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Interests: Universality, large deviations + extremes, anti-concentration
Estimates & asymptotics (as opposed to exact formulae)
Emergence of "smooth" behavior for high-dimensional discrete structures

Methods from: high-dimensional geometry / geometric functional analysis,
extremal graph theory,
additive number theory.

Current areas of interest:

(I) Spectrum + pseudospectrum for random matrix polynomials

w/ Guionnet & Husson: convergence to the Brown measure for quadratic polynomials of Ginibre matrices

(e.g. the commutator $X_1X_2 - X_2X_1$) $\longrightarrow$ $\begin{pmatrix} -z & X_1 & X_2 \\ X_2 & I & \\ -X_1 & & I \end{pmatrix}$ $3N \times 3N$

$N \times N$

anticoncentration for $\det\left(\sum_{j=1}^{N} A_j \Xi_j\right)$

↑ random walk in $M_3(\mathbb{C})$

Problems: higher degree, $*$-polynomials, general entries

(II) Large deviations for random hypergraphs.

w/ Dembo & Pham: Quantitative LDPs for sparse Bernoulli tensors under generalized cut norms (à la Gowers).

Related to open problems about sparse regularity method + graph limits

& justifying the Naive mean-field approx. for partition functions (exponential random graph models).

Related directions: LDPs for extremal eigenvalues (Guionnet & Husson)

Disordered models? (Onsager correction)

(III) Extreme values of random fields.

(a) Kac polynomials: minimum modulus on the circle (w/ H. Nguyen, Yakir & Zeitouni). nearest roots to the circle

* Quantitative CLTs under Diophantine conditions

(b) Characteristic polynomials: max-modulus on the circle for Haar permutations (w/ Zeitouni).

* Quantitative LDPs under Diophantine conditions

(Non-) universality? - Other groups? iid matrices?

(c) Fisher-KPP systems + BVPs in higher dimension

w/ Dembo: front propagation for the Road-field model (H. Berestycki et al.)

Adapting Bramson's paradigm to branching processes interacting with a boundary.