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Rapport d'activité sur mon séjour de recherche dans l'IRL France-Vietnam in Mathematics and its Applications

From August 2024 to January 2025, I worked at the Vietnam Institute for Advanced Study in Mathematics (VIASM) as a CNRS researcher affiliated with the France-Vietnam International Research Laboratory for Mathematics and its Applications. It was a very enriching experience, both personally and professionally.

Firstly, I had the opportunity to meet many colleagues from various Vietnamese research institutions. In particular, I began a new collaboration with Ngo Hoang Long, an associate professor at the National University of Education in Hanoï. I also fostered a collaboration with Viet Hung Hoang, a lecturer at the Industrial University of Ho Chi Minh City. See below for a complete list of collaborations.

I have also been invited to several universities to deliver talks, meet research groups, and develop new collaborations. I have given research presentations at the Vietnam Institute of Advanced Science and Mathematics (VIASM), the Vietnam Academy of Science and Technology (VAST), Hanoï National University of Education (HNUE), the Industrial University of Ho Chi Minh City, and the University of Da Nang. See below for a comprehensive list of the talks I gave during my time in Vietnam.

One of the highlights of my time in Vietnam was organising the Winter School on Representation Theory and Combinatorics Tools in the Study of Some Probabilistic Models, which took place at the beginning of December 2024 and was organised in collaboration with Le Minh Ha, Ngo Hoang Long and Marc Peigné. Four French colleagues came to Hanoï for this event and gave talks on models inspired by probability theory and algebra; four Vietnamese colleagues gave research talks on various probabilistic models. The participation of many students, as well as the subsequent mathematical discussions, contributed to the success of the Winter School.

The Winter School lecturers (François Chapon from the University of Toulouse, Sandro Franceschi from Telecom Sud Paris, Cédric Lecouvey and Marc Peigné from the University of Tours) were all able to extend their stay in order to make progress on various research projects. These activities have strengthened the research network between Vietnam and France in the fields of probability theory and representation theory. See this document below for more details on the Winter School. I have been able to enjoy wonderful working conditions at VIASM, which is undoubtedly an inspiring place to work. From the building's architecture to the welcoming cafeteria and canteen, the terrace and the beautiful, modern Laurent Schwartz amphitheatre, not to mention the weekly tea breaks and proximity to many restaurants, everything is designed to provide the best possible conditions for researchers. In addition, the numerous scientific activities offered by VIASM contribute to the institute's dynamism and provide an opportunity to meet colleagues from all over the world.

I received tremendous support from the VIASM staff and my colleagues. In particular, I would like to thank Le Minh Ha, Ho Tu Bao, Marc Peigné, Hong Anh Nguyen and Le Thi Lan Anh for their invaluable assistance.

List of talks given at Vietnamese institutions

- October 9, 2024 at VIASM (Vietnam Institute for Advanced Study in Mathematics): research talk on "Persistence probabilities for autoregressive processes"
- October 16, 2024 at HNUE (Hanoï National University of Education): research talk on "Reflected Brownian motion in wedges: a functional equation approach"
- November 7, 2024 at VAST (Vietnam Academy of Science and Technology): research talk on "Harmonic functions for singular random walks"
- January 3, 2025 at Industrial University of Ho Chi Minh City: presentation of a few open problems in probability theory, to propose possible collaboration
- January 7, 2025 at Da Nang University: presentation for Master students on "Persistence in probabilistic and physical models". I would like to emphasise that over 150 students attended my lecture.

On 25 September 2024, I participated in the "États Généraux de la Recherche Francophone au Vietnam", held at the Agence Universitaire de la Francophonie in Hanoï. I took part in a panel discussion, presenting my experience of working as a CNRS researcher at an international institute.

Winter School Several probabilistic models (random walks conditioned to stay in some domains, percolation problems, TASEP, etc.) are naturally related to combinatorial objects appearing in the representation theory of Coxeter groups, Lie algebras or their generalisations. In particular, new results and objects have recently been introduced in representation theory (crystal graphs, shifted Schur functions, Macdonald polynomials, generalisations of the RSK procedure, etc.), suggesting new interactions with probability theory.

This Winter School comprises four mini-courses led by François Chapon (University of Toulouse, France), Sandro Franceschi (Telecom Sud Paris, France), Cédric Lecouvey (University of Tours, France) and Marc Peigné (also University of Tours, France). The topics are as follows:

- The simple random walk on \mathbb{Z}^d and the Pitman transform (Marc Peigné)
- Lévy and Pitman representation theorems (Sandro Franceschi)
- Some probabilistic aspects of representation theory (Cédric Lecouvey)
- Non-commutative probability, representation theory and the orbit method (François Chapon)

Additionally, we have provided many researchers specialising in representation and probability theory with the opportunity to present their work focusing on the aforementioned topics:

- Ngo Hoang Long (Hanoï National University of Education)
- Lam Hoang Chuong (Can Tho University)
- Vu Thi Huong (Institute of Mathematics, Vietnam Academy of Science and Technology)
- Pham Viet Hung (Institute of Mathematics, Vietnam Academy of Science and Technology)

Visits Several colleagues have visited me, including: Théo Ballu (University of Angers), François Chapon (University of Toulouse), Sandro Franceschi (Télécom Sud Paris), Viet Hung Hoang (Industrial University of Ho Chi Minh City), Cédric Lecouvey (University of Tours) and Marc Peigné (also University of Tours).

The stays of Cédric Lecouvey and Marc Peigné were related to the Winter School (see above). Théo Ballu, a PhD student in his third year under my supervision, stayed for around one month to make progress on his research and collaborate with me. During this time, we finished writing the paper Limit shape of the leaky Abelian sandpile model with multiple layers.

François Chapon and Sandro Franceschi gave lectures at the Winter School. We then collaborated on deriving explicit formulas for the heat kernel of degenerate reflected Brownian motion in two dimensions.

Viet Hung Hoang was my PhD student (2019/2023) at the University of Tours and the University of Münster. We have worked on various joint projects together, one of which is due to be completed soon. This project involves considering models of walks in cones. Motivated by problems arising from statistical physics, we describe the distributions that appear when counting the time spent by a random walk close to the boundaries of the cone. There is a relation with polymer models. Viet Hung Hoang came to Hanoï for a week-long research stay. In January 2025, I travelled to Ho Chi Minh City to collaborate with him. I met several members of his department, all of whom were very interested in my work.

Collaboration My time in Vietnam enabled me to develop and pursue existing collaborations and create new ones. I work regularly with Viet Hung Hoang from the Industrial University of Ho Chi Minh City. We typically meet (now online) twice a month and have several ongoing projects. He is planning to visit the University of Angers for a month in June 2026.

I started collaborating with Ngo Hoang Long (HNUE), and we are working on correlated particle systems inspired by biological models. He will be visiting the University of Tours in September 2025 to work with Marc Peigné and me.

At an institutional level, I am in discussion with the organisers of the international congress on mathematical physics (2027) in Da Nang regarding the organisation of a satellite workshop on probabilistic aspects of mathematical physics.

I have also started collaborating with VAST and several of its researchers, including those in the probability theory group (Thai Son Doan and Pham Viet Hung) and the algebra group (Giang Nam Tran).

Conclusion My research stay in Vietnam was exceptionally enriching from both a human and a scientific perspective. A significant proportion of my current research activities and projects are now conducted in collaboration with Vietnamese colleagues and institutions.