

## CURRICULUM VITAE

## SERGE MASSAR

- **PERSONAL INFORMATION**

Family name, First names: MASSAR, Serge Alexandre

Researcher unique identifier: <http://orcid.org/0000-0002-4381-2485>

Nationality: Belgium and USA

Date of birth: 11 February 1970

Marital status: Divorced, 3 children

Languages: bilingual English-French

Web: <http://liq.ulb.ac.be>

- **EDUCATION**

2003: Agrégation de l'enseignement supérieur, Université libre de Bruxelles: Title of thesis: *Quantum information theory*.

1995: PhD in Sciences, Université libre de Bruxelles with highest honours (« la plus grande distinction »). Promotor: Prof. R. Brout. Title of thesis: *From vacuum fluctuations to radiation: pair creation in the presence of external electric fields, accelerated detectors, accelerated mirrors and black holes*.

1991: Master in Physical Sciences, Université libre de Bruxelles. With highest honours (« la plus grande distinction »)

- **CURRENT POSITION**

2018-present : Professeur Ordinaire at Université libre de Bruxelles, Belgium (permanent position)

- **PREVIOUS POSITIONS**

2013-2018: Professeur at ULB, Belgium (permanent position)

2012-2013: Chargé de Cours at ULB, Belgium (permanent position)

2008-2012: Research Director of the F.R.S.-F.N.R.S at ULB, Belgium (permanent position)

2003-2008: Senior Research Associate of the F.R.S.-F.N.R.S at ULB, Belgium (permanent position)

1998-2003: Research Associate of the F.R.S.-F.N.R.S at ULB, Belgium (permanent position)

1997-1998: Postdoctoral Fellow, Utrecht University (Netherlands)

1995-1997: Postdoctoral Fellow, Tel Aviv University (Israel)

1991-1995: PhD Fellow, ULB (Belgium)

- **INSTITUTIONAL RESPONSIBILITIES**

2004-present: Director of the “Laboratoire d’Information Quantique” (LIQ), Physics Department, ULB

2016: Vice-President of the Physics Department, ULB, Belgium

2014-2015: President of the Physics Department, ULB, Belgium

2013: Vice-President of the Physics Department, ULB, Belgium

2011-2012: Member of the “Bureau Facultaire”, Science Faculty, ULB, Belgium

- **FELLOWSHIPS AND AWARDS**

2021-present : Member of the Royal Academy of Science, Letters, and Fine Arts of Belgium

2012: STOC, Best paper award.

2010 : Prix la Recherche (Prix du Ministère).

2003-2004 : Leverhulme visiting Professorship to the University of Bristol

2003: Alcatel Bell Scientific Prize of the F.R.S.-F.N.R.S.

- **SUPERVISION OF GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS**

Currently: supervising 2 PhD students.

Previously: 13 PhD students graduated under my supervision (3 of which now have permanent positions in academia at ULB (two) and Metz), and I have supervised 19 PostDocs (5 of which now have permanent positions in academia at Oxford, Besancon, Grenoble, Cochin, 3-5lab Paris).

- **TEACHING ACTIVITIES**

Courses taught during the past 10 years: General Physics (1<sup>st</sup> year Bachelor for Physics, Math, Chemistry), Physics Laboratories (2<sup>nd</sup> year Bachelor in Physics), Quantum mechanics (2<sup>nd</sup> and 3<sup>rd</sup> year Bachelor in Physics), Quantum Information (1<sup>st</sup> year Master in Physics), Quantum Optics (1<sup>st</sup> year Master in Physics).

- **COMMISSIONS OF TRUST**

- Expert Panel Member for ST2 Fundamental Constituents of Matter, National Science Center (NCN), Poland (2022-present)
- Expert Panel Member for the Academic Research Panel Tier 2 Physics and Engineering Cluster, Ministry of Education (MOE), Singapore (2016-present)
- Member of the selection committee for the Antonella Karlson Prize of the FRS-FNRS (2021)
- Member of the selection committee for the John Stewart Bell prize (2017-2019)
- Member of the scientific commission W&T2: Physics, FWO (Flanders, Belgium) (2014-2019)
- Member of the interdisciplinary scientific commission, FWO (Flanders, Belgium) (2015)
- Member of the scientific commission Sciences Exactes et Naturelles 2, FRS-FNRS (Belgium) (2013)
- Roadmap committee member *Quantum Information Processing and Communication: Strategic report on current status, visions and goals for research in Europe* <http://qurope.eu/content/Roadmap> (2005-2013)
- President of three recruitment committees, Physics Department, ULB (2014)
- Evaluator for promotions and recruitments: National University of Singapore, Ghent University, Bristol University, Rochester Institute of Technology (USA), ULB (Polytechnic Faculty)
- Evaluator of Scientific Projects for the European Union and funding agencies from France, Belgium, Israel, Switzerland, Canada, U.K., Singapore, Poland, Sweden, etc.
- Member of the Editorial Board: Scientific Reports, Sci-Post
- Referee for: Nature, Nature Physics, Nature Comm, PNAS, Phys. Rev. Lett., Phys. Rev. X, etc... (Selected as Outstanding Referee of the Physical Review Journals in 2019)

