

Bryan W. Roberts

1017 Cathedral of Learning, Pittsburgh, PA 15260 USA

✉ bwr6@pitt.edu | 🌐 www.pitt.edu/~bwr6

Curriculum Vitae: *September 18, 2011*

Specialization

AOS history & philosophy of physics

AOC philosophy of science, philosophy of mathematics, logic, metaphysics, bioethics

Education

Ph.D. History & Philosophy of Science, University of Pittsburgh, Apr. 2012 (anticipated)
Dissertation. “Time and Ontology: A Study in the Foundations of Quantum Theory.”
Supervisors. John Earman (co-supervisor), John D. Norton (co-supervisor), Robert Batterman, Laura Ruetsche, Giovanni Valente

B.A. Philosophy, University of Washington, Dec. 2005
With College Honors

B.S. Mathematics, University of Washington, Dec. 2005

Refereed Publications

2011 Roberts, Bryan W. “Group Structural Realism.” *The British Journal for the Philosophy of Science* 62(1):47-69. doi:10.1093/bjps/axq009.

2011 Roberts, Bryan W. “How Galileo Dropped the Ball and Fermat Picked It Up.” *Synthese* 180(3):337-356. doi:10.1007/s11229-009-9705-7.

Manuscripts in progress

Norton, John D. and Bryan W. Roberts. “Galileo’s Refutation of the Speed-Distance Law of Fall Rehabilitated,” manuscript under review; preprint at PhilSci-Archive.pitt.edu/5479.

Roberts, Bryan W. “Three myths about time reversal in quantum mechanics,” manuscript draft available upon request.

Roberts, Bryan W. “Does quantum time have a preferred direction?” manuscript draft available upon request.

Roberts, Bryan W. “An earnest account of why classical mechanics is time reversal invariant,” manuscript draft available upon request.

Gyenis, Balázs and Bryan W. Roberts. “Supertasks in general relativity? Gödel strikes back,” manuscript draft available upon request.

Awards, Honors & Appointments

- 2011 (to present) Program Assistant, Center for Philosophy of Science, *University of Pittsburgh*.
- 2011 (Winter) Visiting Scholar, Logic & Philosophy of Science, *University of California, Irvine*.
- 2011 Dissertation Research Improvement Award #1058902, *National Science Foundation*.
- 2010 Rob Clifton Memorial Book Prize in Philosophy of Physics, *University of W. Ontario*.
- 2008 Wesley Salmon Fund Grant, *University of Pittsburgh*.
- 2007 Arts & Science Teaching Fellowship, *University of Pittsburgh*.
- 2006 Andrew Mellon Fellowship, *University of Pittsburgh*.
- 2005 Distinguished Service Award in Philosophy, *University of Washington*.

Invited Talks

- 2011 “ T -invariance and T -violation.” University of Bristol Quantum Field Theory Workshop, May 24.
- 2011 “Three myths about time reversal.” University of Oxford Philosophy of Physics Research Seminar, May 19.
- 2011 “Notes on the CPT Theorem.” UCSD Philosophy of Science Reading Group, University of California, San Diego, March 3.
- 2011 “How to time reverse a quantum system.” Southern California Philosophy of Physics Reading Group, University of California, Irvine, February 19.
- 2010 “Group Theory and the Structure of Quantum Theory.” University of Notre Dame Workshop: *Structuralism in Philosophy of Science*, November 18-20.

Conference Presentations

“How to time reverse a quantum system”

- Nov 2010 Philosophy of Science Association 22nd Biennial Meeting, Montréal, QC.
- Jul 2010 British Society for the Philosophy of Science Annual Meeting, University College Dublin, Ireland.
- Feb 2010 North Carolina Philosophical Society annual meeting in Charlotte, NC.

“Galileo’s Refutation of the Speed-Distance Law of Fall Rehabilitated”

- Sep 2010 &HPS₃, University of Indiana, Bloomington, IN.

“Group Structural Realism”

- Apr 2009 Logic, Mathematics, and Physics Graduate Philosophy Conference, University of Western Ontario, London, ON.

Teaching Experience

- Spr 2010 Instructor, “Morality & Medicine” (Intro to Bioethics), University of Pittsburgh.
- Fall 2009 Instructor, “Principles of Scientific Reasoning,” University of Pittsburgh.
- Spr 2008 TA, “Einstein for Everyone,” University of Pittsburgh, Assistant for John D. Norton.
- Fall 2007 TA, “Introduction to the Philosophy of Science,” University of Pittsburgh, assistant for John Earman.

