

Curriculum Vitae

Valentin Féray

Assistant professor, University of Zurich

PERSONAL INFORMATION

ID: Valentin Féray, French, born September, 1984, married, 2 children.

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• EDUCATION

2006 – 2009 PhD at Université Paris-Est Marne-La-Vallée:

Advisor Philippe Biane, senior CNRS researcher;

Title Functions on the set of Young diagrams: characters of symmetric groups and Kerov polynomials.

2003 – 2007 Student at *École Normale Supérieure de la rue d'Ulm* (ranked 2nd at the entrance national competition).

2001 – 2003 Undergraduate studies in *Classes Préparatoires* at *Lycée Louis-Le-Grand (Paris)*.

• EMPLOYMENT HISTORY

2013 – ... Assistant professor for pure Mathematics at the University of Zurich (Switzerland).

2009 – ... CNRS junior researcher at LaBRI, Université de Bordeaux (France). On leave from August 2013.

2007 – 2009 PhD fellow and teaching assistant at University Paris-Est Marne-La-Vallée.

• PRIZES AND AWARDS

1. 2013: I was invited to give a series of lectures in *Collège de France* by the "Peccot Foundation": this prestigious opportunity is given to one or two French mathematician(s) (or mathematician(s) working in France) under 30 each year.

2. 2010-2013: *Prime d'Excellence Scientifique* awarded by CNRS.

3. Best student paper award at FPSAC 20 international conference.

• GRANTS

2017 – 2019 Principal investigator of the SNSF (Swiss National Science Foundation) grant "Shifted symmetric functions". Approved amount: 309 kCHF (290 k€). Grant nb: 200020_172515.

2017 I was one of the four main organizers of a thematic trimester at *Institut Henri Poincaré*, Paris. Total budget: >250 k€.

2014 – 2017 Principal investigator of the SNSF (Swiss National Science Foundation) grant "Dual combinatorics of Jack polynomials". Approved amount: 242 kCHF (232 k€). Grant nb: SNF-149461.

- SUPERVISION OF GRADUATE STUDENTS AND POSTDOCTORAL STUDENTS

- 2017 – ... Cosupervision with Mathilde Bouvel of a PhD student, Jacopo Borga.
- 2016 – ... Supervision of a PhD student, Raúl Penaguião.
- 2014 – 2017 Supervision of a PhD student, Dario De Stavola.
- 2013 – 2017 Cosupervision with Paul-Olivier Dehaye of a PhD student, Helen Riedtmann.
- 2011 – 2014 Cosupervision with Jean Christophe Aval of a PhD student, Omar Tout (graduated in Nov. 24th, 2014).
- 2014 – ... Supervision of four postdoctoral students, Per Alexandersson (1 year, 2014), Jehanne Dousse (3 years, 2015-2018), Marko Thiel (3 years, 2015-2018) and Benedikt Stufler (2 years, 2017-2019).

- TEACHING ACTIVITIES

- 2013 – ... Teaching as professor at University in Zurich (courses: representation theory, enumerative combinatorics, random combinatorial structures, complex analysis, student seminar on permutations, analytic combinatorics, introduction to Ising model, martingales and Markov chains).
- 2007 – 2009 Teaching assistant during my PhD (courses: Analysis I, Algebra I, Programming in C I and II).

- OUTREACH ACTIVITIES

- Aug. 2012, 2014, 2016 Participation to “Mat’les Vacances”, a math “summer camp” to convince underprivileged high school students that they can also do long studies in mathematics or other scientific areas.
Participation to the associated book *Maths la Terminale, Ed. Ellipse., 2016*
- Nov. 2013 Talk for first year university students at « Mathematical Park » in Institut Henri Poincaré, Paris.
- May 2009 & May 2010 I organized and animated a stand for CNRS at “salon de la culture et des jeux mathématiques” (mathematical culture and games show).

- MEMBERSHIPS IN PANELS, BOARDS AND INDIVIDUAL SCIENTIFIC REVIEWING ACTIVITIES

- 2010 – 2013 I have been a member of four hiring committees for permanent junior teacher-researcher positions (Marne-La-Vallée 2010-2012-2013, Caen 2012).
- 2008 – ... Referees of more than 40 papers for various journals (JEMS, JCTA, J. Alg. Comb., J. Comb. Alg., IMRN, J. Alg., Pacific J. Math., J. Math. Soc. Japan, Math. Zeitschrift, SIAM J. Disc. Math., Ann. IHP (B), Ann. Comb., SLC, Method. Comp. Appl. Prob., Adv. Appl. Math., PTRF, RSA, Stat. Prob. Letters, Elec. J. Comb., CPC, Ann. Appl. Prob., SIGMA, Asterisque) and for FPSAC and AofA conferences.
- 2017 Reviewer for UK grant agency EPSRC.

