

FRÉDÉRIC HOLWECK

Associate Professor (Mathematics and Applications of Mathematics)

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Employement

- Since 2014 Associate Professor at University of Technology of Belfort-Montbéliard (UTBM).
- 2006-2014 Teaching Position (Agrégation de Mathématiques) at UTBM.
- 2005-2006 Teaching Position (Professeur Agrégé), Highschool, Decazeville, France.
- 2004-2005 Teaching Position, Highschool, Cahors, France.
- 2003-2004 Research and Teaching assistant (A.T.E.R) Toulouse University, France.
- 2001-2002 Teaching Assistant at Georgia Institute of Technology, Atlanta, USA.
- 2000-2003 Research assistant (PhD grant) Toulouse University, France.

Education

- 2019 Habilitation thesis (09/11/2020) from University Bourgogne Franche-Comté (UBFC)
On the projective geometry of entanglement and contextuality
- 2005 French Agrégation of Mathematics (option: numerical analysis).
- 2000-2004 PhD (10/09/2004) from Toulouse University, Supervisor Joseph Landsberg.
*Singular Locus of Dual Varieties:
Geometrical approach and applications to homogeneous varieties*
- 2000-2002 Visiting graduate student at Georgia Institute of Technology, Atlanta.
- 1998-2000 Master Research in Pure Mathematics (with honors) from Toulouse University III.
Master Thesis, Supervisor Joseph Landsberg.
Geometrical Construction of Simple Lie Algebras.
- 1995-1998 Bachelor in Mathematics, Toulouse University.
Bachelor Thesis, Supervisor Thomas Fiedler.
Singularities of Hypersurfaces following Milnor.

Publications

• Research papers

1. [avec H. Jaffali] Quantum entanglement involved in Grovers and Shors algorithms: the four-qubit case. *Quantum Information Processing*, 18(5), 133. (2019).
2. [with P. Lévy] Finite geometric toy model of spacetime as an error correcting code. *Physical Review D*, 99(8), 086015. (2019)
3. [with M. Saniga, Jérôme Boulmier, Maxime Pinar] Veldkamp Spaces of Low-Dimensional Ternary Segre Varieties. *Results in Mathematics* 74 (1), 54 (2019).
4. Geometric constructions over \mathbb{C} and \mathbb{F}_2 for Quantum Information. In *Quantum Physics and Geometry*, Lecture Notes of the Unione Matematica Italiana Springer (2019).
5. [avec P. Lévy] A fermionic code related to the exceptional Lie group E_8 . *Journal of Physics A: Mathematical and Theoretical* (2018).
6. [avec P. Lévy, M. Saniga] The magic three-qubit Veldkamp line: A finite geometric underpinning for form theories of gravity and black hole entropy. *Physical Review D* (2017).
7. [with M. Saniga] *Contextuality with a small number of observables*. *International Journal of Quantum Information* (2017).
8. [with R. Cai, F. Zhi-Qiang, F. Peyraut] *A simple polyconvex strain energy density with new invariants for modeling four-fiber family biomaterials*. *International Journal of Solids and Structures* 115 (2017): 126-139.

