

# Postdoctoral Retreat in Stochastics

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## 1 Overview

This was a first meeting of the PIMS Postdoctoral Training Centre in Stochastics in which 4 of the 5 postdoctoral fellows in the first year of the program, together with their advisors and 6 Ph.D. students from UA, U. Calgary, UBC and U. Washington met to discuss research in a variety of areas in pure and applied probability. All of the students and postdocs attending made 40 minute presentations on their current research. The one postdoc (at U. Washington) who did not attend could not obtain his visa in time in spite of his very best efforts. The purpose of the meeting was for the postdocs, faculty and senior students to get acquainted with each other and give the young researchers an opportunity to explain their work to the Western Canadian probability community.

The Retreat in Stochastics was a huge success from both mathematical and collaborative points of view. It became apparent that our postdoctoral fellows and senior students are already attacking challenging problems at the forefront of probability and stochastics.

## 2 Presentation Highlights

The mix of the latest theoretical developments in the subject and some more applied modelling results was very healthy for the young researchers. For example, in the regime of heavy tailed distributions there were two quite different sets of results presented. Mathav Murugan (UBC) spoke on his recent work on getting precise on-diagonal asymptotics for heavy-tailed random walks on general graphs. The interesting part of this work was that the key hypothesis concerned a sub-Gaussian estimate for the simple random walk on the graph—something that is relatively well-understood now. Getting off-diagonal estimates was presented as an important open question. In a more applied direction, recent PhD graduate Samira Sadeghi (UA) presented optimal convergence results on stochastic approximation and outer products of two-sided linear processes in the heavy-tailed and long-range dependent setting, while demonstrating their use in big-data parameter estimation.

Khoa Le (UC/UA) presented some very recent results on the parabolic Anderson model driven by space-time noise, which is white in time and coloured (so long range dependent) in space. There has been much activity recently on the asymptotic behaviour in  $t$  of the  $n$ th moments. Xia Chen recently confirmed a conjecture of Mueller and Khoshnevisan and calculated the precise exponential growth rate of the  $n$ th moments in the white noise setting in one spatial dimension when the initial data is constant. Le studies the long term rate of propagation of the moments when the initial data is compact and gives a variational characterization of the critical propagation rate for a quite general setting and goes on to develop large deviation results. Also

in the realm of stochastic pde, PhD student Chi Dong (UA) presented a purely topological technique (as opposed to classic Ray-Knight theorems) for replicating measures and processes living on “bad spaces” (e.g., the tau topology, pseudopath topology) or non-compact spaces onto compact metric spaces. As applications, several filtering equation, stationary filter, and martingale problem solution results (that were only known for compact or Polish spaces) were all extended to these more general settings.

Richard Balka (UBC) gave a complete and elegant proof of his recent result with Yuval Peres that a.s. Brownian motion can only be of bounded variation on time sets of dimension at most  $1/2$ . Hence the zero set and points where the path equals its past maximum attain the maximal dimension. The result has recently been extended to include fractional Brownian motions of any Hurst index.

In the mathematical finance area, Jonathan Chavez (UC) presented a new (more realistic) limit order book model and considered the resulting price process. He gave a weak invariance principle for this price process and supported his result with simulations. PhD student Ilnaz Asadzadeh (UC) presented a time series model for energy prices that was tested on real data. The model was based upon a copula between the current price and most recently prior price that handled atypical joint tail behaviour. Evidence was given that there was little gain in including earlier prices in the model.

PhD student Brett Kolesnik (UBC) gave a wonderful introduction to the Brownian map, the random surface counterpart of Brownian motion which was featured in J.F. Le Gall’s plenary talk at the 2014 ICM. He went on to describe his work with Angel and Miermont on the geometry of the cut loci of the Brownian map. Last but certainly not least, PhD student Matt Junge (UW) presented his recent proof of equidistribution of the max-2 process, answering an open problem of Benjamini, Maillard and Paquette. The max-2 process is an inductively defined sequence of points in the unit interval where at the  $n$ th step two points are chosen at random and the one falling in the larger interval determined by the previously chosen points is kept. The result states that the empirical distribution of the resulting set of points converges to the uniform distribution.

### 3 Open Problems

During an open problem session, a number of senior and junior researchers presented problems. These included classical problems on competing species models in measure-valued diffusions (Ed Perkins, UBC) and on the Martin boundary for super-Brownian motion (Deniz Sezer), and questions of current interest such as the probability of human extinction due to an asteroid collision (Matt Junge, UW). Brett Kolesnik (UBC) posed an interesting question on coexistence of competing binary branching Brownian motions in one dimension (the two populations annihilate upon contact) which generated interested discussion among participants.

### 4 Scientific Progress Made

Chi Dong made progress on recovering the classic Ray-Knight theorem from his replication technique. Ilnaz Asadzadeh started investigating particle filters and discussion with the UA group. Brett Kolesnik’s problem prompted further discussion at UBC where Nathanael Berestycki, an international expert on branching Brownian motion, was visiting. Some simulations suggest coexistence should be possible and it has evolved into a working project for Brett with Nathanael and Omer Angel.

### 5 Outcome of the Meeting

An enjoyable aspect of the meeting was the interest of all participants in the wide range of topics discussed. It confirmed the high level of the PTCS postdoctoral fellows. There was also an opportunity to discuss future plans for the program including broadcast seminars, outside speakers and short courses. Participants clearly enjoyed the informal atmosphere and plans were made for visits to other PIMS sites. Everyone was happy to learn that this will be an annual event for the program.