Scientific Curriculum Vitae of Bob Coecke

ID: Belgian - Born 23|07|1968 in Willebroek [1]

Speech: Dutch/Flemish (mother tongue) - French (fluent) - English (fluent)

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Present appointment: Oxford University Computing Laboratory, Parks Road, OX1 3QD Oxford, UK.

RESEARCH FIELD

- **Fundamentals of Physics, Logic and Computation**
- **Quantum Information and Computation (structures and applications)**
- **Ordered (algebraic/toplogical) Structures, Probability Theory and Category Theory**

RESEARCH EXPERIENCE SYLLABUS

- Quantum Entanglement, Quantum Computing, Quantum Probability, Quantum Information Theory;
- Proof and Type Theory, Sequent Calculus, Type Theory, Categorical logic, Linear Logic, Dynamic Logic, Modal Logic, Intuitionistic Logic, Epistemic Logic, Quantum Logic;
- Information Content and Entropy, Information-flow, Information Update in Multi-Agent Systems;
- Lattices, Domains, Measure Theory, (multi-)Linear Algebra, Quantales, Enriched Categories, Traced and Closed Monoidal Categories, Bicategories.

STUDIES at the Free University of Brussels

- 1st & 2nd Kan. Polytechnics (Architecture - Engineering) July 1987/88 - High Distinction.
- 1st & 2nd Kan. Mathematics (Pure Mathematics) July 1990 - the Highest Distinction.
- 1st & 2nd Kan. Physics (Theoretical Physics) July 1990 - the Highest Distinction.
- 1st & 2nd Lic. Physics (Theoretical Physics) July 1991/92 - the Highest Distinction.
- Ph.D. (in Sciences) February 1996 - the Highest Distinction.

CAREER AFFILIATIONS

1992 $\rightarrow$ 1996 Free University of Brussels - Department of Physics

1996 $\rightarrow$ 1997 Free University of Brussels - Interdisciplinary Research Institute CLEA

1997 $\rightarrow$ 2000 Free University of Brussels - Department of Mathematics

2000 $\rightarrow$ 2001 Imperial College in London - Department of Physics

2001 $\leftrightarrow$ 2001 McGill University in Montreal - Department of Mathematics and Statistics

2001 $\rightarrow$ 2002 Cambridge University - Department of Pure Mathematics and Mathematical Statistics

2002 $\rightarrow$ 2007 Oxford University - Computing Laboratory

[1] This is the town where the Belgian beer Duvel is brewed.

DETAILED RESEARCH CAREER DESCRIPTION

[Academic Years 1992 → 1996] Research assistant at the Belgian National Fund for Scientific Research on a Physics Board Fellowship while affiliated to the Theoretical Physics Group of the Free University of Brussels.

[Academic Year 1996 → 1997] Self-funded through teaching of computer aided musical composition & performance at art schools while affiliated to the Interdisciplinary Research Center CLEA of the Free University of Brussels.

[Academic Years 1997 → 2000] Research Associate at Flander's Fund for Scientific Research on both a Physics Board and Mathematics Board Fellowship while affiliated to the Foundations of Exact Sciences Group in the Department of Mathematics of the Free University of Brussels.

[$\frac{1}{2}$ Academic Year 2000 → 2001] Postdoctoral Researcher in the Theoretical Physics Group of Imperial College of Science, Technology and Medicine in London.

[$\frac{1}{2}$ Academic Year 2000 → 2001] Postdoctoral Researcher in the Department of Mathematics and Statistics (which hosts the Category Theory Group) of McGill University in Montreal.

[Academic Year 2001 → 2002] Research Associate on the European TMR (Training and Mobility) network 'Linear Logic in Computer Science' in the Department of Pure Mathematics and Mathematical Statistics of Cambridge Unversity - Academic Visitor of Oxford University Computing Laboratory.

[Academic Years 2002 → 2004] Grade I Research Officer partly on the ONR (US Office of Naval Research) grant 'Combining Qualitative and Quantitative Theories of Information' and partly on Oxford University funds while affiliated to Oxford University Computing Laboratory.

[Academic Years 2004 → 2007] Grade II Research Officer on the EPSRC grant 'High-level Methods in Quantum Computation and Information' while affiliated to Oxford University Computing Laboratory.

TEACHING AND SUPERVISION EXPERIENCE

[Academic Years 1992 → 2000] Class Tutor for Computing, Mathematics and Physics courses at the Free University of Brussels ('Calculus' for biology, computer science, mathematics, medicine and physics students - 'Introduction to Physics' for biology, computer science, mathematics, medicine and physics students - 'Discrete Mathematics' for computer science and mathematics students - 'Analytical Mechanics' and electro-magnetism for mathematics and physics students - 'Projective Geometry' for mathematics students).

[Academic Years 1996 → 1997] Lecturer and Clinic Instructor (part-time) in Computer Aided Musical Composition and Performance at several art departments in Belgium.

[Academic Year 1997 → 2000] Substitute Lecturer of Mathematics and Physics courses at the Free University of Brussels ('Thermodynamics' for physics students - 'Projective Geometry' for mathematics students).

[Academic Year 1997 → 2000] Supervisor of four Lic. Thesis at VUBrussels.[2]

[Academic Year 2001 → 2002] Lecturer of an advanced course entitled 'Structure, Logicality and Sense in Quantum Theory' at Oxford University Computing Laboratory.[3]

[Academic Years 2001 → 2006] Class Tutor for Computing and Mathematics courses at Oxford University ('Categories, Proofs and Games' for computer science and mathematics students - 'Intelligent Systems' for computer science students - 'Logic of Multi-Agent Information Flow' for computer science and mathematics students).

[Academic Years 2002 → 2006] Co-supervisor of Ph.D. student at VUBrussels.[4]

[Academic Year 2004 → 2006] Guest Lecturer for Computing and Mathematics courses at Oxford University ('Categories, Proofs and Games' for computer science and mathematics students - 'Logic of Multi-Agent Information Flow' for computer science and mathematics students).