- ORGANIZATION OF SCIENTIFIC MEETINGS

- June 2019 Co-organizer of Conference on "Permutation Patterns" at the University of Zurich (expected: ~ 80 participants).
- Jan–Mar 2017 Co-organizer of the thematic quarter "Combinatorics and Interactions" at Institut Henri Poincaré, Paris (~ 200 participants).
- 2014 – ... Organizer of a Discrete Math Seminar every second week at the University of Zurich.
- Mar. 2013 Co-organizer of the annual week-long meeting of the ALÉA French research group in CIRM, Marseille (~ 100 participants).

- INSTITUTIONAL RESPONSABILITIES

2013 – ... Faculty member (Faculty of Sciences, University of Zurich)
2011 – 2013 Deputy head of the *Combinatorics and Algorithms* research team in LaBRI.

- MISCELLANEOUS

Small contribution to the open source mathematical software sage.

- SELECTED LISTS OF INVITATIONS

1. Plenary speaker for AofA (Analysis of Algorithms) Conference, Marseille (France), June 2019.
2. Invited to a conference on "Stochastic processes, geometry and algebraic structure", Madhia (Tunisia), April 2019.
3. Invited to a conference on "Asymptotic Algebraic Combinatorics", BIRS, Banff (Canada), March 2019.
4. Invited to a workshop "Algebraic combinatorics", Berlin, November 2018.
5. Invited to a workshop "Randomness and symmetry", Dublin, June 2018.
6. Invited to conferences on "Enumerative Combinatorics", Oberwolfach (Germany), May 2018 and March 2014.
7. Mini-course in *Séminaire Lotharingien de Combinatoire*, Bertinoro (Italy), September 2017.
8. Mini-course in a *Summer-School on probability and mathematical physics*, Laggo Maggiore (Italy), September 2017.
9. Invited speaker in the special sessions on *Integrable Probability* at SPA 2017 (Russia) on *Random structure in asymptotic representation theory* at SPA 2010 (Japan) and . SPA: International Conference on *Stochastic Processes and Applications*.
10. Mini-course in the *workshop on "Cumulants, concentration and superconcentration"*, Osnabrück (Germany), December 2016
11. Invited speaker at the conference on the scientific legacy of Marcel-Paul Schützenberger, Bordeaux (France), March 2016.
12. Plenary speaker at FPSAC 27 (International Conference on *Formal Power Series and Algebraic Combinatorics*) at Daejeon, South Korea, July 2015.
13. Mini-course lecturer (3 hours lecture, plus exercise sessions) in the workshop *Probability and representation theory in Edinburgh*, February 2014.
14. Mini-course in Collège de France, Paris, January/February 2013 (*Cours Peccot*).

A complete list of my presentations in workshops, seminars and conferences can be found on my web page.

Publication list

(In my field, authors are listed in alphabetic order.)

Monographs:

1. *Mod φ convergence: Normality zones and precise deviations*, with Pierre-Loïc Méliot and Ashkan Nikeghbali.
Springer Briefs in Probability and Mathematical Statistics, Springer, 2016.
2. *Approche duale des représentations du groupe symétrique*.
Collection "Les cours Peccot", Spartacus, 2016.

Journals papers:

1. *Mod-phi convergence II: Estimates on the speed of convergence*, with Pierre-Loïc Méliot and Ashkan Nikeghbali.
Accepted in Séminaire de Probabilités.
2. *The Brownian limit of separable permutations*, with Frédérique Bassino, Mathilde Bouvel, Lucas Gerin and Adeline Pierrot.
Accepted in Annals of Probability.
3. *Shifted symmetric functions and multirectangular coordinates of Young diagrams*, with Per Alexandersson.
Journal of Algebra, **483**, pp. 262-305, 2017.
4. *Cumulants of Jack symmetric functions and b-conjecture*, with Maciej Dołęga.
Transactions of the AMS, **369** (12), pp. 9014-9039, 2017
5. *Gaussian fluctuations of Young diagrams and structure constants of Jack characters*, with Maciej Dołęga.
Duke Mathematical Journal, **165** (7), pp. 1193-1282, 2016.
6. *Cyclic inclusion-exclusion*, SIAM J. Discrete Math, 29 (4), pp. 2284-2311, 2015.
7. *On products of long cycles: short cycle dependence and separation probabilities*, with Amarpreet Rattan.
Journal of Algebraic Combinatorics, **42**, (1) pp. 183-224, 2015.
8. *Quasi-symmetric functions as polynomial functions on Young diagrams*, with Jean-Christophe Aval, Jean-Christophe Novelli and Jean-Yves Thibon.
Journal of Algebraic Combinatorics, **41** (3), pp. 669-706, 2015.
9. *Jack polynomials and orientability generating series of maps*, with Maciej Dołęga and Piotr Śniady.
Séminaire Lotharingien de Combinatoire, **B70j**, 50 pp (electronic), 2014.
10. *An edge-weighted hook formula for labelled trees*, with I. P. Goulden and Alain Lascoux.
Journal of Combinatorics, **5** (2), pp. 245-269, 2014.
11. *A simple model of trees for unicellular maps*, with Guillaume Chapuy and Éric Fusy.
Journal of Combinatorial Theory Series A, **120**, pp. 2064–2092, 2013.
12. *Asymptotics of some statistics in Ewens random permutations*.
Electronic Journal of Probability, **18** (76), pp. 1-32, 2013.

13. *A multivariate hook formula for labelled trees*, with I. P. Goulden.
Journal of Combinatorial Theory Series A, **120**, pp. 944-959, 2013.
14. *P-partitions revisited*, with Victor Reiner.
Journal of Commutative Algebra, **4** (1), pp. 101-152, 2012.
15. *Linear extension sums as valuations of cones*, with Adrien Boussicault, Alain Lascoux and Victor Reiner.
Journal of Algebraic Combinatorics, **35** (4), pp. 573-610, 2012.
16. *On complete functions in Jucys-Murphy elements*.
Annals of Combinatorics, **16** (4), pp. 677-707, 2012.
17. *Bijective enumeration of some colored permutations given by the product of two long cycles*, with Ekatarina Vassilieva.
Discrete Mathematics, **312** (2), pp. 279-292, 2012.
18. *Partial Jucys-Murphy elements and star factorizations*.
European Journal of Combinatorics **33**, pp. 189-198, 2012.
19. *Asymptotics of q -Plancherel measures*, with Pierre-Loïc Méliot.
Probability Theory and Related Fields, **152** (3-4), pp. 589-624, 2012.
20. *Asymptotics of characters of symmetric groups related to Stanley character formula*, with Piotr Śniady.
Annals of Mathematics, **173** (2), 887-906, 2011.
21. *Zonal polynomials via Stanley's coordinates and free cumulants*, with Piotr Śniady.
Journal of Algebra, **334**, pp. 338-373, 2011.
22. *Explicit combinatorial interpretation of Kerov character polynomials as numbers of permutation factorizations*, with Maciej Dołęga and Piotr Śniady.
Advances in Mathematics, **225** (1), pp. 81- 120, 2010.
23. *Stanley's Formula for Characters of the Symmetric Group*.
Annals of Combinatorics, **13** (4), pp. 453 - 461, 2010.
24. *Combinatorial interpretation and positivity of Kerov's character polynomials*.
Journal of Algebraic Combinatorics, **29** (4), pp. 473-507, 2009.
25. *Application of graph combinatorics to rational identities of type A*, with Adrien Boussicault.
Electronic Journal of Combinatorics, **16** (1), R145, 2009.

Conference papers:

(These conference papers are extended abstracts of 12 pages of some of the journal publications above; FPSAC is the major annual conference in algebraic combinatorics; around 150 extended abstracts are usually submitted, among which 25 are accepted as talks and 50 as posters.)

1. *Cyclic inclusion-exclusion*.
Talk, FPSAC 2016. Vancouver (Canada), DMTCS proc. BC, 515–526, 2016.
2. *Cumulants of Jack symmetric functions and b -conjecture*, with Maciej Dołęga.
Poster, FPSAC 2016, Vancouver (Canada), DMTCS proc. BC, 395–406, 2016.
3. *Super quasi-symmetric functions via Young diagrams*, with Jean-Christophe Aval, Jean-Christophe Novelli and Jean-Yves Thibon.
Poster, FPSAC 2014, Chicago (USA), DMTCS proc. AT, 169-180, 2014.