Referee Service

- 2011 Erkenntnis, Synthese, PhilSci-Archive.
2010 The British Journal for the Philosophy of Science, Foundations of Physics, Humana.mente
Journal of Philosophical Studies, Philosophy of Science, PhilSci-Archive.
2009 Dialectica, The British Journal for the Philosophy of Science, Philosophy of Science, PhilSci-
Archive, Theoria.

Languages

- fluent English, French, Spanish.
reading German, Latin.

Courses Taken (University of Pittsburgh)

- | | |
|--|--|
| Causation (Glymour) | Philosophy of Mathematics (Manders) |
| Determinism and Causation (Earman & Norton) | Philosophy of Science (Norton) |
| Differential Geometry (T. Hales) | Philosophy of Time (Earman & Norton) |
| General Relativity & Gravitation (D. Boyanovsky) | Phil. Algebraic QFT (Earman & Ruetsche) |
| History of Science 1 (Palmieri) | Scientific Realism (K. Stanford) |
| History of Science 2 (Palmieri) | Topics in History: Newton's Principia (Palmieri) |
| Independent Study: Phil. of Stat. Mech. (Norton) | Topics in History: Infinitesimals (Palmieri) |
| Leibniz* (Rescher) | Topics in History: Manuscripts (Lennox & Palmieri) |
| Metaphysics and Epistemology (Rescher) | Topics in Logic: Modal Logic (Belnap) |
| Model Theory (Manders) | Topics in Logic: Theories of Truth* (Gupta) |
| Phil. General Relativity (Earman & Norton) | Wittgenstein (Ricketts) |
| Phil. Classical & Quant. Phys. (J. Butterfield) | |

(* = audited)

Dissertation Summary

Time and Ontology: A Study in the Foundations of Quantum Theory

This dissertation investigates the relationship between the ontology of fundamental physics and the direction of time. I first develop an account that clarifies what it can mean for quantum theory to distinguish past from future. I then show that if ordinary quantum theory does distinguish a preferred direction in time, then this has consequences for the ontology of the physical world. In particular, it requires substance to admit measurable properties not describable in terms of spatial position alone. This is not a purely quantum phenomenon, and can be shown to have an expression in classical mechanics as well. I illustrate a general template for generating quantum systems that distinguish a preferred temporal direction in this way. Finally, I develop and then critique a precise account of “structural realism” about the ontology of quantum physics.

My account of what it means for quantum theory to distinguish between past and future provides a philosophical and mathematical grounding for the standard concept of *time reversal*. In particular, I show how to build up the meaning of time reversal from successively stronger assumptions. I begin with a bare assumption that time reversal preserves mutual incompatibility or *orthogonality* between pure states, and point out that this severely restricts what time reversal operators are available. I then show that in the presence of some plausible background assumptions, if there exists just one system at all that is time reversal *invariant*, then time reversal must have an unusual property called “antiunitarity.” I then show a way in which the unique transformation rules for the time reversal operator can be derived, whenever a “position observable” is available.

With this account in hand, I then turn to the question of whether quantum theory *does* distinguish between past and future. I state and prove a precise sense in which, if all the measurable properties of an ordinary quantum mechanical system are ultimately derivable from position, then time in quantum mechanics can have no preferred temporal direction. In particular, I show that when the position observable forms a complete set of commuting observables, Galilei invariant quantum mechanics is guaranteed to be time reversal invariant.

A natural question about this is whether it is a purely quantum result, or if it has a classical expression as well. I confirm that the latter is in fact the case. I begin by showing how many existing formulations of the time reversal invariance of classical mechanics are insufficient. I then show that some very bare conditions guarantee that Galilei invariant Hamiltonian mechanics is time reversal invariant.

Given that a distinction between past and future seems to have consequences for physical ontology, another natural question is how to produce systems that have this property. I give a template for generating such systems, and show that it captures several known examples of systems that fail to be time reversal invariant. This template has the further advantage of being independent of the particular symmetry group (Galilei, Lorentz, or other) of quantum theory.

In conclusion, I discuss the ontology of quantum mechanics in the context of scientific realism. I show that vague ‘structural realist’ claims about realism in scientific theories can in fact be given precise expression in the language of group theory and quantum mechanics. I then show the price of this precision is an extremely inflated ontology that risks incoherence.