- **ORGANISATION OF SCIENTIFIC MEETINGS** (last 10 years)

- Member of Program Committee: QIP 2021, TQC 2019, TPNC 2019, QCRYPT 2018, Frontiers in Optics 2017 (Quantum Electronics sub-committee), QCRYPT 2015, SPIE-Photonics Europe (Quantum Optics parallel session) 2014, TQC 2012
- Co-Organiser, *Neuromorphic Information Processing workshop*, ECOC 2019 (Dublin)
- Co-Organiser, *Dynamical systems and brain inspired computing*, Brussels, May 2017
- Co-Organiser, *Surprising AND Unexpected Paradoxes Of Physics Enable SCientific Understanding*, Romania, May 2017
- Co-Organiser, 20<sup>th</sup> Annual Symposium of the IEEE Photonics Benelux Chapter, Brussels, February 2016
- Member Organising Committee, *Dynamical systems and brain-inspired information processing*, Besancon, France, November 2015
- Member of the Local Organising Committee, CEWQO 2014, Brussels, June 2014.
- Co-organiser, *Workshop on Experimental Reservoir Computing*, Besancon, France, 2013
- Co-organiser of the ECCS12 Satellite Meeting *Information processing with recurrent dynamical systems: theory and experiment*, Brussels, September 2012

- **INVITED PRESENTATIONS AT CONFERENCES**

(Last 10 participations in conferences as invited speaker)

- Neuromorphic Photonics (NMP2021), Monte Bondone, Italy
- Photonic Reservoir Computing and Information Processing in Complex Network, Trento, December 2019.
- Workshop on Dynamical Systems and Brain-inspired Information Processing, Konstanz, Germany, July 2019.
- Workshop on Quantum Algorithms and Complexity Theory WQACT18, Singapore, February 2018
- Dynamical systems and brain-inspired information processing, Konstanz, Switzerland, October 2017
- BEYOND! Von Neumann Computing, Berlin, May 2016
- Workshop on Quantum Nonlocality, Causal Structures and Device-independent Quantum Information, Tainan, Taiwan, December 2015
- About various kinds of interactions, Mons, Belgium, June 2015

- Dynamical systems and brain-inspired information processing, Besancon, France, November 2015
- GISIN workshop, Riederalp, Suisse, September 2014

- **GRANTS AND FUNDING**

Partner of the following EU projects: CHIC, RESQ (coordinator), SECOQC, COVAQIAL, QAP (responsible for theory sub-project), QUROPE, QCS, DIQIP, QALGO, QuantAlgo, QRANGE, POST-DIGITAL. I have three times in a row obtained funding from the Belgium Federal Government through the InterUniversity Attraction Poles (IAP) Program (including roles as deputy coordinator and coordinator). I also obtain funds from the French Community of Belgium, from the Region of Brussels-Capital, from the FRS-FNRS and its associated funds, and internally from the ULB.

- **MAJOR COLLABORATIONS**

- Within ULB: M. Haelterman, Ph. Emplit, S.-P. Gorza, P. Kockaert, D. Terwagne, S. Pironio, S. Fiorini, N. Cerf
- National: J. Dambre, P. Bienstman and R. Baets (Gent University), J. Danckaert, G. Verschaffelt, G. van der Sande (VUB).
- International: N. Gisin (Geneva), A. Acin (Barcelona), S. Popescu (Bristol), H. Buhrman and R. de Wolf (CWI, Amsterdam), C. Monroe (Maryland), J.-M. Merolla and K. Phan Huy (Besancon), E. Bente (Technical University of Eindhoven), S. Pokutta (Georgia Tech), D. Dolfi (Thales Research and Technology-France), J.-L. Oudar (LPN, Paris), N. Godbout (Montreal), V. Sacarani (Singapore), M. Santha (Paris and Singapore), P. Antonik and D. Rontani (Centrale Supélec, Metz), F. Duport (3-5 lab, France), D. Brunner and E. Lantz (Université de Franche Comté)

- **RESEARCH INTERESTS**

During my PhD, I studied quantum gravity and in particular black hole evaporation (Hawking radiation). The aim of these works was to understand the gravitational backreaction to the evaporation process. The most important results obtained concerned the role of the transplanckian frequencies needed to explain the origin of the radiation.

Later I started working in the nascent field of quantum information, and this gradually became my main topic of research. Significant contributions concern quantum measurement theory, quantum cloning (together with N. Gisin we introduced the first bounds on the quality of quantum clones), entanglement, quantum non-locality, quantum cryptography. I pioneered the use of non-locality to realize “device independent” quantum cryptographic tasks such as key distribution or random number generation, whose security does not rely on modelling of the internal workings of the devices used. My work in quantum information led to an important offshoot in theoretical computer science when we solved a 20-year old conjecture on the Travelling Salesman Problem.

