List of Publications

Gideon Amir

1. G. Amir, I. Corwin and J. Quastel: *Probability Distribution of the Free Energy of the Continuum Directed Random Polymer in 1+1 dimensions*(**Accepted for publication in Communications in Pure and Applied Math (CPAM)**)(arxiv:10030443)

2. G. Amir, I. Benjamini and G. Kozma: *Excited random walk against a wall*(**Probability Theory and Related Fields, Volume 140 1-2, January 2008, p83-102**) (arxiv:0509464).

3. G. Amir and C. Hoffmann: *A special set of exceptional times for dynamical random walk on* $\mathbb{Z}^2$(**Electronic Journal of Probability; Vol. 13 (2008) paper 63, pages 1927-1951.**)(arxiv:0609267).

4. G. Amir, O. Angel and B. Valko: *The TASEP speed process* (**Accepted for publication in the annals of Probbaility**)
(arxiv:0811.3706) ().

5. G. Amir, O. Gurel-Gurevich, E. Lubetzky and A. Singer: *Giant components in biased graph processes*(**To appear in the Indiana Journal of Math**)(arxiv:0511526)

6. G. Amir and O. Gurel-Gurevich: *The diameter of random cayley graphs on* Z_q
(arxiv:0609620)(**To Appear in Groups – Complexity – Cryptology**).

7. G. Amir and O. Gurel Gurevich: *On Fixation of Activated Random Walks*
(arxiv:0910.3730)(**Accepted for publication in the Electronic Communications in Probability**).

8. G. Amir, O. Angel and B. Virag: *Amenability of linear-activity automaton groups*
(arxiv:0905.2007) (submitted).

9. G. Amir and B. Virag: *A phase transition for automaton groups* (In preparation).

10. G. Amir, O. Angel, I. Benjamini and G. Kozma: *One-dimensional long-range diffusion-limited aggregation I*
(arxiv:0910.4416)(submitted).

11. G. Amir: *One-dimensional long-range diffusion-limited aggregation III - The limit aggregate*
(arxiv:0911.0122)(submitted).

12. G. Amir, O. Angel and G. Kozma: *One-dimensional long-range diffusion-limited aggregation II - the transient case* (In preparation).

13. G. Amir and E. Lubetzky: *On two biased graph processes*(arxiv:0608097)(Submitted).

14. G. Amir, O. Angel and A. Holroyd: *Multi-coloured matchings*(In preparation).

15. G. Amir, I. Benjamini, O. Gurel-Gurevich and G. Kozma: *Random walk in changing environment* (In preparation).

Non - mathematical paper:

16. G. Amir and R. Axelrod: *Architecture and Techniques for an MMORTS.* (**Massively Multiplayer Game Development 2 (Charles River Media, 2005)**).

List of Publications with abstracts

1. G. Amir, I. Corwin and J. Quastel: *Probability Distribution of the Free Energy of the Continuum Directed Random Polymer in 1+1 dimensions*(**Accepted for publication in Communications in Pure and Applied Math (CPAM)**)

   We consider the solution of the stochastic heat equation

   $$\partial_T \mathcal{Z} = \frac{1}{2}\partial_X^2 \mathcal{Z} - \mathcal{Z}\dot{\mathfrak{W}} \quad (1)$$

   with delta function initial condition

   $$\mathcal{Z}(T=0) = \delta_0 \quad (2)$$

   whose logarithm, with appropriate normalizations, is the free energy of the continuum directed polymer, or the solution of the Kardar-Parisi-Zhang equation with narrow wedge initial conditions.

   We obtain explicit formulas for the one-dimensional marginal distributions – the crossover distributions – which interpolate between a standard Gaussian distribution (small time) and the GUE Tracy-Widom distribution (large time).

   The proof is via a rigorous steepest descent analysis of the Tracy-Widom formula for the asymmetric simple exclusion with anti-shock initial data, which is shown to converge to the continuum equations in an appropriate weakly asymmetric limit. The limit also describes the crossover behaviour between the symmetric and asymmetric exclusion processes.

