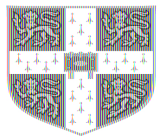
UNIVERSITY OF CAMBRIDGE

A PhD in Probability?

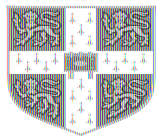


UNIVERSITY OF CAMBRIDGE

A PhD in Probability?

Do you enjoy courses on the following topics?

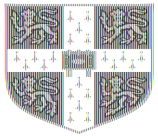
- Probability
- Markov chains
- Random processes
- Martingales
- Brownian motion
- Stochastic calculus
- Financial mathematics
- Analysis



UNIVERSITY OF CAMBRIDGE

A PhD in Probability?

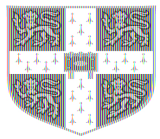
- **Expanding and dynamic area**
- **Makes connections with many areas of mathematics**
- **Increasingly an essential tool in mathematical modelling and computational mathematics**
- **Links rigorous mathematics and applications**



UNIVERSITY OF CAMBRIDGE

Where in the UK?

- **Bath:** Harris, Kyprianou, Moerters, Penrose
- **Cambridge:** Berestycki, Grimmett, Norris, Rogers
- **Durham:** Hryniv, MacPhee, Menshikov
- **Edinburgh:** Gyongy
- **Heriot Watt:** Foss, Waters, Zachary
- **Imperial:** Crisan, Zegarlinski
- **Leeds:** Veretennikov
- **Manchester:** Peskir, Zhang



UNIVERSITY OF CAMBRIDGE

Where in the UK?

- **Oxford:** Donnelly, Etheridge, Hambly, Lyons, Martin
- **Sheffield:** Applebaum, Biggins
- **Strathclyde:** Higham, Mao
- **Swansea:** Jacob, Wang
- **Warwick:** Hairer, Hobson, Jacka, Kendall, Kolokoltsov, Li, Kotecky, O'Connell, Stuart, Warren
- **York:** Brzezniak

UNIVERSITY OF CAMBRIDGE

Masters and PhD Study in Mathematics at Cambridge

Masters and PhD study in mathematics at Cambridge

- **Master of Advanced Study in Mathematics (also known as Part III)**
- **PhD (including Cambridge Centre for Analysis)**
- **See www.maths.cam.ac.uk/postgrad**

UNIVERSITY OF CAMBRIDGE

Part III

- **Intensive one-year taught Masters course**
- **Around 250 students, more than half coming from other universities worldwide**
- **First class degree is a usual entry requirement**
- **Most Cambridge PhD students take Part III first**
- **Applications preferred by 31 January**

PhD (excluding CCA)

- Department of Pure Mathematics and Mathematical Statistics (DPMMS)
  - Around 17 students per year
  - Two direct from other UK universities
- Department of Applied Mathematics and Theoretical Physics (DAMTP)
  - Around 24 students per year
  - Four direct from other UK universities

UNIVERSITY OF CAMBRIDGE

PhD (excluding CCA)

- **Direct transfers most common in Fluids and Statistics**
- **Entry requirement is a good First**
- **Funding from EPSRC, STFC, Cambridge Trusts**

EPSRC

Cambridge Centre for Analysis

What is the CCA?

The Admissions Process

Admissions

Who should apply?

We expect our candidates to have either completed or to be in the final year of *either*:

- A Masters-level course in mathematical sciences *or*
- A four-year (or longer) degree course in a mathematical subject

We are aware that standards vary across universities and countries, and that the very structure of mathematics degrees is very different, e.g. in different European countries. If in doubt whether your credentials measure up to our requirements, it is always a good idea to contact the CCA directors for advice.

Admissions

The timeline

- The deadline for applications is **15th January 2011**.
- Shortlisted applicants will be interviewed in mid-February, whether in Cambridge or by Skype.
- We will make offers in early March.

What are the criteria for admission?

1) Our first and foremost criterion is academic excellence and promise.

We expect to assemble a cohort of excellent students hence academic performance so far and our impression of you during the interview are critical.

2) A frame of mind that seeks breadth across mathematical analysis, as well as depth in your own area of study.

A central tenet of the CCA ethos is that *all* of analysis matters and that, inasmuch as (being human) you are likely to focus on one of its aspects, you should have basic understanding across the subject. We are aware that some students might (legitimately) prefer standard, more immediately focussed PhD studies.

What are the criteria for admission?

3) Knowledge of analysis.

It is an advantage to have taken courses across the analysis range. Mind you, gaps can be closed, whether by taking first-year supplementary courses or by self-study, but clearly the *size* of gaps matters.

Knowledge of analysis in greater detail

We expect no student to have knowledge of everything. Enjoyment of some subset of such courses is a positive indicator for the CCA.

- Real Analysis
- Complex Analysis
- Functional Analysis
- Fourier Analysis
- Measure Theory
- Probability
- Markov Chains
- Martingales
- Brownian Motion
- Partial Differential Equations
- Numerical Analysis of DEs
- Numerical Algebra
- Applied PDEs
- Asymptotic Analysis
- Integrable Systems
- Mathematical Physics
- Theoretical Fluid Dynamics
- Scattering and Wave Theory
- Dynamical Systems

The offers

Offers to those in the final year of their studies will usually be conditional upon performance in the relevant course of studies.