[Academic Year 2005 → 2006] Lecturer of a course entitled 'Quantum Computer Science' offered to BA in Mathematics & Computer Science students, MSc in Computer Science students and MSc in Mathematics and the Foundations of Computer Science students.[5]

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[2] These 4 lic. thesis resulted in 5 international refereed publications and all are still in academic positions (Haroun Amira at VUBrussels, Dr. Isar Stubbe at Univ. Coimbra, Dr. Steven Sourbron at VUBrussels and Johan Depoorter at KULeuven).

[3] `http://web.comlab.ox.ac.uk/oucl/seminars-mt01/spec-lec.html`

[4] Named Karin Verelst (Lic. Molec. Bio & Phil. VUBrussels).

[5] `http://web.comlab.ox.ac.uk/oucl/courses/topics05-06/qcs/`

[Academic Year 2005 → 2006] Supervisor for 'MSc in Computer Science' at Oxford University Computing Laboratory.[6]

[Academic Year 2005 → 2006] Co-supervisor of 2 D.Phil.-students at Oxford University Computing Laboratory[7] and one D.Phil.-student at the National Autonomous University of Mexico.[8]

PRIZES

I received the 1992 annual 'Prize of Sciences' awarded by the Science Faculty of the Free University of Brussels to the best graduating student of the Faculty of Sciences of that year.

I received the 2004 biennial 'Prize for Meritorious Research in the Field of Quantum Structures' awarded by the International Quantum Structures Association.

FELLOWSHIPS

A 4 year Physics Board Research Aspirant Fellowship of Belgium's National Fund for Scientific Research.[9]

A 3 year Physics & Mathematics Board Research Associate Fellowship of Flanders' Fund for Scientific Research.[10]

A 1 year Research Fellowship awarded by the EC TMR network Linear Logic in Computer Science.

GRANTS (only substantial ones are listed[11]):

A 25.000 EUR Mobility grant obtained from VUBrussels' Research and Development Council in 2000.

A 160.000 £ EPSRC grant for the project 'High-level Methods in Quantum Computation and Information' obtained jointly with Samson Abramsky (also Oxford University Computing Laboratory) in 2004.

BOARDS

Student representative and research assistant representative in Departmental and Faculty boards at VUBrussels.

Referee for major journals in computing, logic and physics e.g. TCS, MSCS, JSL, SL, PRL, PRA.

Former voted Council Member of the International Quantum Structures Association (April 2001-2004).

Referee for major conferences in computing e.g. IEEE-LiCS, ICALP, CSL.

Member of Jury of several Ph.D., MSc. and Lic. Vivas in Belgium and in the United Kingdom.

Member of the program committee of:

- '6th' & '7th Biennial International Quantum Structures Meeting' (Vienna & Denver, July 2002 & 2004)
- '3rd Workshop on Quantum Programming Languages' (QPL III - Chicago - July 2005)
- 'Analytic Topology in Maths and C.S.' seminar serries, Mathematical Institute, Oxford University.

ORGANIZATION OF WORKSHOPS, SYMPOSIA AND SEMINARS

Member of the organizing team of interdisciplinary conference Einstein meets Magritte (VUBrussels - May 1995).

Organizer of workshop series Current Research in Operational Quantum Logic (CROQL) namely CROQL I (VUBrussels - June 1998), CROQL II (VUBrussels - May 1999)[12] and CROQL III (VUBrussels - April 2000).[13]

Organizer of 2-day symposium Peripatetic Seminar on Sheaves and Logic 72 (Brussels - April 2000).[14]

Organizer (and creator of name & concept) of the weekly interdisciplinary Oxford Advanced Seminar on Informatic Structures (OASIS) which takes place in the Computing Laboratory since October 2004.[15]

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[6] http://web.comlab.ox.ac.uk/oucl/courses/grad05-06/cs/geninfo.html

[7] Named Dmitri Akatov (MSc. Math. & Found. Comp. Oxford) and William Edwards (MSc. Theor. Phys. Imperial College).

[8] Named Hugo Nava Kopp (MSc. Comp. UNAM).

[9] This was (see below) Belgium's analogue to the French CNRS itself abbreviated as NFWO/FNRS.

[10] What remains after federalizing NFWO/FNRS and abbreviated as FWO (the N of National and Francophone variant are gone).

[11] I obtained many smaller grants for organizing workshops (see below) and for participation of others and myself at conferences.

[12] `www.vub.ac.be/CLEA/Bob/WS99.html`

[13] `www.vub.ac.be/CLEA/Bob/WS2000.html`

[14] `www.vub.ac.be/CLEA/Bob/WS2000.html♯CTS` - (in)famously known as the 'swimming pool conference'

[15] `http://se10.comlab.ox.ac.uk:8080/InformaticPhenomena/index.html`

Organizer of 1-day workshop Logic from Quantales (Computing Laboratory - January 2005). [16]

Co-organizer (with Vincent Danos) of 2-day workshop Q-day II (Institut H. Poincaré Paris - December 2005).[17]

Local organizer of 4rd workshop on Quantum Programming Languages (QPL IV - Oxford - Summer 2006).[18]

INVITED RESEARCH VISITS

Theoretical Physics Group, University of Geneva (September 1996 - 2 weeks, August 1997 - 2 weeks, August 1998 - 2 weeks, October 1998 - 2 weeks) invited by Constantin Piron.

Department of Mathematics, Masaryk University in Brno (November 1999, 2 weeks) invited by Jiri Rosicky.

Department of Mathematics, Instituto Superior Téchnico in Lisbon (June 2000 - 2 weeks) as departmental guest.

Department of Arts and Technology, The Art Institute of Chicago (April 2001 - 1 week) as departmental guest.

Department of Mathematics and Statistics, University of Ottawa (May 2001 - 1 week, August 2001 - 1 week, March 2004 - 1 week) invited respectively as departmental guest, by Rick Blute and by Philip J. Scott.