2. G. Amir, I. Benjamini and G. Kozma: *Excited random walk against a wall* (**Probability Theory and Related Fields, Volume 140 1-2, January 2008, p83-102**).

   We analyze random walk in the upper half of a three dimensional lattice which goes down whenever it encounters a new vertex, a.k.a. excited random walk. We show that it is recurrent with an expected number of returns of $\sqrt{\log t}$.

3. G. Amir and C. Hoffmann: *A special set of exceptional times for dynamical random walk on* $\mathbb{Z}^2$ (**Electronic Journal of Probability; Vol. 13 (2008) paper 63, pages 1927-1951.**).

   Benjamini, Häggström, Peres and Steif introduced the model of dynamical random walk on $\mathbb{Z}^d$ *. This is a continuum of random walks indexed by a parameter* t*. They proved that for* $d = 3, 4$ *there almost surely exist* t *such that the random walk at time* t *visits the origin infinitely often, but for* $d \geq 5$ *there almost surely do not exist such* t*.*

   Hoffman showed that for $d = 2$ *there almost surely exists* t *such that the random walk at time* t *visits the origin only finitely many times. We refine this result for dynamical random walk on* $\mathbb{Z}^2$*, showing that with probability one there are times when the origin is visited only a finite number of times while other points are visited infinitely often.*

4. G. Amir, O. Angel and B. Valko: *The TASEP speed process* (**Accepted for publication in the Annals of Probability**).

   In the multi-type totally asymmetric simple exclusion process (TASEP), each site of $\mathbb{Z}$ is occupied by a labeled particle, and two neighboring particles are interchanged at rate one if their labels are in increasing order. Consider the process with the initial configuration where each particle is labeled by its position. It is known that in this case a.s. each particle has an asymptotic speed which is distributed uniformly on $[-1, 1]$. We study the joint distribution of these speeds: the TASEP speed process.

   We prove that the TASEP speed process is a stationary measure for the multi-type TASEP dynamics. Consequently, we can describe every ergodic stationary measure as a projection of the speed process measure. This generalizes previous descriptions restricted to finitely many classes.

   By combining this result with known stationary measures for TASEPs with finitely many types we compute several marginals of the speed process, including the joint density of two and three consecutive speeds. One striking property of the distribution is that two speeds are equal with positive probability and for any given particle there are infinitely many others with the same speed.

   We also study the (partially) asymmetric simple exclusion process (ASEP). We prove that the states of the ASEP with the above initial configuration, seen as permutations of $\mathbb{Z}$, are symmetric in distribution. This allows us to extend some of our results, including the stationarity and description of all ergodic stationary measures, also to the ASEP.

5. G. Amir, O. Gurel-Gurevich, E. Lubetzky and A. Singer: *Giant components in biased graph processes* (**Submitted**).

   A random graph process, $\mathcal{G}_1(n)$, is a sequence of graphs on n vertices which begins with the edgeless graph, and where at each step a single edge is added according to a uniform distribution on the missing edges. It is well known that in such a process a giant component (of linear size) typically emerges after $(1+o(1))\frac{n}{2}$ edges (a phenomenon known as "the double jump"), i.e., at time $t = 1$ when using a timescale of $n/2$ edges in each step.

   We consider a generalization of this process, $\mathcal{G}_K(n)$, which gives a weight of size 1 to missing edges between pairs of isolated vertices, and a weight of size $K \in [0, \infty)$ otherwise. This corresponds to a case where links are added between n initially isolated settlements, where the probability of a new link in each step is biased according to whether or not its two endpoint settlements are still isolated.

