Extrema of Logarithmically Correlated Processes, Characteristic Polynomials, and the Riemann Zeta Function

Monday 9 May 2016 – Friday 13 May 2016

Venue NSQI Seminar Room, G05, Ground Floor
The Bristol Centre for Nanoscience and Quantum Information (NSQI),
Tyndall Avenue, Bristol BS8 1FD

Organisers: **Yan. V. Fyodorov**, Queen Mary University of London, UK
Christopher Hughes, University of York, UK
Christian Webb, Aalto University, Finland

Monday 9 May 2016

Session 1

08:30-09:00	Registration
09:00-10:00	**Nina Snaith** Introduction to Riemann zeta and characteristic polynomials.
10:00-10:30	**Break**
10:30-11:15	**Jon Keating** Extreme values of Riemann zeta in finite intervals and RMT.
11:15-11:45	**Christopher Hughes** Extreme values of Riemann zeta over (0,T).
11:45-15:00	Work in groups and Lunch

Session 2

15:00-16.00	**David Belius** Free energy and entropy of the CUE characteristic polynomial
16:00-16:30	**Break**

16:30-17:15 **Adam Harper**
Log-correlated processes and number theory.

17:15-17:45 **Christian Webb**
Log correlated Gaussian fields and log-gases

Tuesday 10 May 2016

Session 1

09:00-10:00 **Elliot Paquette**
The correction term for the maximum of the CUE characteristic polynomial

10:00-10:30 **Break**

10:30-11:15 **Boris Khoruzhenko**
Fractional Brownian motion with Hurst index H= 0 and the Gaussian Unitary Ensemble.

11:15-11:45 **Nick Simm**
On Maxima of GUE characteristic polynomials.

11:45-15:00 Work in groups and Lunch

Session 2

15:00-16.00 **Dmitry Ostrovsky**
Theory of Barnes beta probability distributions.

16:00-16:30 **Break**

16:30-17:15 **Pierre Le Doussal**
Extrema of log-correlated fields: duality and freezing, moments of their position, and applications.

17:15-17:45 **Xiangyu Cao**
Extreme value statistics of 2D Gaussian free field: effect of finite domains.

Wednesday 11 May 2016

Session 1

09:00-10.00 **Nathanael Berestycki**
Introduction to Gaussian multipliccative chaos.

10:00-10:30 **Break**

10:30-11:15 **Rémi Rhodes**
Freezing for log-correlated fields

11:15-11:45 **Eero Saksman**
Multiplicative chaos measures for a random model of the Riemann zeta function

11:45-15:00 Work in groups and Lunch

Session 2

15:00-16:00 **Paul Bourgade**
Rigidity of one-component plasma in 2D

16:00-16:30 **Break**

16:30-17:15 **Ashkan Nikeghbali**
The Circular Unitary Ensemble and the Riemann Zeta Function: the microscopic landscape.

17:15-17:45 **Joseph Najnudel**
On the maximum of the characteristic polynomial of the Circular Beta Ensemble.

Thursday 12 May 2016

Session 1

09:00-10:00	Open Problem Session.
10:00-10:30	**Break**
10:30-11:15	**Anna Lytova** Linear eigenvalue statistics for sample covariance matrices without independent structure in columns
11:15-11:45	**Alexi Reynolds** Moments of beta-ensembles.
11:45-15:30	Work in groups and Lunch

Session 2

15:30-16:30	**Igor Krasovsky** Transition asymptotics for Toeplitz and Fredholm determinants
16:30-17:00	**Break**
17:00-17:45	**Anna Maltsev** Linear statistics of half-heavy-tailed random matrices.
19:00	Conference Dinner at **the Square Kitchen** 15 Berkeley Square, Bristol, BS8 1HB

Friday 13 May 2016

09:15-10.00	**Francis Lane** The largest fragment of a homogeneous fragmentation process
10:00-10:30	**Break**
10:30-11:15	**Jonathan Bober** Statistics of character sums
11:15-11:45	**Yan Fyodorov** Concluding remarks
11:45-15:30	Work in groups and Lunch
15:30	Departure

Heilbronn Institute for Mathematical Research

Abstracts:

Monday 9 May 2016

Nina Snaith

Introduction to Riemann zeta and characteristic polynomials.
This survey will give some background on the use of characteristic polynomials of random unitary matrices to model the values of the Riemann zeta function.

