

Charles Phelps Taft Research Center
at the University of Cincinnati
Research Support Application

Each section (I-V) should be placed at the start of a new page. All required materials must be included in a single document, uploaded to the electronic submissions system, no later than 5PM on the published day of the deadline. Departmental review is not required for this program.

I. General Information

- a. Name: XXXXXX
- b. M#: XXXXXX
- c. Department: XXXX
- d. Position: XXXXXX
- e. Project title: From random partitions to self-similar random fields
- f. Time Period: 2016-2019
- g. Probable Results of a Grant (such as external funding, publications, and presentations): 3 more publications in peer-reviewed journals of probability in addition to 11 already submitted and published since 2017, and an external funding application in 2019.
- h. Other Funding Applied For or Received for This Project (list source and amounts requested and awarded): This project received Young Investigator Grant from National Security Agency (NSA, H98230-16-1-0322, 09/2016-09/2018, \$40,000), Young Investigator Program from Army Research Office (ARO, W911NF-17-1-0006, 12/2016-12/2019, \$357,789). Notices of award attached at the end.
- i. If applying for a Cost-Share grant, please indicate whether or not Cost-Share is required by grant giving organization and/or the budget items are necessary for the project but not covered by grant. No.

II. Budget

The following budget is needed for the invitation of Professor Olivier Durieu From Université François Rabelais, Tours, France. The PI plans to invite Professor Durieu to visit Cincinnati from November 4 to November 16 in 2018. The following budget will be for his 6-day stays (per Taft policy) during his visit.

Flight ticket: \$1,350

Other transportation (trains between Tours and Paris) \$100

Lodging for 6 days (\$102 per night): \$612

Per diem for 6 days (\$69 per day): \$414

Total budget: \$2,476

From applicant's current grant: \$976

Departmental Allocated Research Support: \$750

Request from Taft Research Support: \$750

Rationale of the proposed expenses

Professor Durieu will be visiting the applicant at University of Cincinnati during November 4 to November 16, 2018, for two purposes. One is for collaboration with me, and the other is to give a talk as an invited speaker in the Cincinnati Symposium on Probability and its Applications during November 9-11. Other resources to support Professor Durieu's travel consist of applicant's current grant (Army Research Office, ARO) and the Taft Conference Grant for the symposium.

The proposed budget above is on the **6-day visits** of Professor Durieu for **research collaboration cost only**, not including the period of the symposium. The Taft Conference Grant will cover Professor Durieu's stay during the symposium (4 nights + 4 days per diem, not included in the above budget). The remaining days of his visit (3 days) will be covered by the applicant's ARO grant.

Applicant is applying for Taft Research Support for research collaboration cost. His current grant is not enough to cover the entire visit of Professor Durieu, as the grant (total travel budget \$4800 in 2018) has been used to cover several expenses of other activities of the applicant (in year 2018 this consists of invitations of Professor Takashi Owada from Purdue University and Professor Rafal Kulik from University of Ottawa, travel to a workshop in Oaxaca, Mexico, by applicant's PhD student Zuopeng Fu, and applicant's own travel to an American Mathematics Society meeting in October in Ann Arbor). **The applicant has already obtained a partial \$750 DARS funding** from the Head of the Department of Mathematical Sciences, Professor Shuang Zhang.

III. Internal & External Grant History

The PI has been supported by the following internal & external grants.