   Combining methods of Spencer and Wormald with analytical techniques, we describe the typical emerging time of a giant component in this process, $t_c(K)$, as the singularity point of a solution to a set of differential equations. We proceed to analyze these differential equations and obtain properties of $\mathcal{G}_K$, and in particular, we show that $t_c(K)$ strictly decreases from $\frac{3}{2}$ to 0 as K increases from 0 to ∞, and that $t_c(K) =$

$\frac{4}{\sqrt{3K}}(1+o(1))$. *Numerical approximations of the differential equations agree both with computer simulations of the process* $\mathcal{G}_K(n)$ *and with the analytical results.*

6. G. Amir and O. Gurel-Gurevich: *The diameter of random cayley graphs on* Z_q (**To Appear in Groups – Complexity - Cryptology**).
   Consider the Cayley graph of the cyclic group of prime order q *with* k *uniformly chosen generators. For fixed* k*, we prove that the diameter of said graph is asymptotically (in* q*) of order* $\sqrt[k]{q}$.

   The same also holds when the generating set is taken to be a symmetric set of size $2k$.

7. G. Amir and O. Gurel Gurevich: *On Fixation of Activated Random Walks On Fixation of Activated Random Walks*(arxiv:0910.3730)(**Accepted for publication in the Electronic Communications in Probability**). *We prove that for the Activated Random Walks model on transitive unimodular graphs, if there is fixation, then every particle eventually fixates, almost surely. We deduce that the critical density is at most* 1*. Our methods apply for much more general processes on unimodular graphs. Roughly put, our result apply whenever the path of each particle has an automorphism invariant distribution and is independent of other particles' paths, and the interaction between particles is automorphism invariant and local. This allows us to answer a question of Rolla and Sidoravicius, in a more general setting then had been previously known (by Shellef).*

8. G. Amir, O. Angel and B. Virag: *Amenability of linear-activity automaton groups* (**submitted**)

   We prove that every linear-activity automaton group is amenable. The proof is based on showing that a sufficiently symmetric random walk on a specially constructed degree 1 automaton group – the mother group – has asymptotic entropy 0. Our result answers an open question by Nekrashevich in the Kourovka notebook, and gives a partial answer to a question of Sidki.

9. G. Amir and B. Virag: *A phase transition for automaton groups*(**In preparation**)

   We show that for any $d \geq 3$ *there exist polynomial-activity automaton groups of degree* d *which are not Liouville. This complements the results in 7 which showed that Linear activity (*$d = 1$*) automaton groups are Liouville , and is related to Sidki's conjecture on the amenability of all polynomial activity automaton groups. The proof involves analyzing the ascension operator defined in 7 to get bounds on the resistance between vertices in the Schrier graphs of these automaton groups, and using the bounds to construct a finite energy flow on the Schrier graph. The case* $d = 2$ *remains open.*

10. G. Amir, O. Angel, I. Benjamini and G. Kozma: 1-*Dimensional long range Diffusion Limited Aggregation I & II* (**Part I submitted**).

    We examine diffusion-limited aggregation generated by a random walk on $\mathbb{Z}$ *with long jumps. We derive upper and lower bounds on the growth rate of the aggregate as* *a function of the number of moments a single step of the walk has. Under various regularity conditions on the tail of the step distribution, we prove that the diameter grows as $n^{\beta+o(1)}$, with an explicitly given β. The growth rate of the aggregate is shown to have three phase transitions, when the walk steps have finite third moment, finite variance, and, conjecturally, finite half moment.*

11. G. Amir: *One-Dimensional long range Diffusion Limited Aggregation III - the limit aggregate*(**submitted**).

    In this paper we study the structure of the limit aggregate $A_\infty = \bigcup_{n\geq 0} A_n$ of the one-dimensional long range diffusion limited aggregation process defined in Part I. We show (under some regularity conditions) that for walks with finite third moment A_∞ has renewal structure and positive density, while for walks with finite variance the renewal structure no longer exists and A_∞ has 0 density. We define a tree structure on the aggregates and show some results on the degrees and number of ends of these random trees.