9. [with M. Saniga, P. Pracna] Veldkamp spaces: From (Dynkin) diagrams to (Pauli) groups. *International Journal of Geometric Methods in Modern Physics* 14 (05) 1750080 (2017).
10. [with J.-G. Luque and J.-Y. Thibon] *Entanglement of four-qubit systems: a geometric atlas with polynomial compass II (the tame world)*. *Journal of Mathematical Physics* 58.2 (2017): 022201.
11. [with H. Jaffali] Three-qutrit entanglement and simple singularities. *Journal of Physics A: Mathematical and Theoretical* (2016) 49(46).
12. [with H. Jaffali et I. Nounouh] *Grover's algorithm and the secant varieties*. *Quantum Inf Processing* (2016) doi:10.1007/s11128-016-1445-2.
13. [with P. Levay] *Classification of multipartite systems featuring only $|W\rangle$ and $|GHZ\rangle$ genuine entangled states*. *Journal of Physics A: Mathematical and Theoretical* 49 (8), 085201 (2016) (arXiv:1501.03621)
14. [with M. Saniga, P. Pracna] *Cayley-Dickson Algebras and Finite Geometry*. Mathematics (MDPI).
15. [with R. Cai, F. Zhi-Qiang, F. Peyraud] *A new hyperelastic model for anisotropic hyperelastic materials with one fiber family*. *International Journal of Solids and Structures* (2016).
16. [with P. Levay] *Embedding qubits into fermionic Fock space, peculiarities of the four-qubit case*. *Physical Review D* (2015); 91(12). DOI:10.1103
17. [with M. Saniga, H. Havlicek, M. Planat, P. Pracna] *Veldkamp-Space Aspects of a Sequence of Nested Binary Segre Varieties*. *Annales de l'Institut Henri Poincaré D* vol 2. No 3. (2015)
18. [with M. Planat, A. Giorgetti, M. Saniga] *Quantum contextual finite geometries from dessins d'enfants*. *International Journal of Geometric Methods in Modern Physics* (2015): 1550067
19. [with Anh-Tuan Ta, N. Labeled, A. Thionnet and F. Peyraud] *A constructive approach of invariants of behavior laws with respect to an infinite symmetry group - Application to a biological anisotropic hyperelastic material with one fiber family*. *International Journal of Solids and Structures* 51 (21), 3579-3588.
20. [with M. Saniga and P. Lévy] *A Notable Relation Between N -Qubit and 2^{N-1} -Qubit Pauli Groups via Binary $LGr(N, 2N)$* . *SIGMA* 10 (2014), 041
21. [with J.-G. Luque and M. Planat] *Singularity of type D_4 arising from four qubit systems*. *Journal of Physics A: Mathematical and Theoretical* 47 (2014) 135301 doi:10.1088/1751-8113/47/13/135301.
22. [with J.-G. Luque et J.-Y. Thibon] *Entanglement of four qubit systems: A geometric atlas with polynomial compass I (the finite world)*. *Journal of Mathematical Physics* 55 (2014) (1), 012202.
23. [with Anh-Tuan Ta, N. Labeled, A. Thionnet and F. Peyraud] *A new invariant-based method for building behaviour laws - application to a biological anisotropic hyperelastic material*. *International Journal of Solids and Structures* (2013), 7p.
24. [with M. Planat and M. Saniga] *Distinguished three-qubit "magicity" via automorphisms of the split Cayley hexagon*. *Quantum Information Processing*. DOI 10.1007/s11128-013-0547-3 (2013), 15p.
25. [with J.-G. Luque and J.-Y. Thibon] *Geometric descriptions of entangled states via auxiliary varieties*. *Journal of Mathematical Physics* 54 (2012), 30p.
26. *Singularities of duals of Grassmannians*. *Journal of Algebra* 337 (2011), 15p.

• **Book**

1. [with J.-N. Martin] *Geometries for Engineers* (in French). Ed. Ellipses (Février 2013), 480p.

PhD Supervisions

- Co-supervisor of the PhD thesis of Grace Amouzou. Grace is registered in a dual PhD program between UBFC and University of Lomé (Togo). She started her PhD in Fall 19 and works on Mermin's polynomials to evaluate entanglement.
- Co-supervisor of the PhD thesis of Henri de Boutray. Henri works on proof and specification of quantum programs. Henri is in his second year of the PhD program.
- Supervisor of the PhD thesis of Hamza Jaffali. Hamza works on quantifying entanglement in quantum algorithm by means of geometric techniques. Hamza is supported by the PHYFA (2017-2020) and he is expected to defend his thesis in June 2020.
- Co-supervisor of the PhD thesis of Renye Cai who designed new behaviour laws for anisotropic materials. Renye defended her PhD in March 2017.
- Co-supervisor of the PhD thesis of Anh-Tuan Ta on the application of invariant theory for behaviour laws of anisotropic materials. Anh-Tuan defended his thesis in September 2014.

Research Project Grants

- 2019-2022: Regional mobility grant to spend a sabbatical at Auburn University. Expected dates of mobility July 20 – June 21. **Funding** 33k€.
- 2018-2019: french-PI of the bilateral project *Finite geometry shaping quantum information*. Mobility grant between France and Slovakia financed by Campus France (Stefanik 2018). **Funding** 12k€.
- 2018: UTBM mobility grant for international research invitation (2 months). **Funding** 12k€.
- 2017-2020 : co-PI of the research project PHYFA (Photonic platform for hyperentanglement in frequencies and applications) supported by the region Bourgogne Franche-Comté. **Funding** 250k€+PhD contract.
- 2017-2020 : PI of the research project I-QUINS (Integrated QUantum INFORMATION at the NanoScale), supported by the French program "Investissement d'Avenir". ANR within the I-SITE BFC ANR-15-IDEX-03. **Funding** 150k€.
- 2016 : Regional grant for international senior researcher invitation (4 months). **Funding** 21k€.
- 2015 : UTBM Research grant (BQR) *Quantum Information Semester*. **Funding** 2.5k€.
- 2015 : Regional grant for international senior researcher invitation (4 months). **Funding** 21k€.
- 2013 : French Research National Center (CNRS) grant for exploring research in quantum computing. **Funding** 10k€.