Laboratoire des Preuves, Programmes et Systèmes at Paris 7 (May 2004 - 1 week) invited by Vincent Danos.

Kestrel Institute, Palo Alto, Silicon Valley, California (July 2005 - 2 weeks) invited by Dusko Pavlovic.[19]

Physics Institute, University of Innsbruck (January 2006 - 1 week) invited by Hans-J. Briegel.

Department of Computing, Instituto Superior Téchnico in Lisbon (date still to be set - 1 week) on QuantLog.[20]

PUBLICATIONS (57)

Books:

1. B. Coecke, D.J. Moore and A. Wilce (editors): *Current Research in Operational Quantum Logic: Algebras, Categories, Languages*. Kluwer Academic Publishers, 2000. ISBN 0-7923-6258-6.

Extensive Research Reports:

2. B. Coecke (1996): *Hidden Measurement Systems*. (99 pages) Ph. D. Thesis, Free University of Brussels.
3. B. Coecke and K. Martin (2002): *A Partial Order on Classical and Quantum States*. (92 pages). Research Report OUCL PRG-RR-02-07. `web.comlab.ox.ac.uk/oucl/publications/tr/rr-02-07.html`
4. B. Coecke and K. Martin (2003): *Domain Theory and Quantum Mechanics*. (7 pages) Short and slightly elaborated version of the above.
5. B. Coecke (2003): *The Logic of Entanglement. An Invitation*. (160 pages). Research Report OUCL PRG-RR-03-12. `web.comlab.ox.ac.uk/oucl/publications/tr/rr-03-12.html`
6. B. Coecke (2003): *The Logic of Entanglement*. (8 pages) Short and slightly elaborated version of the above; `arXiv:quant-ph/0402014`

Refereed Journal Papers including in Refereed Special Issues for Conferences:

7. B. Coecke: Generalisation of the Proof on the Existence of Hidden Measurements to Experiments with an Infinite Set of Outcomes. *Foundations of Physics Letters* **8**, 437–447, 1995.
8. B. Coecke: Hidden Measurement Model for Pure and Mixed States of Quantum Physics in Euclidean Space. *International Journal of Theoretical Physics* **34** [QS'94 volume] 1313–1320, 1995.[21]
9. B. Coecke: Hidden Measurement Representation for Quantum Entities Described by Finite Dimensional Complex Hilbert Spaces. *Foundations of Physics* **25**, 1185–1208, 1995.
10. B. Coecke: Representation of a Spin-1 Entity as a Joint System of Two Spin-1/2 Entities on which we Introduce Correlations of the Second Kind. *Helvetica Physica Acta* **68**, 396–406, 1995.

[16] `http://se10.comlab.ox.ac.uk:8080/InformaticPhenomena/LogicfromQuantales_en.html`
[17] Web page in preparation.
[18] Web page in preparation.
[19] `http://www.kestrel.edu/`
[20] QuantLog := Logic in Quantum Computation and Information. `http://clc.math.ist.utl.pt/quantlog.html`
[21] QS := Biannual meeting of the *International Quantum Structures Association* (IQSA).

11. B. Coecke: Superposition States through Correlations of the Second Kind. *International Journal of Theoretical Physics* **35** [QS'95 volume] 2339–2351, 1996.

12. B. Coecke: New Examples of Hidden Measurement Systems and Outline of a General Scheme. *Tatra Mountains Mathematical Publications* **10**, 63–74, 1997.

13. D. Aerts, B. Coecke, T. Durt and F. Valckenborgh: Quantum, Classical and Intermediate I : a Model on the Poincaré Sphere. *Tatra Mountains Mathematical Publications* **10**, 225–240, 1997.

14. D. Aerts, B. Coecke, T. Durt and F. Valckenborgh: Quantum, Classical and Intermediate II : the Vanishing Vector Space Structure. *Tatra Mountains Mathematical Publications* **10**, 241–266, 1997.

15. D. Aerts, B. Coecke, B. D'Hooghe and F. Valckenborgh: A Mechanistic Macroscopical Physical Entity with a Three Dimensional Hilbert Space Quantum Description. *Helvetica Physica Acta* **70**, 793–802, 1997.

16. B. Coecke: Classical Representations for Quantum-like Systems through an Axiomatics for Context Dependence. *Helvetica Physica Acta* **70**, 442–461, 1997 ; arXiv:quant-ph/0008061.

17. B. Coecke: A Classification of Classical Representations for Quantum-like Systems. *Helvetica Physica Acta* **70**, 462–477, 1997 ; arXiv:quant-ph/0008062.

18. H. Amira, B. Coecke and I. Stubbe: How Quantales Emerge by Introducing Induction within the Operational Approach. *Helvetica Physica Acta* **71**, 554–572, 1998.

19. B. Coecke: A Representation for Compound Systems as Individual Entities: Hard Acts of Creation and Hidden Correlations. *Foundations of Physics* **28**, 1109–1135, 1998 ; arXiv:quant-ph/0105093.

20. B. Coecke: A Representation for a Spin-S Quantum Entity as a Compound System in $\mathcal{R}^3$ Consisting of 2S Individual Spin-1/2 Entities. *Foundations of Physics* **28**, 1347–1365, 1998 ; arXiv:quant-ph/0105094.

21. B. Coecke: A Representation of Projection Lattices and their States in Euclidean Space. *Journal of Mathematical Analysis and its Applications* **220**, 603–612, 1998.

22. B. Coecke and F. Valckenborgh: Hidden Measurements, Automorphisms and Decompositions in Context Dependent Components. *International Journal of Theoretical Physics* **37** [QS'96 volume] 311–322, 1998.

23. B. Coecke and I. Stubbe: Operational Resolutions and State Transitions in a Categorical Setting. *Foundations of Physics Letters* **12**, 29–49, 1999 ; arXiv:quant-ph/0008020.