- NSF, DMS-1832863, 09/01/2018–08/31/2019, \$20,000. Co-PI (with PI Robert Buckingham, Co-PI Magda Peligrad and Ju-Yi Yen).
Cincinnati Symposium on Probability Theory and Applications.
- Taft Conference Proposal Co-PI (with Wlodek Bryc, Robert Buckingham, Joseph Najnudel, Magda Peligrad and Ju-Yi Yen).
Cincinnati Symposium on Probability Theory and Applications 2018.
- Taft Research Support, May/June 2017, \$2,464 (Taft Research Support) + \$1,500 (DARS) = \$3,964.
Visit of Professor Olivier Durieu from Université François Rabelais, Tours, France to University of Cincinnati.
- ARO Young Investigator Award, W911NF-17-1-0006, 12/05/2016-12/04/2019. \$357,789
From random partitions to self-similar processes.
- NSA Mathematical Sciences Program, Young Investigator Grant, H98230-16-1-0322, 09/14/2016-09/13/2017. \$20,000
From random partitions to self-similar processes.
- NSA Mathematical Sciences Program, Young Investigator Grant, H98230-14-1-0318, 09/22/2014-09/21/2016. \$40,000
Limit theorems for random fields.
- NSF DMS-1441641, 2014/07/01-2015/06/30. \$20,000. Co-PI (with PI Robert Buckingham, Co-PI Magda Peligrad and Ju-Yi Yen).
Cincinnati Symposium on Probability Theory and Applications, September 19-21, 2014.
- Taft Research Support, May/June 2016, \$2,872 = \$1,572 + DARs \$1,300.
Visit of Professor Olivier Durieu from Université François Rabelais, Tours, France to University of Cincinnati.
- Taft Competitive Lecture, September 2015, \$899.
Professor Larry Goldstein from University of Southern California.

- Taft Research Support, May/June 2015, \$3,376 = \$1,876 + DARs \$1,500.
Visit of Professor Olivier Durieu from Université François Rabelais, Tours, France to University of Cincinnati.
- Faculty Development Fund, June 2015, \$1,600.
For attending and presenting results at International Conference of Extreme Value Analysis, University of Michigan, Ann Arbor, June 2016.
- Taft Conference Proposal, 2014. \$9,000. (With Co-PI Wlodek Bryc, Magda Peligrad and Ju-Yi Yen)
Cincinnati Symposium on Probability Theory and Applications 2014
- Taft Competitive Lecture, December 2013. \$1,000.
Invited Professor Yimin Xiao from Michigan State University.
- University Research Council, Faculty Research Grant, University of Cincinnati, 2013 summer. \$8,000.
- Startup Grant, University of Cincinnati. 2012/08-2014/08. \$10,000.

The PI has applied for the following grants before.

- NSA DMS 2016. Not funded.
From random partitions to self-similar processes
- Simons Collaboration Grants for Mathematicians, 2014. \$35,000. Not funded.
Topics on max-stable processes and central limit theorems
- NSF DMS, 2014. \$168,903. Not funded.
Limit theorems for random fields
- NSF DMS, 2013. \$198,535. Not funded.
Limit laws of extreme values

IV. Project Proposal

Brief overview My current project “From random partitions to self-similar processes” has been partially supported by an NSA grant and an ARO grant since 9/2016. 11 manuscripts have been submitted to peer-reviewed journals in probability since 2017, including 3 already accepted. The main goal of the project, in short and non-technical terms, is to establish *limit theorems*, a mathematical framework, to characterize certain real-life phenomena that are commonly described by *stochastic models* in probability theory and its applications.

This is my fourth time applying for Taft Research Support **for research collaboration cost**. The goal of my application this time is the same as in previous times: to host my collaborator Professor Olivier Durieu from Université de Tours, France to visit University of Cincinnati. Professor Durieu is one of my main collaborators, with whom I have the most co-authored papers, most of which are at the core of my current research program. **The visits of Professor Durieu at UC in spring/summer 2015, 2016 and 2017, all sponsored by the Taft Research Support in the past, have significantly facilitated the progress of our collaborations (7 published and submitted papers since 2015), and hence my current research program. Moreover, this has helped me obtain successfully external grants (NSA 2016-2018, ARO 2016-2019) based mainly on results from our collaborations.** The Taft Research Support in the past years have been crucial to our success and is hence much appreciated, as often the external grants do not support foreign researchers (NSA) no have very strict limit on foreign traveling (ARO).

Background Nowadays, stochastic modeling has become a standard tool when dealing with complex phenomena. The first emphasis of the project is the focus on a specific type of complex phenomena, termed as *long-range dependence*. Generally speaking, data structure with long-range dependence can be understood as reflecting the situations that at large temporal (or spatial) scales, the correlations at various different points decay slowly as the distance increases. The long-range dependence is well known to exist from empirical data from notably econometrics, finance and insurance and network traffics. The second emphasis is to investigate of a few models related to *random partitions* that recently appeared in the literature. Such models have a strong combinatorial flavor and their connections with long-range dependence have yet to be fully understood in mathematical terms. The project includes several problems on establishing limit theorems, a mathematical framework, for various models with long-range dependence, many of which based on random partitions. Different self-similar processes arise in limit theorems, and a main goal is to discover new models that lead to new self-similar processes in the limit.

