergraduate Program in Liberal Studies-Philosophy, Polytechnic Univ., 1999–01.
- Professional Review Development Committee, Dept. of Humanities & Social Sciences, Polytechnic Univ., 2000.
- Search Committee, Assistant Professor of Psychology, Polytechnic Univ., 1999–00.

## MENTORING AND ADVISING

### NYU-Tandon

- Faculty Mentor, Science and Technology Studies, 2010–2022.
- Supervisor (\*)/External Reader (†), Science and Technology Studies Senior Capstone:
  - Spr. 2019. Sindhu Avuthu, "Embodying Inequality: Effects on Race and Epigenetics on Public Health Disparities".†
  - Summer 2018. San Wong You, "Wind Farms and Environmental Impact in Palm Springs, California".\*
  - Spr. 2015. Diego Tasso, "Theory, Practice, and Scientific Progress: An Analysis of late 19th Century Electrical Theory versus Practice Debates".\*
  - F. 2013. Deniss Vinogradov, "The Quantum Hypothesis and Physics of Principle".\*
  - F. 2010. Sirazum Islam, "Social Constructivism in the Diagnosis and Treatment of Schizophrenia".\*
  - Spr. 2010. Ricardo Davis, "Mathematics Education in the U.S. in the 20th Century and Tacit Knowledge".\*
  - Spr. 2010. Volkan Turgut, "Technological Determinism".\*
  - Spr. 2008. David Darling, "Defining and Demarcating Unscientific Principles for the Purpose of Advancing Scientific Understanding".\*
- Supervisor, Undergraduate Summer Research Program:
  - 2022. "Black Hole Interior Reconstruction and the Information Loss Paradox". Kyle Lleras (Physics, Univ. Chicago); Herbert Ortiz (Applied Physics, NYU-Tandon).
  - 2021. "A Law-Centric View of Emergence". Jasmine Murphy (Computer Science, NYU-Tandon).
  - 2020. "ER=EPR? Topology and Quantum Entanglement". Nigel Shen (STS, NYU-Tandon; Physics, NYU-CAS).
  - 2019. "Spacetime and Entanglement". Gabriela Avila (Applied Physics, NYU-Tandon); Sam Granade (Physics & Math, NYU-Tandon).

- 2018. "Holographic Spacetime and Quantum Error Correction Codes". Mengmeng Li (Honors Math, NYU-Shanghai); Edison Murairi (Physics, NYU-Abu Dhabi).
- 2017. "Non-Locality in Intrinsic Topologically Ordered Systems". Avedis Baghdasarian (Mechanical Engineering, NYU-Tandon).
- 2016. "Topological Order and Emergence". Song-Chen Xia (Applied Physics/STS, NYU-Tandon).
- 2015. "Emergence in the Fractional Quantum Hall Effect". Louis Ramirez (STS, NYU-Poly); Wells Santos (Computer Engineering/Computer Science, NYU-Poly).
- 2015. "What Explains the Spin-Statistics Connection?" Hind Al-Tantawi (Mechanical Engineering, NYU-Abu Dhabi); Shearyar Khan (Applied Physics, NYU-Poly).
- 2014. "The Explanatory Power of 19th Century Mechanical Models of the Electromagnetic Aether". Yikal Abe (Electrical Engineering, NYU-Abu Dhabi); Felipe Pereira (Electrical Engineering, NYU-Poly); Wells Santos (Computer Engineering/Computer Science, NYU-Poly).

#### **NYU-Gallatin**

- Supervisor, Senior Project:
  - Spr. 2018. Melody Xu "History of Artificial Intelligence: A Historical Analysis of Newell and Simon's Physical Symbol System Approach to AI in the 1950s-1960s". Honors distinction.
- Committee member, Undergraduate Colloquium:
  - F. 2017. Melody Xu "The History and Philosophy of Intelligence Studies".
  - Spr. 2011. Zhipan Ren "The Mind-Body Problem and the Problem of Physical Determinism".

#### **NYU-Tisch**

- Faculty science advisor, Writing and Production Award:
  - Spr. 2022. David Huang
  - Spr. 2020. Jason Brownrigg "Destroyer of Worlds".

#### **TEACHING (Undergraduate Courses Taught at NYU-Tandon)**

##### Intro

Science, Technology, and Society (history & philosophy of science; science & technology studies)  
 Space and Spacetime (history and philosophy of space)  
 Science and Pseudoscience  
 Symbolic Logic  
 Social Philosophy  
 Conceptual Mathematics: Intro to Category Theory  
 Intro to 20th Century Physics

##### Intermediate

Relativity and Spacetime (philosophy of special and general relativity)  
 Quantum Mechanics and Information (philosophy of quantum mechanics)  
 From Heat Engines to Black Holes (history & philosophy of thermodynamics)  
 Magic, Medicine and Science (history & philosophy of science)

##### Advanced

History of Light (history & philosophy of electrodynamics)  
 Physics, Information, and Computation (philosophy of physics)  
 Philosophy of Science  
 Philosophy of Mathematics  
 Metalogic  
 Seminar in Science and Technology Studies  
 Senior Capstone, Science and Technology Studies

##### Guided Study

Category Theory  
Minds and Machines (philosophy of mind)  
Whitehead

#### **CURRENT RESEARCH**

1. 'Motivating ER=EPR', preprint.
2. 'A Law-Centric View of Emergence', preprint.
3. 'The Role of Entanglement Wedge Reconstruction in the Black Hole Information Loss Paradox', in preparation.