I also have an activity in experimental quantum optics and non-linear optics. Results obtained include the demonstration of frequency bin entanglement, the generation of photon pairs in micro ring resonators, and the discovery of the remarkable non-linear optical properties of amorphous silicon waveguides.

Recently I have been devoting increasing time to artificial intelligence, machine learning and its relation to complex systems. In this context, I focus on the experimental implementation of the concept of “reservoir computing”. Important results are the first realisation of a new architecture based on a single nonlinear node and a delay loop, of opto-electronic and all-optical reservoirs, of a fully analog system.

I also co-authored 2 papers in biology on the origin of the DNA code and of proteins.

- **SUMMARY OF PUBLICATIONS** (bibliometric information: Google Scholar)

- Patents: 2
- Publications in refereed journals: 143 (including: 1 Nature, 1 Nature Comm., 25 Phys. Rev. Lett, 1 JACM; and 4 review articles (including 1 Phys. Repts. and 1 Rev. Mod. Phys.))
- Conference proceedings: 84 (including: 1 STOC, 1 NIPS, 2 AAAI)
- Non-scientific publications: 6 (including 1 News&Views in Nature Physics and 1 Viewpoint in Physics)
- Total citations: 18.150; h index = 56

**SELECTED PUBLICATIONS.**

10 selected publications illustrating the different fields in which I have worked. (Bibliometric information: Google Scholar)

**Quantum Information Theory.**

1) S. Massar et S. Popescu, *Optimal extraction of information from finite quantum ensembles*, Phys. Rev. Lett. **74**, 1259 (1995). Alphabetical order, 829 citations.

Showed how to realize optimal measurements on quantum systems, and that optimal measurements on product systems could be entangled.

2) N. Gisin et S. Massar, *Optimal quantum cloning machines*, Phys. Rev. Lett. **79**, 2153 (1997). Alphabetical order, 855 citations.

Established the ultimate limits of quantum cloning.

3) D. Collins, N. Gisin, N. Linden, S. Massar, S. Popescu, *Bell inequality for arbitrarily high dimensional systems*, Phys. Rev. Lett. **88** 040404 (2002). Alphabetical order, 1023 citations.

The inequality published in this paper is now known in the literature as the CGLMP inequality, after the initials of the authors.

4) A. Acín, N. Brunner, N. Gisin, S. Massar, S. Pironio, V. Scarani, *Device-independent security of quantum cryptography against collective attacks*, Phys. Rev. Lett. **98**, 230501 (2007). Alphabetical order, 1486 citations.

The term “device independent” introduced in the title of this paper has now become standard in the field.

5) S Pironio, A Acín, S Massar, A. Boyer de La Giroday, D. N. Matsukevich, P. Maunz, S. Olmschenk, D. Hayes, L. Luo, T A. Manning, C. Monroe, *Random numbers certified by Bell’s theorem*, Nature **464**, 1021-1024 (2010). First 3 authors are joint first authors, 1291 citations.

S. Pironio, A. Acin, S. Massar (first 3 authors) were awarded the 2010 La Recherche prize for this work. Showed that non locality could be used to certify random number generators. The theoretical analysis was accompanied by an experimental demonstration by the team of C. Monroe.

**Theoretical Computer Science.**

6) S. Fiorini, S. Massar, S. Pokutta, H. R. Tiwary, R. de Wolf, *Linear vs. Semidefinite Extended Formulations: Exponential Separation and Strong Lower Bounds*, in Proceedings of STOC 2012 (ACM, New York), page 95. Alphabetical order, 252 citations.

Won the best paper award at the highly competitive Symposium on the Theory of Computing (STOC). Journal version published in 2015 by invitation to JACM, the premier theoretical computer science journal. Discussed on several computer science blogs, including selected both as best paper of the year 2012 and as one of the 10 best paper of the decade 2005-14 on the *Complexity Blog* of Lance Fortnow.

**Experimental Quantum Optics.**

7) S. Clemmen, K. Phan Huy, W. Bogaerts, R. G. Baets, Ph. Emplit, S. Massar, *Continuous wave photon pair generation in silicon-on-insulator waveguides and ring resonators*, Optics Express **17**, 16558-16570 (2009). Last author, 302 citations.

8) L. Olislager, J. Cussey, A. T. Nguyen, Ph. Emplit, S. Massar, J.-M. Merolla, K. Phan Huy *Frequency bin entangled photons*, Phys. Rev. A **82**, 013804 (2010). Joint last author, 183 citations.

**Reservoir Computing**

9) L. Appeltant, M. C. Soriano, G. Van der Sande, J. Danckaert, S. Massar, J. Dambre, B. Schrauwen, C. R. Mirasso, I. Fischer, *Information processing using a single dynamical node as complex system*, Nature Communications **2**, 468 (2011). Co-author, 993 citations.

First analog reservoir computer with performance comparable to digital implementations.

10) Y. Paquot, F. Duport, A. Smerieri, J. Dambre, B. Schrauwen, M. Haelterman, S. Massar, *Optoelectronic Reservoir Computing*, Scientific Reports **2**, 287 (2012). Last author, 599 citations.

High-speed reservoir computer, capable of real time information processing.