Current state of research The first couple years (2016-2017) of the project have been very fruitful, with 11 manuscripts submitted (see Impact below). I am about to start the last year of my current research project, with three remaining sub-projects.

1. With Durieu, we continue our investigation on the so-called Karlin model, a model extensively investigated in this project (with three papers already finished, all with Durieu). An unsolved issue is on the so-called *tightness property* in a limit theorem that we investigated for the Karlin model with heavy-tailed randomization. Establishing the tightness will improve our understanding on the regularity of the sample paths of the Karlin stable processes.
2. With my PhD student, Zuopeng Fu, we established an extension of the so-called Karlin processes to stable processes indexed by other manifolds. They may serve in the future as models defined on line (time series), on a plane (spatial models) and on a sphere (with applications in cosmology, for example).
3. With Professor Takashi Owada from Purdue University and Professor Shuyang Bai from University of Georgia, Athens, we are currently working on a new family of processes with long-range dependence and its limit theorem. A new family of multiple-stable processes arise in the limit theorem.

In addition, I am also currently preparing a proposal for another grant, to be submitted early next year to Army Research Office. The proposal will be based on our latest developments on limit theorems for long-range dependence. The aforementioned results with Fu and with Owada and Bai would be the motivating examples, of which a few follow-up limit theorems are expected. In particular, the Karlin process indexed by manifolds (joint work with Fu) raises a few challenging questions regarding the corresponding simulation methods, as computationally it is extremely difficult to maintain both high resolution and small approximation errors at the same time.

Schedule

- 2018 November: visit of Professor Durieu to University of Cincinnati, to work mostly on tightness for Karlin stable processes.
- 2019 January: finish and submit the manuscript with Zuopeng Fu on *Stable processes with stationary increments indexed by manifolds*.
- 2019 January: submit an ARO research proposal for year 2020.
- 2019 March: finish and submit the paper with Owada and Bai on *A functional non-central limit theorem for multiple-stable processes with long-range dependence*.
- 2019 summer: finish and submit the paper with Durieu on *Tightness of Karlin stable processes*.

Other faculty and students involved at University of Cincinnati

- Wlodek Bryc, Professor in Mathematical Sciences. 3 joint papers.
- Zuopeng Fu, PhD student in Mathematical Sciences, 2015-2020 (expected). 1 joint paper (to be submitted).

Impact Below is a list of published and preprints of my publications from the current project since 2017.

1. G. Samorodnitsky and Y. Wang. *Extremal theory for long range dependent infinitely divisible processes.* <https://arxiv.org/abs/1703.07496>
2. W. Bryc and Y. Wang. *Dual representations of Laplace transforms of Brownian excursion and generalized meanders.* *Statistics and Probability Letters*, 140:77–83, 2018.
3. H. Biermé, O. Durieu and Y. Wang. *Generalized random fields and Lévy's continuity theorem on the space of tempered distributions.* <https://arxiv.org/abs/1706.09326>
4. W. Bryc and Y. Wang. *Limit fluctuations for density of asymmetric simple exclusion processes with open boundaries.* <https://arxiv.org/abs/1707.07350>
5. O. Durieu, G. Samorodnitsky and Y. Wang. *From infinite urn schemes to self-similar stable processes.* <https://arxiv.org/abs/1710.08058>
6. O. Durieu and Y. Wang. *From random partitions to fractional Brownian sheets.* *Bernoulli*; to appear.
7. Y. Shen and Y. Wang. *Operator-scaling Gaussian random fields via aggregation.* <https://arxiv.org/abs/1712.07082>
8. O. Durieu and Y. Wang. *A new family of random sup-measures with long-range dependence.* <https://arxiv.org/abs/1804.07248>
9. S. Stoev and Y. Wang. *Exchangeable random partitions from max-infinitely-divisible distributions.* <https://arxiv.org/abs/1806.05317>
10. H. Biermé, O. Durieu and Y. Wang. *Generalized operator-scaling random ball model.* *Latin American Journal of Probability and Mathematical Statistics*, to appear.
11. W. Bryc and Y. Wang. *Fluctuations of random Motzkin paths.* <https://arxiv.org/abs/1807.10057>

Below are invited talks that I gave and plan to give since 2017.