24. B. Coecke and I. Stubbe: On a Duality of Quantales emerging from an Operational Resolution. *International Journal of Theoretical Physics* **38** [QS'97 volume] 3269–3281, 1999.

25. B. Coecke: Structural Characterization of Compoundness. *International Journal of Theoretical Physics* **39** [QS'98 volume] 581–590, 2000 ; arXiv:quant-ph/0008054.

26. B. Coecke and S. Smets: Logical Description for Perfect Measurements. *International Journal of Theoretical Physics* **39** [QS'98 volume] 591–599, 2000 ; arXiv:quant-ph/0008017.

27. B. Coecke and I. Stubbe: State Transitions as Morphisms for Complete Lattices. *International Journal of Theoretical Physics* **39** [QS'98 volume] 601–610, 2000 ; arXiv:math.DS/0008039.

28. B. Coecke, D.J. Moore and I. Stubbe: Quantaloids Describing Causation and Propagation of Physical Properties. *Foundations of Physics Letters* **14**, 133–145, 2001 ; arXiv:quant-ph/0009100.

29. B. Coecke: Quantum Logic in Intuistionistic Perspective. *Studia Logica* **70**, 353–382, 2002 ; arXiv:math.LO/0011208.

30. B. Coecke: Disjunctive Quantum Logic in Dynamic Perspective. *Studia Logica* **71**, 1–10, 2002 ; arXiv:math.LO/0011209.

31. S. Abramsky and B. Coecke: Physical Traces: Quantum vs. Classical Information Processing. *Electronic Notes in Theoretical Computer Science* **69** [CTCS'02 volume] 1–22, 2002;[22] arXiv:cs.CG/0207057.

32. B. Coecke: Entropic Geometry from Logic. *Electronic Notes in Theoretical Computer Science* **83** [MFPS'03 volume] 2003;[23] arXiv:quant-ph/0212065.

[22] CTCS := The *Category Theory and Computer Science* biannual conference.

[23] MFPS := The *Mathematical Foundations for Programming Semantics* annual conference.

33. B. Coecke and S. Smets: The Sasaki-Hook is not a [Static] Implicative Connective but Induces a Backward [in Time] Dynamic One that Assigns Causes. *International Journal of Theoretical Physics* **43** [QS'01 volume] 1705–1736, 2004; `arXiv:quant-ph/0111076`.

34. A. Baltag, B. Coecke and M. Sadrzadeh: Algebra and Sequent Calculus for Epistemic Actions. *Electronic Notes in Theoretical Computer Science* **126** [LCMAS'04 volume] 27–52, 2004.[24]

35. S. Abramsky and B. Coecke: Abstract Physical Traces. *Theory and Applications of Categories* **14** [CTCS'02 post proceedings] 111–124, 2005.

36. A. Baltag, B. Coecke and M. Sadrzadeh: Epistemic Actions as Resources. *Journal of Logic and Computation* [LRPP'04 post proceedings].[25] (to appear)

37. B. Coecke: De-linearizing Linearity: Projective Quantum Axiomatics from Strong Compact Closure. *Electronic Notes in Theoretical Computer Science* **126** [QPL'05 volume];[26] `arXiv:quant-ph/0506134`.

Invited Contributions to (usually) Refereed Journals:

38. S. Abramsky and B. Coecke: Physics from Computer Science. *Journal of Unconventional Computing* [GC7'05 volume].[27] (in preparation)

39. S. Abramsky and B. Coecke: Abstract Quantum Mechanics. *Journal of Pure and Applied Algebra*. (in preparation)

Refereed Conference Proceedings:

40. S. Abramsky and B. Coecke: A Categorical Semantics of Quantum Protocols. Proceedings of the *19th Annual IEEE Symposium on Logic in Computer Science* (LiCS), pp. 415–425, IEEE Computer Science Press, 2004. `arXiv:quant-ph/0402130`

41. B. Coecke: Quantum Information Flow, Concretely, Abstractly. In *Proceedings of the 2nd Workshop on Quantum Programming Languages*, pp. 57–74, P. Selinger, Ed., TUCS General Publication, 2004.

Invited Speaker's Contribution to Conference Proceedings (unrefereed):

42. B. Coecke (invited) and K. Martin: Partiality in Physics. In *Quantum Theory: Reconsideration of the Foundations II*, pp. 129–148, A. Khrennikov, Ed., World Scientific, 2004; `arXiv:quant-ph/0312044`

43. B. Coecke: Quantum Information Flow, Concretely, and Axiomatically. In *Proceedings of Quantum Informatics 2004*, pp. 15–29, Y. I. Ozhigov, Ed., Proceedings of SPIE Vol. 5833;[28] `arXiv:quant-ph/0506132`

44. B. Coecke: Kindergarten Quantum Mechanics — lecture notes. In *Proceedings of Quantum Theory: Reconsiderations of the Foundations III.* A. Khrennikov, Ed., AIP Press.[29] (to appear)

45. B. Coecke: Strongly Compact Closed Semantics — lecture notes. *Electronic Notes in Theoretical Computer Science* [MFPS'05 volume] 2005.

Invited Contributions to Books:

46. D. Aerts and B. Coecke: The Creation-Discovery-View: Towards a Possible Explanation of Quantum Reality. In *Language, Quantum, Music*, pp. 105–116, M.L. Dalla-Chiara *et al.*, Eds., Kluwer Academic Publishers, 1999.

47. D. Aerts, B. Coecke and S. Smets: On the Origin of Probabilities in Quantum Mechanics: Creative and Contextual Aspects. In *Metadebates of Science*, pp. 299–310, G. Cornelis, S. Smets and J.P. Van Bendegem, Eds., Kluwer Academic Publishers, 1999.

48. B. Coecke and K. Verelst: Early Greek Thought and New Perspectives in Quantum Mechanics: Outlines of an Approach. In *Metadebates of Science*, pp. 163–196, G. Cornelis, S. Smets, J.P. Van Bendegem, Eds., Kluwer Academic Publishers, 1999.