Jon Keating

Extreme values of Riemann zeta in finite intervals and RMT.
I will review the background to recent developments concerning the extreme value statistics of the characteristic polynomials of random matrices and of the Riemann zeta-function on short sections of the critical line.

Christopher Hughes

Extreme values of Riemann zeta over (0,T).
In 2007 Farmer, Gonek and myself put forward a precise conjecture for the maximum value of the Riemann zeta function on the critical line up to height T. This talk will explain how we arrived at that conjecture.

David Belius

Free energy and entropy of the CUE characteristic polynomial

Adam Harper

Log-correlated processes and number theory.
I will describe some instances of the connection between log-correlated processes and number theory. I will focus on the "typical maximum" of the Riemann zeta function and its connection, via random Euler products, with branching random walk, giving some further details of my joint work with Arguin and Belius (which will partly be discussed in their talks as well). If time permits, I will also mention some related work and open problems involving random multiplicative functions.

Christian Webb

Log correlated Gaussian fields and log-gases
This will be an overview talk about different objects in models related to random matrix theory giving rise to log-correlated Gaussian fields. We will also discuss briefly some related results concerning Gaussian Multiplicative Chaos measures in random matrix theory.

Tuesday 10 May 2016

Elliot Paquette

The correction term for the maximum of the CUE characteristic polynomial.

With Ofer Zeitouni, we investigate the correction term to the maximum of the CUE characteristic polynomial, building on recent work of Arguin, Belius, and Bourgade. We show that the correction term to the maximum of the CUE characteristic polynomial agrees with the prediction of Fyodorov, Hiary and Keating. We will give an overview of this approach, which is roughly based on an approach of decomposing the problem into two sub-problems, one problem on a mesoscopic scale and one problem on a microscopic scale. On the mesoscopic scale, we use strong Gaussian approximations to execute the canonical barrier method technique for bounding the maximum of log-correlated fields. On the microsocopic scale, we use a novel exponential moment technique, sufficient to capture the leading order behaviour of the subfield. Moreover, using a new class of Toeplitz determinant identities, we can effectively condition on the behaviour of the mesoscopic field while making estimates about the microscopic field.

Boris Khoruzhenko

Fractional Brownian motion with Hurst index H= 0 and the Gaussian Unitary Ensemble.

We introduce a regularized version of fractional Brownian motion with zero Hurst index. This is a Gaussian process with stationary increments and logarithmic increment structure which appears as a limit of D_N(z) = ? log | det(H ? zI)| for GUE matrices
H on mesoscopic scales in the limit of infinite matrix dimension N. The fractional Brownian motion with zero hurst index can also be used to prove a continuous analogue of the Diaconis-Shahshahani theorem. [This is a joint work with Yan Fyodorov and Nick Simm]

Nick Simm

On Maxima of GUE characteristic polynomials.

The characteristic polynomial p_N(x) of an (N x N) random matrix is a fundamental object with important connections to other fields such as number theory. It is also an important example of a log correlated field. For the GUE ensemble of Gaussian random matrices, we provide a heuristic method for determining the law of the maximum of \log|p_N(x)| for large N. The limit law is a randomly shifted Gumbel variable and we conjecture an explicit formula for the Laplace transform of the shift. This is joint work with Yan Fyodorov.

Heilbronn Institute for Mathematical Research

Dmitry Ostrovsky

Theory of Barnes beta probability distributions

I will give an overview talk on the theory of Barnes beta probability distributions to be based on the following publications:

Ostrovsky D 2013 Selberg integral as a meromorphic function Int. Math. Res. Not.
Ostrovsky D 2013 Theory of Barnes beta distributions Electron. Commun. Probab.
Ostrovsky D 2014 On Barnes beta distributions, Selberg integral and Riemann XI Forum Math.

Pierre Le Doussal

Extrema of log-correlated fields: duality and freezing, moments of their position, and applications.