1. *University of Kansas, Probability Seminar, Lawrence, November 28, 2018*
2. *Indiana University, Bloomington, Probability Seminar, Bloomington, October 29, 2018.*
3. *AMS Fall Central Sectional Meeting, Special Session on Self-similarity and Long-range Dependence in Stochastic Processes, Ann Arbor, October 20–21, 2018.*
4. *Cornell University, Probability Seminar, Ithaca, September 11, 2018.*

5. *University of Illinois, Urbana Champaign, Probability Seminar, Urbana, April 25, 2017.*
6. *Purdue University, Probability Seminar, West Lafayette, March 7, 2017.*
7. *University of Tennessee, Knoxville, Stochastics Seminar, Knoxville, February 14, 2017.*

Below are the events on closely related topics that I co-organized.

1. *Cincinnati Symposium on Probability Theory and Applications*
University of Cincinnati, Cincinnati, November 9–11, 2018.
2. *Self-similarity and Long-range Dependence in Stochastic Processes*
Special Session, AMS Spring Central Sectional Meeting at University of Michigan, Ann Arbor, October 20–21, 2018.
3. *Self-similarity, Long-range Dependence and Extremes*
CMO–BIRS workshop, Casa Matematica Oaxaca (CMO), Mexico, June 17–22, 2018.
4. *Self-similarity and Long-range Dependence in Stochastic Processes Special Session,*
AMS Spring Central Sectional Meeting at Indiana University, Bloomington, April 1–2, 2017.

V. Curriculum Vitae

Please include here a current (updated within the last month) curriculum vitae of no more than two pages.

Please see below for the current CV of myself and Professor Durieu.

Olivier Durieu
Maître de conférences

Institut Denis Poisson
Université de Tours
UFR Sciences et Techniques
Parc de Grandmont
37200 Tours - FRANCE

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Date of birth: 8th March 1980
Nationality: French

web page :
<http://www.idpoisson.fr/durieu/>

Curriculum Vitae

I am currently Maître de conférences at the Institut Denis Poisson, University of Tours.

Diplomas and Jobs

- 2009- : Maître de conférence at the University of Tours, France.
- 2008-2009: ATER (research and teaching position) at the University of Rouen.
- 2005-2008: PhD student at the University of Rouen, France.
- 2004-2005: Master (Mathématiques fondamentales et appliquées), University of Rouen.
- 2003-2004: Agrégation de mathématiques.

Research interest

Central limit theorems; Invariance principles; Stationary random sequences and fields; Dynamical systems; Empirical processes; Martingale approximations; Weak dependence; Long-range dependance; Self-similar processes.

Publications

- **Invariance principles for operator-scaling Gaussian random fields**, with Hermine Biermé et Yizao Wang.
Annals of Applied Probability, volume 27, 2, p. 1190-1234, 2017.
- **From infinite urn schemes to decompositions of self-similar Gaussian processes**, with Yizao Wang.
Electronic Journal of Probability, volume 21, 43, p. 1-23, 2016.
- **Invariance principles for self-similar set-indexed random fields**, with Hermine Biermé.
Transactions of the American Mathematical Society, volume 366, 11, p. 5963-5989, 2014.
- **A sequential empirical central limit theorem for multiple mixing processes with application to B-geometrically ergodic markov chains**, with Herold Dehling et Marco Tusche.
Electronic Journal of Probability, volume 19, 87, p. 1-26, 2014.
- **Approximating class approach for empirical processes of dependent sequences indexed by functions**, with Herold Dehling et Marco Tusche.
Bernoulli, volume 20, 3, p. 1372-1403, 2014.
- **An empirical process central limit theorem for multidimensional dependent data**, with Marco Tusche.
Journal of Theoretical Probability, volume 27, 1, p. 249-277, 2014.