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[24] LCMAS := The *Logic and Communication in Multi-Agent Systems* affiliated workshop of the *16th European Summer School in Logic, Language and Information* (ESSLLI).

[25] LRPP:= The *Logics for Resources, Processes and Programs* affiliated workshop at the *19th annual IEEE Symposium on Logic in Computer Science* (LiCS).

[26] QPL III:= *Quantum Programming Languages* workshop affiliated to the 20th IEEE Symposium on Logic in Computer Science.

[27] The Microsoft Research sponsored Grand Challenge in Non-Classical Computation International Workshop

[28] SPIE := The International Society for Optical Engineering.

[29] AIP := The American Institute of Physics.

49. B. Coecke, D.J. Moore and A. Wilce: Operational Quantum Logic: An Overview. In *Current Research in Operational Quantum Logic: Algebras, Categories, Languages*, pp. 1–36, B. Coecke, D.J. Moore and A. Wilce, Eds., Fundamental Theories of Physics (series), Kluwer Academic Publishers, 2000 ; arXiv: quant-ph/0008019.

50. B. Coecke and D.J. Moore: Operational Galois Adjunctions. In *Current Research in Operational Quantum Logic: Algebras, Categories, Languages*, pp. 195–218, eds., B. Coecke, D.J. Moore and A. Wilce, Fundamental Theories of Physics (series), Kluwer Academic Publishers, 2000 ; arXiv:quant-ph/0008021.

51. B. Coecke, D.J. Moore and S. Smets: Logic of Dynamics & Dynamics of Logic: Some Paradigm Examples. In *Logic, Epistemology and the Unity of Science*, pp. 527–556, S. Rahman, J. Symons, D. M. Gabbay and J.-P. Van Bendegem, Eds., Kluwer, 2004 ; arXiv:math.LO/0106059.

52. B. Coecke: Introducing Category Theory to Practicing Physicists. In *What is Category Theory?* G. Sica, Ed., Advanced Studies in Mathematics and Logic (series), Polimetrica.

53. S. Abramsky and B. Coecke: Axiomatic Description of Compound Systems. In *Handbook of Quantum Logic.* K. Engesser, D. M. Gabbay and D. Lehmann, Eds. (in preparation)

54. S. Abramsky and B. Coecke: Categorical Quantum Logic. In *Handbook of Quantum Logic.* K. Engesser, D. M. Gabbay and D. Lehmann, Eds. (in preparation)

Conference Proceedings (unrefereed):

55. D. Aerts, S. Aerts, B. Coecke, B. D'Hooghe, T. Durt and F. Valckenborgh: A Model with Varying Fluctuations in the Measurement Context. In *Fundamental Problems in Quantum Physics II*, pp. 7–9, M. Ferrero, A. van der Merwe, Eds., Fundamental Theories of Physics (series), Kluwer Academic Publishers, 1997.

56. B. Coecke, B. D'Hooghe and F. Valckenborgh: Classical Physical Entities with a Quantum Description. In *Fundamental Problems in Quantum Physics II*, pp. 103–107, M. Ferrero, A. van der Merwe, Eds., Fundamental Theories of Physics (series), Kluwer Academic Publishers, 1997.

57. B. Coecke: Discretization and Determination in Quantum History Theories. In *Quantum Probability and White Noise Analysis* XIII, pp. 85–94, A. Khrennikov, Ed., World Scientific, 2001 ; arXiv:quant-ph/ 0105085.

INVITED TALKS (59)

Invited Talks at Workshops and Conferences:

1. B. Coecke: Quantaloids Describing Propagation of Physical Properties. At *Categorical Methods in Algebra and Topology*, Nassogne, Belgium, June 1999.

2. B. Coecke: Why Quantales of Physical Inductions? At *Quantales and their Applications*, Instituto Superior Téchnico, Lisbon, July 2002.

3. B. Coecke: Towards Multiplicative Domains. At *Quantales and their Applications*, Instituto Superior Téchnico, Lisbon, July 2002.

4. B. Coecke: Probability = Logic + Partiality + Entropy. At *Seminar on Logic and Informatics 2003*. Free University of Brussels, March 2003.

5. B. Coecke: Probability from Logic. At *Quantum Logic meets Quantum Information*. A special session at *Quantum Theory: Reconsideration of the Foundations 2*. Vaxjo, Sweden, June 2003.

6. B. Coecke: Entanglement Specification. At *Quantum Programming Languages*. Workshop at the *Fields Institute Summer School on Logic and Foundations of Computation*. University of Ottawa, June 2003.

7. B. Coecke: Processes in Computing and Physics. At *Causality in Computer Science and Physics*. Workshop at the IEEE *Symposium on Logic in Computer Science* (LiCS). University of Ottawa, June 2003.

8. B. Coecke: Probability as Order. *Applications of Lattice Theory and Ordered Sets to Computer Science*. Workshop at the *Center for Discrete Mathematics and Theoretical Computer Science* (DIMACS). Rutgers University, New Jersey, July 2003.

9. B. Coecke: Categories and Processes. At *Ramifications of Category Theory. A workshop Dedicated to F. W. Lawvere.* Florence, November 2003.

10. B. Coecke: Partial orders for Computing, Physics and Probability. At the *Joint Mathematics Meetings. AMS Special session on The Many Lives of Lattice Theory and the Theory of Ordered Sets, with Connections to Combinatorics.* Phoenix, Arizona, January 2004.

11. B. Coecke: The Logic of Entanglement. At *Philosophical Logic meets Mathematical Logic: from Classical to Quantum*. Free University of Brussels, February 2004.

12. S. Abramsky and B. Coecke (6 lectures): Tutorial on Categorical Quantum Mechanics. At *Logical and Semantical Methods in Quantum Computation*. Workshop at the *Bellairs Research Centre* of McGill University, Barbados, April 2004.