I will briefly review the duality-freezing conjecture for a class of integrable log-correlated gaussian random fields. I will present recent results about the moments of the position of the maximum and applications, and about the min-max correlations.

Xiangyu Cao

Extrema of 2D Gaussian Free Field on a circle: observables and deformations

The 2D Gaussian Free Field (GFF) on a circle provides an exactly solvable logarithmically correlated random energy model, first studied by Fyodorov and Bouchaud (FB), who calculated the free energy/minimum distribution, when the GFF is on the infinite plane.

In this talk, we discuss the deformed case of the GFF in a disk with Dirichlet boundary condition. Using the replica trick and Jack polynomials, we calculate exactly the high-temperature free energy distribution, and show the duality invariance property, essential for applying the Freezing-Duality Conjecture to the low-temperature phase.

Then we re-interpret our results in terms of infinite series of observables in the original FB model. The first one, the Edwards-Anderson order parameter, provides a very convincing numerical test of the Freezing-Duality conjecture.
More recent results on opposite extrema obtained with similar techniques will be discussed if time permits.

Based on joint work with P. Le Doussal, A. Rosso and R. Santachiara.

Wednesday 11 May 2016

Nathanael Berestycki

Introduction to Gaussian multipliccative chaos

Gaussian multiplicative chaos is the theory introduced by Kahane in the 80s whose aim is to make sense of random measures of the form \exp (\gamma X(z)) dz where X is a log-correlated Gaussian random field in \R^d. Roughly speaking this is done by first choosing a regularisation of the field and then taking a limit.
I will discuss a recent elementary argument for the construction of such measures when \gamma < \sqrt{2d} (corresponding to the so-called subcritical phase) which shows that the limiting measure is a function of the field X and is furthermore independent of the chosen regularisation.
Time-permitting I will also discuss some recent joint work with Scott Sheffield and Xin Sun on the converse question, which asks whether the field X can be recovered given the multiplicative chaos measure.

Rémi Rhodes

Freezing for log-correlated fields

In this talk I will review results on freezing for log-correlated fields. More precisely, I will discuss freezing for real values of the temperature and then explain results and conjectures in the complex case.

Eero Saksman

Multiplicative chaos measures for a random model of the Riemann zeta function.

We study the existence of non-Gaussian multiplicative chaos measures that are constructed over a random field that arises as a model for the statistical behaviour of the Riemann zeta-function over the critical line. The talk is based on joint work with Christian Webb (Aalto University).

Paul Bourgade

Rigidity of one-component plasma in 2D

The one-component plasma (OCP) is a Coulomb gas of N equal negatively charged particles (in the continuum) confined by a potential. In two dimensions, for a special temperature, it is integrable as a determinantal point process, and the system can be understood is much detail. However, for generic temperatures, our understanding is rather limited, and even basic properties of its behaviour are not even understood heuristically. I will discuss a proof that fluctuations are much smaller than for a Poisson process, at all finite temperatures.
This is joint work with Bauerschmidt, Nikula, and Yau.

Ashkan Nikeghbali

The Circular Unitary Ensemble and the Riemann Zeta Function: the microscopic landscape.

We show in this paper that after proper scalings, the characteristic polynomial of a random unitary matrix converges almost surely to a random analytic function whose zeros, which are on the real line, form a determinantal point process with sine kernel. As an application, we give a solution to the problem of convergence of ratios of characteristic polynomials at the microscopic scale and we conjecture some new limit theorems for the value distribution of the Riemann zeta function on the critical line at the stochastic process level.

Joseph Najnudel

On the maximum of the characteristic polynomial of the Circular Beta Ensemble.

We present recent progress on the extremal values of (the logarithm of) the characteristic polynomial of a random unitary matrix whose spectrum is distributed according to the Circular Beta Ensemble. Using different techniques, it constitutes a follow-up to the work by Arguin, Belius, Bourgade on the one hand, and Paquette, Zeitouni on the other hand. They recently treated the CUE case, which corresponds to beta equal to 2.

Thursday 12 May 2016

Anna Lytova

Linear eigenvalue statistics for sample covariance matrices without independent structure in columns.