- **Empirical processes of iterated maps that contract on average.**
Statistics and Probability Letters, volume 83, 11, p. 2454-2458, 2013.
- **An indicator function limit theorem in dynamical systems**, with Dalibor Volný.
Stochastics and Dynamics, volume 11, 4, p. 681-690, 2011.
- **Empirical processes of multidimensional systems with multiple mixing properties**, with Herold Dehling.
Stochastic Processes and their Applications, volume 121, 5, p. 1076-1096, 2011.
- **On sums of indicator functions in dynamical systems**, with Dalibor Volný.
Ergodic Theory and Dynamical Systems, volume 30, 5, p. 1419-1430, 2010.
- **New techniques for empirical processes of dependent data**, with Herold Dehling et Dalibor Volný.
Stochastic Processes and their Applications. volume 119, 10, p. 3699-3718, 2009.
- **Independence of four projective criteria for the weak invariance principle.**
Aléa, Latin American Journal of Probability and Mathematical Statistics, volume 5, p. 21-27, 2009.
- **A fourth moment inequality for functionals of stationary processes.**
Journal of Applied Probability, volume 45, 4, p. 1086-1096, 2008.
- **Empirical invariance principle for ergodic torus automorphisms; Genericity**, with Philippe Jouan.
Stochastics and Dynamics, volume 8, 2, p. 173-195, 2008.
- **Comparison between criteria leading to the weak invariance principle**, with Dalibor Volný.
Annales de l'Institut Henri Poincaré, Probabilités et Statistiques, volume 44, 2, p. 324-340, 2008.

Preprints

- **Generalized operator-scaling random ball model**, with Hermine Biermé et Yizao Wang.
- **A family of random sup-measures with long-range dependence**, with Yizao Wang.
- **From infinite urn schemes to self-similar stable processes**, with Gennady Samorodnitsky et Yizao Wang.
- **From random partitions to fractional Brownian sheets**, with Yizao Wang. To appear in *Bernoulli*.
- **Generalized random fields and Lévy's continuity theorem on the space of tempered distributions**, with Hermine Biermé et Yizao Wang.

Phd Thesis

"Asymptotic behavior of stationary processes and empirical processes in dynamical systems"
 Thesis advisors: Dalibor Volný and Philippe Jouan.
 Date of defense: 1th December 2008.

Visits abroad

- University of Cincinnati, USA, invited by Y. Wang, 1 month in 2015, 2 weeks in 2016, 3 weeks in 2017.
- Bochum University, Germany, invited by H. Dehling, 2 weeks in 2009, 2 weeks in 2010, 1 month in 2011, 2 weeks in 2012, 1 month in 2013.
- UTIA, Charles University, Praha (Projet BARRANDE), 1 week in 2008.
- University of Michigan, Ann Arbor, USA, invited by M. Woodrooffe, 1 week in 2006.
- University of Notre Dame, USA, invited by F. Ledrappier, 1 month in 2006.

PHD Students

- Marco Tusche (between 2010 and 2013 with Herold Dehling).

Thesis title: *Empirical Processes of Multiple Mixing Data.*

Date of defense: November, 29, 2013.

Committee:

Jérôme Dedecker (Referee), Professeur, Université Paris Descartes
Herold Dehling, Professeur, Ruhr-Universität Bochum
Manfred Denker (Referee), Professeur, Pennsylvania State University
Olivier Durieu, MCF, Université François-Rabelais de Tours
Gerhard Knieper, Professeur, Ruhr-Universität Bochum
Emmanuel Lesigne, Professeur, Université François-Rabelais de Tours

- Vivien Despax (since 2013, with Cédric Lecouvey): *Marches aléatoires conditionnées à rester dans des chambres de Weyl avec dérive quelconque.*

Responsibilities

- Responsible of the Master MEEF (Métiers de l'Enseignement, de l'Education et de la Formation) (since 2016).
- Member of the council of the laboratory (since 2011).
- Member of the “Commision Scientifique Disiplinaire Paritaire” (since 2010).
- Member of the council of the maths departement (Univ. Tours, 2010-2014).
- Representative of the Phd students at the council of the laboratory (2008-2009, LMRS in Rouen).