13. B. Coecke: Quantum Information-Flow. At *Perspectives workshop "Quantum Computing"*. *Dagstuhl Seminar 04202*. Dagstuhl, Germany, May 2004.

14. B. Coecke: Categorical Quantum Logic. Prize Lecture as receiver of *The 2004 Biennial Prize for Meritorious Research in the Field of Quantum Structures* of the *International Quantum Structures association* at the *7th Biannual International Quantum Structures Association Meeting* (QS'04), Denver, July 2004.

15. B. Coecke: Abstract Quantum Mechanics. At *Spatial Representation: Discrete vs. Continuous Computational Models*. *Dagstuhl Seminar 04351*. Dagstuhl, Germany, August 2004.

16. B. Coecke: Quantum Information Flow. At *Quantum Informatics 2004*. Moscow, Russia, October 2004.

17. B. Coecke: Probabilities in abstract Quantum Mechanics. At *Workshop on Probabilistic Semantics.* Imperial College, London, November 2004.

18. B. Coecke: The Logic of Quantum Mechanics — Take II. At *Mathematical Structures for Quantum Computation.* Université Paris 7, December 2004.

19. B. Coecke: Strange Encounters. At *Causality, Spacetime Topology and Domain Theory*. Workshop at the *Bellairs Research Centre* of McGill University, Barbados, April 2005.

20. B. Coecke: Strong Compact Closed Semantics. At the *Quantum Computing* special session of the *Twenty-first Conference on the Mathematical Foundations of Programming Semantics* (MFPS XXI). University of Birmingham, May 2005.

21. B. Coecke: Axiomatic Description of Quantum Entanglement ... of Quantum Mechanics ... and of Quantum Informatics. At *Quantum Theory: Reconsideration of the Foundations III*. Vaxjo, Sweden, June 2005.

22. B. Coecke: Category Theory for the 21st Century Physicist. Tutorial at the Summer School preceding *Quantum Information, Computation and Logic: Exploring New Connections*. Perimeter Institute For Theoretical Physics, Waterloo, Canada, July 2005.

23. B. Coecke: Kindergarten Quantum Mechanics. At *Quantum Information, Computation and Logic: Exploring New Connections*. Perimeter Institute For Theoretical Physics, Waterloo, Canada, July 2005.

24. B. Coecke: From Coherence to Quantum. At *The Impact of Categories: 60 Years of Category Theory in Historical and Philosophical Retrospect*, Ecole Normale Superieure, Paris, October 2005.

25. B. Coecke: Picturing Quantum Informatics. At *Mathematical Theory of Quantum Computation and Quantum Technology*, Texas A&M University, November 2005.

26. B. Coecke: The Logic of Quantum Information. At *The 2006 Association of Symbolic Logic Annual Meeting*, Montreal, May 2006.

27. B. Coecke: Quantum Information: From Domains to Categories. At *Computational Structures for Modelling Space, Time and Causality*. *Dagstuhl Seminar 06341*. Dagstuhl, Germany, August 2006.

Invited Participation to Discussion as Delegate:[30]

28. B. Coecke: [speechless] At *The Grand Challenge in Non-Classical Computation*. Microsoft Research Sponsored International Workshop at York University, UK, 2005.[31]

[30] I indeed had all my expenses covered just to be there.

[31] `http://www.cs.york.ac.uk/nature/workshop/`

Invited Talks at Departments and Research Institutes:

29. B. Coecke: A Deterministic Alternative for non-Kolmogorovian Probability Structures. At 'Department of Physics', University of Utrecht, The Netherlands, December 1994.
30. B. Coecke: Heyting Completion, Quantum Logic with an Intuitionistic Implication and Categories for State Transition. At 'Department of Algebra a Geometry', Masaryk University, Brno, November 1999.
31. B. Coecke: Operational Quantum Logic: History (as Branch of Mathematics) and Recent Developments (on Categories and Processes). At the *Theory of Computation Seminar*, Instituto Superior Téchnico, Lisbon, June 2000.
32. B. Coecke: Quantum Logic: Overview, Intuitionistic Perspective, Dynamical/Categorical Developments. At 'Centro de Matemática', University of Coimbra, Portugal, June 2000.
33. B. Coecke: From Birkhoff-von Neumann to Eilenberg-Mac Lane: Logic and Categories for the Digesting Physicist. At 'Department of Pure Mathematics', University of Cambridge, February 2001.
34. B. Coecke: Waves, Quantum and Space: Blending Physics, Music and Language. At the Art Institute of Chicago, April 2001.
35. B. Coecke: Dynamic Operational Quantum Logic: Towards a Logic for Quantum Gravity and Quantum Processes. At 'Department of Mathematics and Statistics', University of Ottawa, May 2001.
36. B. Coecke: Physical Realization of the Traced Monoidal Category of Finite Dimensional Vector Spaces. At 'Department of Mathematics and Statistics', McGill University, Montreal, December 2001.
37. B. Coecke: Physical Traces: Quantum versus Classical Process Networks. At 'Department of Mathematics and Statistics', University of Ottawa, April 2002.
38. B. Coecke: Observables Without Values and Probability Without Numbers. At 'Theoretical Physics Group', Imperial College of Science, Technology and Medicine, London, June 2002.
39. B. Coecke: The Logic of Entanglement. At 'Laboratoire d'Informatique Théorique et Quantique', Université de Montréal, November 2003.
40. B. Coecke (2 lectures): Abstract Quantum Mechanics I & II. At 'Department of Mathematics and Statistics', McGill University, Montreal, March 2004.
41. B. Coecke: Algebraic Logic, Categorical Logic and Game Semantics. At 'Logic and Foundations of Mathematics Research Seminar', Université de Québec a Montréal, March 2004.
42. B. Coecke: Abstract Quantum Mechanics. At 'Department of Mathematics and Statistics', University of Ottawa, March 2004.
43. B. Coecke (2 lectures of 3 hours): Quantum, Concretely, Abstractly. At 'Laboratoire des Preuves, Programmes et Systèmes' (PPS-CNRS), Université Paris 7, May 2004.
44. B. Coecke: Automated Quantum Reasoning. At 'School of Computer Science', University of Birmingham, August 2004.
45. S. Abramsky and B. Coecke (shared double slot): Abstract Quantum Mechanics: High-Level Methods for Quantum Computation and Information. At 'Logic and Semantics Seminar', Computer Laboratory, University of Cambridge, December 2004.
46. B. Coecke: Abstract Quantum Mechanics. At 'Department of Computer Science', University of Leicester, January 2005.
47. B. Coecke: Abstract Quantum Mechanics III: Abstract Quantum Mechanics III: De-linearizing Linearity. At 'Department of Mathematics and Statistics', McGill University, Montreal, April 2005.
48. B. Coecke: Quantum Pictures. At 'Kestrel Institute', Palo Alto, Silicon Valley, California, July 2005.[32]
49. B. Coecke: Quantum Pictures. At 'Google', Mountain View, Silicon Valley, California, July 2005.