Here we deal with sample covariance matrices having some general dependence structure in columns. In particular, a tensor product version of sample covariance matrices is under consideration. We discuss results on convergence of the corresponding normalized counting measures of eigenvalues and present the CLT for linear eigenvalue statistics.

Alexi Reynolds

Moments of beta-ensembles.

Jack polynomials are symmetric functions which appear numerous times in the theory of beta-ensembles. The moments of the eigenvalue densities of beta-ensembles have explicit formulae, which may be written as linear combinations of the averages of Jack polynomials. These explicit formulae are derived by writing the power sum symmetric polynomials in terms of the Jack polynomials and therefore the coefficients of the formulae are the inverses of specific Jack characters. This talk summarises the work contained in the paper 'Moments of the eigenvalue densities and of the secular coefficients of beta-ensembles' by Francesco Mezzadri and Alexi Reynolds, which can be found here:
http://arxiv.org/abs/1510.02390

Igor Krasovsky

Transition asymptotics for Toeplitz and Fredholm determinants

We will discuss recent results on the asymptotic behaviour of certain Toeplitz and Fredholm determinants appearing in the theory of random matrices and related areas focusing on the situation where a transition between 2 different asymptotic regimes takes place. The talk is based on joint works with Th. Bothner, T. Claeys, P. Deift, and A. Its.

Anna Maltsev

Fluctuations of linear statistics of half-heavy-tailed random matrices.
We will consider a Wigner matrix A with entries whose cumulative distribution decays as $x^{-\alpha}$ with $2 < \alpha < 4$ for large x. We prove that the fluctuations of the linear statistics $N^{-1} \operatorname{Tr} \phi(A)$, for some nice test functions ϕ, have order $N^{-\alpha/4}$. The behavior of such fluctuations has been understood for both heavy-tailed matrices (i.e. $\alpha < 2$) and light-tailed matrices (i.e. $\alpha > 4$). Our result fills in the gap of understanding for $2 < \alpha < 4$. We find that while linear spectral statistics for heavy-tailed matrices have fluctuations of order $N^{-1/2}$ and those for light-tailed matrices have fluctuations of order N^{-1} , the linear spectral statistics for half-heavy-tailed matrices exhibit an intermediate α-dependent order of $N^{-\alpha/4}$.

Friday 13 May 2016

Francis Lane

The largest fragment of a homogeneous fragmentation process
Homogeneous fragmentation processes describe the evolution of an object that breaks down randomly into pieces as time passes. We describe the size of the largest piece at a given large time and argue that this result is in line with predictions arising from the formal classification of homogeneous fragmentation processes as logarithmically correlated random fields. This is joint work with Andreas Kyprianou and Peter Morters.

Jonathan Bober

Statistics of character sums.
I'll talk about sums of Dirichlet characters. I'll mostly focus on the distribution of the maximum of such sums, the frequency with which this maximum is large, and the "random model" we have for the maximum as a maximum of a specific Fourier series with random multiplicative coefficients.

Participants

Ardavan Afshar	UCL, London	UK
Emma Bailey	Bristol	UK
David Belius	Courant	US
Nathanael Berestycki	Cambridge	UK
Jonathan Bober	Bristol	UK
Paul Bourgade	Courant	US
Ian Cooper	Bristol	UK
Pierre Le Doussal	ENS	France
Yan Fyodorov	QMUL	UK
Sven Gnutzmann	Nottingham	UK
Tamara Grava	Bristol	UK
Adam Harper	Cambridge	UK
Christopher Hughes	York	UK
Jon Keating	Bristol	UK
Boris Khoruzhenko	QMUL	UK
Igor Krasovsky	Imperial College London	UK
Francis Lane	Bath	UK
Anna Lytova	Edmonton	Canada
Anna Maltsev	Bristol	UK
Francesco Mezzadri	Bristol	UK
Joseph Najnudel	Toulouse	France
Ashkan Nikeghbali	Zurich	Switzerland
Neil O'Connell	Warwick	UK
Dmitry Ostrovsky	Yale	US
Elliot Paquette	Weizmann Institute	Israel
Alexi Reynolds	Bristol	UK
Rémi Rhodes	Univ. of Paris	France
Alberto Rosso	Paris Sud	France
Eero Saksman	Helsinki	Finland
Marius Schmidt	Frankfurt	Germany
Nick Simm	Warwick	UK
Nina Snaith	Bristol	UK
Christian Webb	Helsinki	Finland
Mo Dick Wong	Cambridge	UK
Ofer Zeitouni	Weizmann Institute	Israel

Network and WiFi

Participants from Eduroam Organisation

The University is part of the Eduroam federation which provides reciprocal access to wireless internet for staff and students from other Eduroam institutions.