We are aware that students seek (legitimately) to maximise their chances by applying to different universities. It might well happen that, having received a conditional offer, you also obtain an unconditional offer from elsewhere and are obliged to give an answer by tight deadline. In that case, do contact us and we'll see what can be done.

Funding

Funding

The CCA offers up to ten EPSRC studentships per year.

The conditions of EPSRC funding are as follows:

- UK and EU nationals ‘normally resident in UK’ are eligible for full funding (fees and maintenance stipends).
- EU nationals resident elsewhere in EU are eligible for fees-only funding. We’ll attempt to help those eligible for fees-only funding to secure additional funding for their maintenance.

Funding

In addition, the CCA offers a small number of studentships funded by the University of Cambridge.

These studentships are open to all applicants, without restrictions of nationality and they cover both fees and maintenance.

Funding

Finally, we are willing to accept a small number of students that have secured funding from other sources, as long as the total size of each year's cohort is at most 16.

The First Year

The first year

Rules of the game

It is a requirement of EPSRC that the first of the four years at a Centre for Doctoral Training (such as CCA) should have substantial taught components.

This chimes well with our philosophy, namely that studies in mathematical analysis require broad basis of knowledge in pure, applied, stochastic and computational analysis.

However … it is clear (and 'market research' confirmed this) that the last thing students wish is yet another year of formal lecture courses and formal exams

The first year structure has been designed consistently with these imperatives.

Components of the first-year programme

1. Three core courses:
    (a) Analysis of partial differential equations
    (b) Stochastic Analysis
    (c) Computational Analysis
2. Supplementary courses
3. Two mini-projects

Each student is assigned a Director of Studies from amongst CCA Members for the duration of the first year.

The Core CCA Courses

The purpose: to provide students with a broad shared body of knowledge in different aspects of mathematical analysis. Each course will be (formally) 24-hours long

All the courses are based on a mixture of formal lectures, group study and exploration and oral presentations by students.

Each core CCA course is the responsibility of a group of academics, with one person at the lead.

At the beginning of the year, students divide into three or four groups that persist through the first year and serve as a focus for the hands-on group work.

CCA Mini-projects

Each student will undertake two mini-projects: one in Michaelmas and the second in Lent Term. One of these will be in pure or stochastic analysis, the other in applied or computational analysis.

Mini-project 1

The first mini-project is modest in scope: commencing from a thorough literature review in a well-defined subject, and making a critical appraisal of the state of the art. The project may also involve some original research work under the guidance of the supervisor.

Mini-project 2

Second mini-projects are more ambitious in their scope.

As well as understanding the relevant literature, the student will engage in original research and be encouraged to include elements drawing on modern techniques of theory and computation.

The assessment of this mini-project is in two parts: a conference-style presentation to the full CCA (in late May) and a substantial final written report (approximately 30 pages in the style of a journal paper) to be submitted in mid-June. Feedback to the student on the second mini-project is given in late June.

Often one of the mini-projects will eventually evolve into a fully-fledged PhD dissertation in years 2–4.

List A – Pure/Stochastic

- Infinite Stationary Coalescence
- A model of percolation with freezing
- Decay and stability properties for linear and nonlinear wave equations
- Generalised harmonic maps associated to nonlocal Skyrme energy functionals
- Continuum percolation
- The complex Monge–Ampère equation with applications to Ricci-flat manifolds
- Information theory and fundamental limitations of feedback
- Hypocoercivity and entropy in kinetic theory
- Fractional diffusion limits
- Functional limit theory for statistical inverse problems
- Shape-constrained density estimation under model misspecification
- Branched minimal graphs
- The two-sided exit problem for Lévy processes
- Mean-field Markov chains
- Coalescing diffusions
- Fractal measures
- Dynamic stochastic games
- A stochastic method for calculating sensitivities in Smoluchowski's coagulation equation

Cambridge Centre for Analysis

List B – Applied/Computational

- Vortex generation in exciton-polariton condensates
- Transient perturbation growth in stratified shear flows
- Efficient quadrature for subdivision-based finite element analysis
- Multiscale coupling of continuum and particle models
- Duality methods for parabolic systems
- The generalized D-to-N map for evolution equations on the half-line and transparent boundary conditions
- Initial-Boundary value problems for a Burgers type equation
- Stochastic dynamics of coupled flagella
- Generalized sampling and compressed sensing in magnetic resonance imaging
- Optimization of compressed sensing by image transformation
- Fast expansions of orthogonal functions
- B-series: from Runge–Kutta methods to multiscale computations to Feynman diagrams
- The classical limit of Bohmian quantum mechanics
- Free boundary problems in finance
- Pseudospectra and the stability of aerodynamic flows
- Padé approximants, the Wiener–Hopf technique and wave scattering
- Wave singularities in ideal fluids
- Low shear viscosity of microgel dispersions
- Inpainting of a vandalised image using a fourth-order nonlinear partial differential equation
- Understanding sparsity – the relation between ℓ_0 and ℓ_1 minimisation
- Explicit form of Zolotarev polynomials
- Landau-Kolmogorov inequalities
- Global existence theorems for 2-D nonlinear Schrödinger equations