[32] My honorarium for this talk included a shirt and a head with a little kestrel (=bird) on it, besides a very generous coverage of travel and local expenses. Kestrel institute is a very hospital computer science research institute!

Invited Talks at the Oxford - Imperial College Quantum Workshops (QUOXIC):[33]

50. B. Coecke: The Logic of Entanglement. At QUOXIC 1, Imperial College, October 2003.
51. B. Coecke: Reasoning about Quantum Behavior. At QUOXIC 3, Imperial College, December 2003.
52. S. Abramsky and B. Coecke (shared 4 hour slot): Abstract Quantum Mechanics. At QUOXIC 5, Imperial College, February 2004.
53. B. Coecke: From von Neumann to QUOXIC. At QUOXIC 09, Merton College, Oxford, December 2004.
54. B. Coecke: From von Neumann to QUOXIC II. At QUOXIC 11, Merton College, Oxford, February 2005.
55. B. Coecke: Kindergarten Quantum Mechanics. At QUOXIC 13, Merton College, Oxford, June 2005.

Invited Talks at other Department of Own University:

56. B. Coecke: Hidden Measurement Systems and Hidden Correlation Systems. At the *Centre for Logic and Philosophy of Science*, Free University of Brussels, November 1996.
57. B. Coecke: Constructivism and Deduction in Physical, Mathematical and Computational Logic. At the *Oxford Society for Physics and Philosophy Seminar*, Oxford University, November 2001.[34]
58. B. Coecke: Observables Without Values and Probability Without Numbers. At the *Philosophy of Physics Research Seminar*, Oxford University, June 2002.
59. B. Coecke: Probability as Order. At *Analytic Topology in Mathematics and Computer Science Research Seminar*, Mathematical Institute, Oxford University, April 2003.

TALKS AND POSTERS THROUGH SUBMISSION

Presentation of accepted (full) Conference Papers:

60. S. Abramsky and B. Coecke: Physical Traces: Quantum vs. Classical Information Processing. At *Category Theory and Computer Science* (CTCS'02), Ottawa, August 2002.
61. B. Coecke: Entropic Geometry from Logic. At the *19th Conference on the Mathematical Foundations of Programming Semantics* (MFPS'03), McGill University, Montreal, March 2003.
62. B. Coecke: Quantum, Concretely, Abstractly. At the *Quantum Programming Languages* (QPL II) workshop of the *19th Annual IEEE Symposium on Logic in Computer Science* (LiCS'04), July 2004.
63. S. Abramsky and B. Coecke: A Categorical Semantics of Quantum Protocols. At the *19th Annual IEEE Symposium on Logic in Computer Science* (LiCS'04), July 2004.
64. B. Coecke: De-linearizing Linearity. At the *Quantum Programming Languages* (QPL III) workshop of the *20th Annual IEEE Symposium on Logic in Computer Science* (LiCS'05), July 2005.

Presentation of accepted (full) Conference Papers by a Co-author:

65. A. Baltag, B. Coecke and M. Sadrzadeh: Epistemic Actions as Resources. At the *Logics for Resources, Processes and Programs* workshop of the *19th Annual* IEEE *Symposium on Logic in Computer Science* (LiCS'04), July 2004.
66. A. Baltag, B. Coecke and M. Sadrzadeh: An Algebra and Sequent Calculus for Epistemic Actions. At the *Logic and Communication in Multi-Agent Systems* (LCMAS'04) workshop of the *16th European Summer School in Logic, Language and Information* (ESSLLI'04), Nancy, France, August 2004.
67. A. Baltag, B. Coecke and M. Sadrzadeh: Reasoning about Dynamic Epistemic Logic. At the *2nd European Workshop on Multi-Agent Systems*, Barcelona, December 2004.

Conference lectures through abstract submission:

68. D. Aerts and B. Coecke: Topologies for State-Space Representations of the Epsilon-model, Including Classical Limit. At the *3rd Winter school on Measure Theory*, Liptovski Jan, Slovakia, February 1993.

[33] `http://www.physics.ox.ac.uk/users/quoxic/` — currently jointly hosted by Merton College Oxford and the Imporial College Quantum Optics group and sponsored by Oxford's Materials Department.

[34] My honorarium for this talk was a bottle of a very good single malt Scotch Whisky, something which should happen more often.

69. B. Coecke: A General Approach for Physical Measurements that Allows the Introduction of non-Ontological Probabilities. At the *4th Winter school on Measure Theory*, Liptovski Jan, Slovakia, February 1995.

70. B. Coecke: Representation of a Spin-1 Entity and Description of Joint Systems in Quantum Mechanics. At the *Symposium on Quantum Structures and the Nature of Physical Reality*, Brussels, May 1995.

71. B. Coecke: A General Approach for Physical Measurements that Allows an Introduction of non-Ontological Probabilities. At the *10th International Congress of Logic, Methodology and Philosophy of Science*, Florence, Italy, August 1995.