Journals reviewing

- Journal of Physics A: Mathematical and Theoretical
- Quantum Information Processing
- Communications in Mathematical Physics
- SIAM Journal on Matrix Analysis and Applications (SIMAX)

Talks & Invitations

- 25/10/2019 *The geometry of Mermin pentagram*
au 31/10/2019 Stay at the Slovak Institute of Astronomy invited by Metod Saniga
Slovak Academy of Science, Tatranská Lomnica.
- 14/04/2019 Colloquium *Projective duality and quantum information*
au 22/04/2019 Stay at Auburn University invited by Luke Oeding
22/02/2019 *Finite Geometries and Associated Algebras Shaping Quantum Information III*
au 28/02/19 Stay at the Slovak Institute of Astronomy invited by Metod Saniga
Slovak Academy of Science, Tatranská Lomnica.
- 25/11/2018 *Finite Geometries and Associated Algebras Shaping Quantum Information II*
au 30/11/18 Stay at the Slovak Institute of Astronomy invited by Metod Saniga
Slovak Academy of Science, Tatranská Lomnica.
- 15/04/2018 *Finite Geometries and Associated Algebras Shaping Quantum Information*
au 20/04/18 Stay at the Slovak Institute of Astronomy invited by Metod Saniga
Slovak Academy of Science, Tatranská Lomnica.
- 27/11/2017 *What representation theory tells us about Quantum Information (and vice versa)*
Seminar *Functional analysis and Quantum Information*
LMB, Besançon
- 1/10/2017 *Split Octonion and the three qubit Pauli group*
au 6/10/2017 Stay at the Slovak Institute of Astronmy, invited by Metod Saniga
Slovak Academy of Science, Tatranská Lomnica.
- 3/07/2017 *Quantum Physics and Geometry*
au 7/06/2017 Invited speaker
Levico Terme, Italy
- 4/09/2016 *Finite geometries behind quantum contextuality*
au 8/09/2016 Stay at the Slovak Institute of Astronmy invited by Metod Saniga
Slovak Academy of Science, Tatranská Lomnica.
- 14/06/2016 *Geometry of Entanglement*
Talk for the *UBFC Quantum Information days*
UTBM
- 18/11/2015 *Quantum Computation*
Philosophy seminar, Laboratory Logique et l'Agir
Besançon University
- 14/09/2015 *Entanglement in Grover's quantum algorithm*
to 17/09/2015 "Conferences Mathematics, Computer science and discrete structures"
Rouen University
- 28/05/2015 *Entanglement of multipartite systems, Fock space and Spinor varieties*
Quantum Information Theory seminar
Munich Technical University
- 23/02/2015 *Finite Geometrical Aspect of Quantum Theory*
to 27/02/2015 One week research stay at TU Vienna.
Invitation by Prof. Hans Havlicek and Metod Saniga.
- 25/09/2014 *The geometry of the tripartite entanglement and the E_8 adjoint variety*
in the workshop *Geometries for Quantum Information*.
UTBM.
- 26/01/2014 *Finite Geometries, Veldkamp Spaces, Grassmannians and Quantum Information*.
to 31/01/2014 One week research stay at Slovakian astronomical institute.
Invitation by Professor Metod Saniga.
Slovakian Academy of Science, Tatranská Lomnica.
- 23/01/2014 *On entanglement classes of four qubits*
Mathematics and Physics seminar, Mathematical Institute of Bourgogne.
Bourgogne University.

- 15/11/2013 *Entanglement of four qubits and simple singularities.*
Second CoGIT (Combinatorics and Geometry for Entanglement) workshop
Toulouse Laboratory of theoretical Physics.
Toulouse University.
- 18/06/2013 *Geometry of Tripartite systems and quantum information theory.*
Join Number theory and Fonctionnal Analysis seminar.
Besançon University.
- 10/06/2013 *Hyperdeterminant in quantum information theory*
Algebraic geometry seminar, Joseph Fourier Institute.
Grenoble University.
- 06/06/2013 *Geometric Atlas of Entanglement*
First CoGIT workshop.
Rouen University.
- 28/06/2012 *Géométrie of Hyperdéterminants.*
Algorithmic and Combinatoric seminar of LITIS laboratory.
Rouen University.
- 01/06/2012 *Geometry of the hyperdeterminants and related topics.*
Geometry Seminar, Texas A & M University (USA).