Visitors from an Eduroam organisation should find their laptops and mobile devices automatically connect to wireless at Bristol, provided that they have been correctly configured for Eduroam in advance at the home organisation.

If there are any problems, requests for technical support must be directed to the home organisation and cannot be handled by IT support at Bristol.

The Cloud WiFi

Staff, students and visitors capable of using Eduroam should do so in preference to The Cloud. If you still want to use The Cloud then connecting is easy.

You simply need to connect to 'The Cloud' wireless signal in the WiFi settings of your device

Once connected, open your web browser and refresh the page

You will see The Cloud landing page and here you can login/register with your account

Once logged in you're good to go! Please note that web based apps will not work until the connection has been established and you have signed in successfully via your web browser.

Travel Information

Workshop Venue:

Nanoscience and Quantum Information (NSQI) Building
G05, Ground Floor Seminar Room
Tyndall Avenue
Bristol BS8 1FD

By Plane: Bristol Airport is 13 km south of the city and has scheduled flights to many UK and European cities. To get to the University from the airport:

- The Bristol Flyer **coach** service: https://flyer.bristolairport.co.uk
  The Airport Flyer is available 24 hours a day, 7 days a week. At peak times, its leaves up to every 8 minutes. Calls at Bristol Bus and Coach Station near the University campus (see map).

- Arrow Cars **Taxi**: www.bristolairport.co.uk/to-and-from-the-airport/taxis
  Offer taxis from Bristol Airport. The journey should take around 30 minutes.

By Rail: Bristol Temple Meads Railway Station is 15 minutes away by car although traffic can be heavy which will increase your travel time. Regular buses and taxis pick up from the train station. The 520, 8 or 9 bus will take you in walking distance of Tyndall Avenue.

By Bus: The number 8 and number 9 buses run to and from Bristol Temple Meads train station and run every 10 minutes in peak times. The nearest stop is on Queens Road, near Sainsbury's supermarket (turn right on exiting Wills Memorial building and walk 200m). The journey should take about 20-30 minutes.

www.firstgroup.com/bristol-bath-and-west

Taxi Service:		
	V-Cars	0117 925 2626
	City Link Taxis	0117 925 1111
	Streamline Taxis	0117 926 4001

Where to Eat

Local Restaurants

Welcome to Bristol! We have included here a small selection of recommended restaurants local to the University precinct that you may want to visit during your stay. However, it's not exhaustive, and you'll find a large variety of eateries in Bristol to suit every taste and budget so consider it a starting point!

The Townhouse Bar & Restaurant
85 Whiteladies Road, Clifton, Bristol BS8 2NT
0117 973 9302 | www.thetownhousebristol.co.uk

No.4 Clifton Village
The Rodney Hotel, 4 Rodney Place, Bristol, BS8 4HY
0117 9706869 | www.no4cliftonvillage.co.uk

Souk Kitchen
59 Apsley Road, Clifton, Bristol, BS8 2SW
0117 906 7690 | http://soukitchen.co.uk/clifton/

NOA Japanese Restaurant
12 -13 Waterloo Street, Clifton, Bristol BS8 4BT
0117 973 2881 | www.noajapanese.co.uk

The Clifton Sausage
7 Portland Street, Bristol, BS8 4JA
0117 973 1192 | www.cliftonsausage.co.uk/clifton

Flinty Red
34 Cotham Hill, Bristol, BS6 6LA
0117 923 8755 | www.flintyred.co.uk

Lido
Oakfield Place, Clifton, Bristol, BS8 2BJ
0117 933 9530 | www.lidobristol.com

Jamie's Italian
87/89 Park Street, Bristol, BS1 5PW
0117 370 00265 | www.jamieoliver.com