72. B. Coecke: Macroscopical Physical Entities with a Quantum Description. At the *2nd International Conference on Fundamental Problems in Quantum Physics*, Oviedo, Spain, July 1996.

73. B. Coecke: A Compatible Axiomatics for Context Dependence and for Correlations. At the *3rd International Quantum Structures Association Meeting* (QS'96), Berlin, Germany, August 1996.

74. B. Coecke: A Representation of Compound Quantum Systems as Individual Entities: Hard Acts of Creation and Hidden Correlations. At the *6th U.K. Conference on Conceptual and Mathematical Foundations of Modern Physics*, University of Hull, September 1997.

75. B. Coecke: Propagation of States, Properties and Context Dependent Components in Consecutive Measurements. At *1997's International Quantum Structures Conference* (QS'97), Atlanta, October 1997.

76. B. Coecke: Compound Systems seen through an Operational Resolution. At the *4th International Quantum Structures Association Meeting* (QS'98), Liptovski Jan, Slovakia, September 1998.

77. B. Coecke and D.J. Moore: Dualizing Temporal Causation and Propagation of Properties through the Galois Connection. At the *23th Holliday Mathematics Symposium: Algebraic Structures for Logic*, New Mexico State University, Las Crucas, January 1999.

78. B. Coecke and D.J. Moore: Properties, Causation, Propagation, Compoundness and Interaction, Adjunctions, Quantaloids. At *Current Research in Operational Quantum Logic II*, Brussels, Belgium, May 1999.

79. B. Coecke, D.J. Moore and I. Stubbe: Quantaloids Describing Propagation of Physical Properties. At *Category Theory '99* (CT'99), Coimbra, Portugal, July 1999.

80. B. Coecke: Quantum Logic in Intuitionistic and Dynamical Perspective. At the workshop *Current Research in Operational Quantum Logic III*, Brussels, Belgium, April 2000.

81. B. Coecke: Classification of Classical Representations for Quantum-Like System via a Minimal Axiomatics for Context Dependence. At *Foundations of Probability and Physics*, Vaxjö, Sweden, November 2000.

82. B. Coecke: Intuitionistic and Dynamic Quantum Logic. At the *5th Biannual International Quantum Structures Association Meeting* (QS'01), Cesena, Italy, March 2001.

83. S. Abramsky and B. Coecke: Physical Traces: Doing Geometry of Interaction in the Lab. At *Geometry of Proofs and Computations. Logic and Interaction Weeks at CIRM*, Marseille, France, February 2002.

84. B. Coecke and K. Martin: The Domain Theoretic Nature of Quantum Mechanics. At the *18th Workshop on the Mathematical Foundations of Programming Semantics* (MFPS'02), Tulane University, New Orleans, March 2002.

85. B. Coecke and K. Martin: A Partial Order on Classical and Quantum States. At the *6th Biannual International Quantum Structures Association Meeting* (QS'02), Vienna, Austria, July 2002.

86. B. Coecke and K. Martin: Probability without Numbers and Time as a Measure of Content. At the *11th UK Conference on Foundations of Physics*, Oxford, September 2002.

Posters through abstract submission:

87. B. Coecke: A Real Space Model for Quantum Mechanics. At the *2nd International Quantum Structures Association Meeting* (QS'94), Prague, Czech Republic, August 1994.

88. B. Coecke, D.J. Moore and I. Stubbe: Categorical Quantum Process Semantics. At *Category Theory 2000* (CT'00), Como, Italy, July 2000.

89. S. Abramsky and B. Coecke: Physical Traces: Quantum vs. Classical Information Processing. At the *6th Biannual International Quantum Structures Association Meeting* (QS'02), Vienna, Austria, July 2002.

90. B. Coecke and S. Smets: Interpreting Orthomodularity Dynamically. At the *6th Biannual International Quantum Structures Association Meeting* (QS'02), Vienna, Austria, July 2002.

PRESENTATIONS AT OWN DEPARTMENT

91. B. Coecke: A Deterministic Alternative for non-Kolmogorovian Probability Structures. At 'Department of Physics', Free University of Brussels, January 1995.
92. B. Coecke: From Birkhoff-von Neumann to Eilenberg-Mac Lane: Categories for the Digesting Physicist. At 'Theoretical Physics Group', Imperial College, London, February 2001.
93. B. Coecke (2 lectures): From Birkhoff-von Neumann to Eilenberg-Mac Lane: Categories for the Digesting Physicist I & II. At 'Department of Mathematics and Statistics', McGill University, Montreal, March 2001.
94. B. Coecke: Questions on Physical Logicality vs. Constructivism and Resource Sensitive Provability. At 'Department of Mathematics and Statistics', McGill University, Montreal, September 2001.
95. B. Coecke: Quantum Logic: The Great Fiasco, or, ... Mistificational Corruption, ... At *Foundations of Computer Science Reserach Seminar*, Oxford University Computing Laboratory, October 2001.
96. B. Coecke: Physical Traces: Quantum vs. Classical Process Networks. At *Foundations of Computer Science Reserach Seminar*, Oxford University Computing Laboratory, February 2002.
97. B. Coecke and K. Martin (each took half of the talk time): The Qualitative beneath the Quantitative. At *Analysis of Informatic Phenomena Seminar*, Oxford University Computing Laboratory, March 2002.
98. B. Coecke: Probability from Logic. At *Analysis of Informatic Phenomena Seminar*, Oxford University Computing Laboratory, January 2003.
99. B. Coecke: Orthomodularity. At *Foundations of Computer Science Research Seminar*, Oxford University Computing Laboratory, February 2003.
100. B. Coecke (2 Lectures): Abstract Quantum Mechanics fur Dummies. At *Foundations of Computer Science Reserach Seminar*, Oxford University Computing Laboratory, February 2005.

FOR REFERENCES

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