Organization of scientific events

- 28/11/19 Quantum Information days
- 29/11/19 Invited speakers: Mladen Pavicic, Ion Nechita
Besançon
- 9/07/19 SIAM Algebraic Geometry Conf 19
- 13/07/19 Organizer of the minisymposium:
Application of Algebraic geometry to quantum information
Speakers: Fulvio Gesmundo, Luke Oeding, Matthias Christandl, Michael Walter,
Adam Sawicki, Szilárd Szalay, Karol Zyczkowski, Péter Lévy
- 7/06/18 *Images, Mathematics, Machine Vision and Neuronal Networks*
Luke Oeding (Auburn Univ)
UTBM
- 17-18/05/2018 I-QUINS meeting
Informatique quantique (student talk)
A universal and complete diagrammatic language for quantum computing
Invited speaker: Simon Perdrix (LORIA)
UTBM & LMB
- 24/10/2017 I-QUINS: Fall semester workshop
- au 27/10/2017 Invited speakers: Adan Cabello, Mohamed Bourenanne, Axel Khun, Marek Zukowsky
Dijon ICB, Besançon FEMTO-ST
- 14/09/2016 UBFC quantum information days
Dijon, ICB
- 14/06/2016 UBFC quantum information days
Sévenans, UTBM
- 15/03/2016 UBFC quantum information days
Besançon, FEMTO-ST
- June 2015 Colloquim *What geometry tells us about Computer science.*
Speaker: Joseph Landsberg.
UTBM
- September 2014 Colloquim *The black holes qubit correspondence.*
Speaker: Peter Lévy.
- September 2014 Workshop *Geometries for Quantum Information.*
Speakers: Michel Planat, Peter Levay, Metod Saniga, Alain Giorgetti.
UTBM

- 10/11/2013-11/2013 Co-organization of *The Second CoGIT days*.
Toulouse University.
- 19/09/2013-26/09/2013 *Finite Geometries with a Quantum Physical Flavor*.
Lectures organized at UTBM.
Speaker Metod Saniga, guest professor at UTBM in September 2013.
- June 2013 Colloquim *Complexity of Matrix multiplication*
Speaker: Joseph Landsberg.
UTBM.
- 5/06/2010-7/06/2013 Co-organization of *The First CoGIT Days*.
Rouen Univesity.
- 03/2010-06/2010 *Invariant Theory, Gröbner basis, behavior laws in continuum Mechanics*.
Invariant Theory seminar for biomechanics, UTBM.

Teaching activities

- Currently in charge of:

2017-present	UTBM
Lectures (28h) Recitation (28h)	<i>Theoretical Foundations of Computer Science</i> Engineering degree in computer science.
Lectures (28h) Recitation (28h)	<i>Numerical Analysis and Splines</i> Engineering degree in Computer science.
Lectures (28h)	<i>Theoretical Foundations of Analysis and Algebra</i> Mechanical engineering degree.
Lectures (28h)	<i>Numerical Analysis</i> course taught in English Mechanical engineering degree.
2017-present	UBFC
Lectures (20h)	<i>Numerical Method for Physics</i> course taught in English International Master in Physics
Lectures (14h)	Quantum algorithm course taught in English PhD training activity
2017-present	UL (Togo)
Lecture (20h)	<i>Mathematics for Computer Science</i> International Master in Computer Science
- Over the past 15 years, I have been teaching at various courses of mathematics (algebra, analysis, probabilities, applied and advanced courses) at various levels (from highschool to university), in various places (France, USA, Togo).

Responsabilities

- Vice-president for Education of UTBM
- Head of international relations of UTBM and member of the effective board (2010-2012).
 - Signature of MOUs with partner universities to develop exchange programs
 - European programs (Erasmus Mundus 2011-2012, Leonardo 2011)
 - Development of Double degrees
- International coordinator for undergraduate studies, UTBM (2008-2010).
 - In charge of the UTBM undergraduate students abroad.

Services

- Member of the Education Council of UTBM (2016-present)
- Board member of the University of Bourgogne Franche-Comté (2015-2016)
- Member of the Education Council of UTBM (2008-2012) and member of board of undergraduate studies (2007-2013)