4. *On Kerov polynomials for Jack characters*, with Maciej Dołęga.
Poster, FPSAC 2013, Paris (France), DMTCS proc. AS, 569-580, 2013.
5. *A simple tree model for unicellular maps*, with Guillaume Chapuy and Éric Fusy.
Talk, FPSAC 2012, Nagoya (Japan), DMTCS proc. AR, 215-226, 2012.
6. *Asymptotics of some statistics in Ewens random permutations*.
Talk, AofA 2012, Montréal (Canada), DMTCS proc. AQ, 43-54, 2012.
7. *Dual combinatorics of zonal polynomials*, with Piotr Śniady.
Talk, FPSAC 2011, Reykyavik (Iceland), DMTCS proc. AO, 317-328, 2011.
8. *Linear coefficients of Kerov's polynomials: bijective proof and refinement of Zagier's result*, with Ekaterina Vassilieva.
Poster, FPSAC 2010, San Francisco (États-Unis), DMTCS proc. AN, 713-724, 2010.
9. *Application of graph combinatorics to rational identities of type A*, with Adrien Boussicault.
Poster, FPSAC 2009, Hagenberg (Austria), DMTCS proc. AK, 229 - 240, 2009.
10. *Explicit combinatorial interpretation of Kerov character polynomials as numbers of permutation factorizations*, with Maciej Dołęga et Piotr Śniady.
Talk, FPSAC 2009, Hagenberg (Austria), DMTCS proc. AK, 337-348, 2009.
11. *Combinatorial interpretation and positivity of Kerov's character polynomials*.
Talk, FPSAC 2008, Viña del Mar (Chile), DMTCS proc. AJ, 93-104, 2008. "best paper from a student" award.

Participation to a collaborative outreach monograph:

1. Maths la Terminale S, collective book, Edn Ellipse, 2016 (in French).
Intended for motivated high school students, who want to discover in an original way some more advanced mathematical notions.

Short description of selected scientific results (May 2018)

Field of research: algebraic combinatorics (combinatorial representation theory, symmetric functions), and applications to stochastic processes. Combinatorial approach in probability theory.

1. Dual combinatorics of symmetric group representations

(My main collaborators on the topic are Piotr Śniady and Maciej Dołęga.)

The representation theory of symmetric groups is a relatively old field of research, starting from the pioneering works of Schur, Young and Frobenius around 1900. The classical theory, based on the combinatorics of Young tableaux, is unfortunately inappropriate when one wants to study *asymptotic* questions: what does a typical representation look like? can we give a simple asymptotic equivalent for irreducible character values of large symmetric group? Yet, these questions arise naturally in discrete probability (when we study statistics of random Young diagrams and random permutations), in algebra (in relation with representation theory of the infinite symmetric group) or in harmonic analysis (for example, to analyse random walks on the symmetric groups).

In the nineties, the Russian school around Kerov, Vershik and Olshanski developed a *dual approach* of representation theory of the symmetric group. Their theory is mainly analytic, based on a formula for irreducible characters as residue of some analytic function associated to the diagram (the Cauchy transform of its transition measure).

Starting in my thesis, I developed a combinatorial framework for this dual approach. In particular, I could prove two positivity conjectures, made by Kerov and Stanley respectively. With collaborators, we have also worked on the extension of these results to a framework involving the so-called Jack symmetric functions. Applications of these results include:

- new upper bounds for irreducible characters of the symmetric groups (finding such bounds is a classical questions, with various applications);
- central limit theorems for the linear statistics of some algebraically defined deformations of random Plancherel Young diagrams (related respectively to the Hecke algebra and to Jack symmetric functions).

This series of work led to the best student paper award at FPSAC 2008 and to publications in top mathematical journals: *Annals of Mathematics*, *Advances in Mathematics*, *Duke Mathematical Journal*, *Probability Theory and Related Fields*, *Journal of Algebra* (twice), ... I was invited to do a series of lecture in Collège de France on the topic (cours Peccot), and published associated lecture notes. Some of these results were also presented in *Séminaire Bourbaki* [P. Cartier, New developments concerning the values of characters of symmetric groups; combinatorial methods (after V. Féray, ...), 373-396, Exp. No. 1071, 2013] and have been recently the subject of a book chapter [P.-L. Meliot, *Representation Theory of Symmetric Groups*, 2017, Chapter 10].