12. G. Amir and E. Lubetzky: *On two biased graph processes* (**Submitted**).

    *In (**??**)[above], the authors consider the generalization $\mathcal{G}_K^\vee$ of the ErdHos-Rényi random graph process $\mathcal{G}_1$, where instead of adding new edges uniformly, $\mathcal{G}_K^\vee$ gives a weight of size 1 to missing edges between pairs of isolated vertices, and a weight of size $K \in [0,\infty)$ otherwise. This can correspond to the linking of settlements or the spreading of an epidemic. The authors investigate $t_g^\vee(K)$, the critical time for the appearance of a giant component as a function of K, and prove that $t_g^\vee = (1+o(1))\frac{4}{\sqrt{3K}}$, using a proper timescale.*

    *In this work, we show that a natural variation of the model $\mathcal{G}_K^\vee$ has interesting properties. Define the process $\mathcal{G}_K^\wedge$, where a weight of size K is assigned to edges between pairs of non-isolated vertices, and a weight of size 1 otherwise. We prove that the asymptotical behavior of the giant component threshold is essentially the same for $\mathcal{G}_K^\wedge$, and namely $t_g^\wedge/t_g^\vee$ tends to $\frac{64\sqrt{6}}{\pi(24+\pi^2)} \approx 1.47$ as $K\to\infty$. However, the corresponding thresholds for connectivity satisfy $t_c^\wedge/t_c^\vee = \max\{\frac{1}{2},K\}$ for every $K>0$. Following the methods of (**??**), $t_g^\wedge$ is characterized as the singularity point to a system of differential equations, and computer simulations of both models agree with the analytical results as well as with the asymptotic analysis. In the process, we answer the following question: when does a giant component emerge in a graph process where edges are chosen uniformly out of all edges incident to isolated vertices, while such exist, and otherwise uniformly? This corresponds to the value of $t_g^\wedge(0)$, which we show to be $\frac{3}{2}+\frac{4}{3e^2-1}$.*

13. G. Amir, O. Angel and A. Holroyd: *Multi-coloured matchings*(**In preparation**)

    Suppose that we are given a sequence of independent poisson processes on Z^d, each having a different "colour", and a set of legal colour patterns (such as red-red-blue or green-green) We investigate translation-invariant schemes for partitioning the points into legal patterns.

Let X be the diameter of the pattern set of a typical point. We give an exact geometric criterion for the optimal tail behavior of X. This generalizes work of Holroyd, Pemantle, Peres and Schramm who studied the case in which there are at most two colours, and all patterns are of size 2 (Which corresponds to finding a perfect matching of the points)

14. G. Amir, I. Benjamini, O. Gurel-Gurevich and G. Kozma: *Random walk in changing environment* (**In preparation**).

    We introduce the notion of random walk in changing environment (RWCE), which is a random-walk process on a graph with conductances, in which the conductances of the edges change after every step of the walk according to some rule. These random walks generalize many known self-interacting random walks such as reinforced random walks and excited random walks.

    We study the following question: Given a graph G and a sequence of conductances C_n on G, perform a random walk on G by making the n-th step of the walk according to the conductances C_n. If $\{C_n(e)\}$ is increasing for each $e \in G$, and $C_n(e) \le C_\infty(e)$ with (G, C_∞) being recurrent, does this necessarily imply that our process is recurrent? We conjecture this to hold for any graph G.

    We prove that when G is a tree, this is indeed the case, even if the sequence of conductances C_n may depend on the history of the walk. On the other hand, we show that on $\mathbb{Z}^2$ and $\mathbb{Z}^3$, if we allow the changes to depend on the history of the walk, the process can be either transient or recurrent even if all conductances are always either 1 or 2

    Non - mathematical paper:

15. G. Amir and R. Axelrod: *Architecture and Techniques for an MMORTS.* **Massively Multiplayer Game Development 2 (Charles River Media, 2005)**

    In this article, we describe the algorithmic basis needed for implementing a Massive Multiplayer Online RealTime Strategy game (MMORTS) capable of sustaining hundreds of units for each player, all of which can affect their surroundings. We focus mainly on the task of keeping data consistency across all servers and all connected clients with minimal bandwidth, while keeping acceptable perceived latency. Stated differently, we need to send only the relevant information for each client and in a way that fits nicely into 1 to 2 KB/sec.