2. Mod- φ convergence and cumulant method

(My collaborators on the topic are P.-L. Méliot and A. Nighekbali.)

The central limit theorem for independent and identically distributed (i.i.d.) random variables is one of the most ubiquitous theorem in probability theory: suitably renormalized, the sum of such variables converges towards a standard normal variable. Many variants or extensions assume, instead of the independence, some structure on the random variables under consideration: martingales, Markov chains, mixing sequences, dependency graphs, exchangeable pairs, determinantal point processes, ...

The convergence in law towards a Gaussian distribution is often complemented by other asymptotic results: speed of convergence, precise tail estimate in various regimes (leading to the determination of the normality zone, *i.e.* the zone where the Gaussian approximation is valid), local limit laws. The notion of mod- φ convergence, introduced in 2010 by Kowalski and Nikeghbali, and further developed

by myself, Méliot and Nikeghbali, is an attempt to obtain such complement results in an automatic way, which is applicable to a large variety of examples.

Mod- φ convergence is defined as the convergence of some suited renormalization of the characteristic functions (as opposed to the usually considered convergence of renormalized versions of the random variable). It is easy to see that it implies a central limit theorem (or the weak convergence to a stable law when the reference law φ is a stable distribution). We have exhibited general conditions so that it also implies precise moderate deviation estimates and upper bounds on the speed of convergence. We also provided many examples: additive arithmetic functions from number theory, log-determinants of classical matrix ensembles, linear functional of Markov chains, magnetization in Ising model, random character values of symmetric groups, subgraph counts in graphon models. . . . The conditions we use on characteristic functions are in many cases easy to check, and we hope that our results will be usable by a large community.

In some of these examples, the control of the characteristic function is obtained via a control of the *cumulants*, for which we obtained sharper bounds than the ones in the literature. This is the case of families of random variables with an underlying sparse dependency graph (such graphs encode the dependency relations of the variables under consideration). In a similar line of research, the applicant has recently introduced a notion of weighted dependency graph. This enables to consider models with weak dependencies between variables and to prove central limit theorems in this context. Examples of applications include multiply indexed statistics in random permutations, particle/void patterns in the symmetric simple exclusion process, arc patterns in random set-partitions, All these results are out of reach with the study of characteristic functions (which are generally intractable) or naive moment methods.

Some of the above-described results led to the publication of the already largely cited research monograph *Mod- φ convergence: Normality zones and precise deviations*. I was also invited to do two mini-courses on the topic (items 8 and 10 in the above list of invitations in my CV).

3. A Brownian universal limiting object for permutation classes

(My collaborators on the topic are F. Bassino, M. Bouvel, L. Gerin, M. Maazoun, A. Pierrot.)

Permutations are one of the most standard objects in combinatorics and are ubiquitous in computer science, data analysis, . . . One question of interest is to study sets of permutations (called *classes*) defined by the avoidance of some given substructures, called *patterns*. After some appearance in the work of MacMahon around 1910, and then of Knuth in the 60's, permutation classes have been considered as an independent object of study in the 90's. The first natural question is to fix some pattern(s) and try to enumerate permutations of a given size avoiding this(ese) pattern(s).

More recently, motivated by many probabilistic works on discrete random structures (graphs, trees, maps, partitions, . . .), there has been a growing interest in understanding typical properties of large permutations in classes (we mention the works of Pak, Madras, Hoffmann, Janson, among others).

Our work fits in this research effort. However, while most previous works on the topic focus on some specific permutation class, we aim at more general results and study families of permutation classes defined by some common structure. As a first step, we considered permutation classes that are closed by the so-called *substitution* operation. Permutations in such classes can be encoded by decorated trees, giving a starting point for the asymptotic analysis of a uniform random element of size n .

We were able to prove that, under some quite general analytic condition, a uniform random element of size n converges to some *universal fractal limit object*, that we call the biased separable Brownian permuton. The notion of convergence in the above statement is a recently introduced notion of *permutons*. This is at the same time an analogue of the dense graph convergence (graphon), as defined by Borgs, Chayes, Lovász, Sós, Vesztegombi in a seminal paper of 2008 and a natural notion of scaling limit for permutations.

Our first paper on the topic *The Brownian limit of separable permutations*, accepted in *The Annals of Probability*, has been the subject of two master theses, by students of Miermont and Le Gall.

To conclude, I include graphical representation of large uniform random permutations in two substitution-closed classes. Both are approximations of biased separable Brownian permutons.