Years Two–Four

PhD study in Years Two to Four

The choice of the PhD supervisor

- The primary PhD supervisor of a CCA student will usually be a member of the CCA Team.
- The primary supervisor can also be another member of the Mathematics Faculty or of another Faculty of the University, or even come from industry.
- In addition, each student will have a second supervisor (chosen according to the criteria above) to provide backup in the absence of the primary supervisor and to extend, as necessary, the thematic range.
- Both supervisors will be chosen by the end of the first year.

PhD study in Years Two to Four

We welcome students into the first year

- Who have not yet decided on their eventual research direction and wish to explore first the different strands of analysis at CCA, or
- Who have a prior direction, even an eventual supervisor in mind, but who are committed also to the breadth of training offered at CCA

In the second case, we recommend prospective students to engage in exploratory discussions with relevant supervisors about the route they want to take. Whilst we will try to oblige, CCA cannot guarantee the willingness of a particular supervisor to take on any particular student, or the availability of a supervisor in a narrowly specified area.

Primary Objective

Original mathematical research leading to a PhD dissertation.

Secondary Objectives

- **Continuing development of a broad range of skills in mathematical analysis:**
  - Mini-courses
  - CCA seminars
- **Learning to collaborate with others:**
  - Ongoing cohort interaction
- **Developing an understanding of the challenges and opportunities facing mathematicians engaging with other sciences, engineering and industry:**
  - Industrial Seminars (monthly)
  - Annual industry connectivity week

Secondary Objectives

- **Acquiring life-skills of a professional mathematician:**
  - Seminar and paper-writing techniques
  - Annual CCA-MASDOC workshop
  - Taking part in conferences and workshops outside Cambridge
  - Preparation of research plans and grant proposals
  - Use of mathematical software
  - LaTeX
  - Mentoring of less experienced students

More about CCA

The home of CCA

CCA is based in modern spacious offices in the Centre for Mathematical Sciences (CMS), with a common room, including a small kitchen as well as a whiteboard, and other amenities.

There are three research students to each office. All offices are equipped with desks, computers, laptop connections, shelves and a whiteboard.

The CCA Administrator, lecturers and research fellows are all situated in the CCA area or nearby in CMS.

The CMS is home to a lively community of mathematicians with numerous seminars and events taking place in the lecture theatres or the *Maths Café,* from the upcoming Emmanuel Candés lectures to salsa lessons.

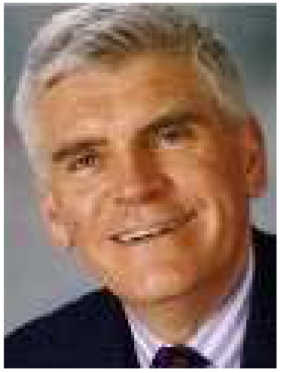
Who's who? CCA Steering Committee

Sir John Ball FRS
University of Oxford

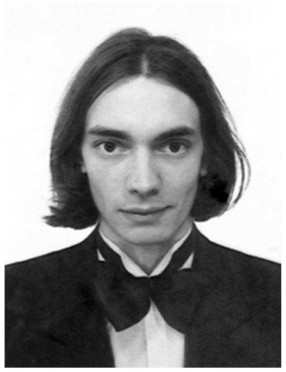
Professor Andrew Blake FRS
Microsoft Research

Professor Peter Haynes
Head of DAMTP

Professor Martin Hyland
Head of DPMMS



Dr Bruce Smith
Smith Institute for Industrial Mathematics



Professor Cédric Villani
École Normale Supérieure de Lyon

Who's who? CCA Staff

Dr Nathanael Berestycki

Dr Colm Caulfield

Dr Mihalis Dafermos

Dr Sophia Demoulini

Professor Thanasis Fokas

Professor Geoffrey Grimmett

Professor Arieh Iserles

Professor Frank Kelly

Professor Thomas Körner

Professor Peter Markovich

Dr Clément Mouhot

Dr Richard Nickl

Professor James Norris

Professor Nigel Peake

Dr Richard Samworth

Dr Carola-Bibiane Schölieb

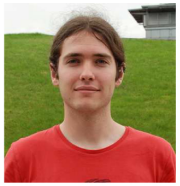
Dr Alexei Shadrin

Dr David Stuart

Dr Neshan Wickramasekera

Who's who? CCA Students

Marc Briant
Bordeaux, France



Damon Civin
Benoni, South Africa

Spencer Hughes
London, UK

Anastasia Kisil
Leeds, UK

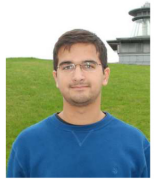
Bernd Kuhlenschmidt
Osnabruek, Germany

Sara Merino
Barcelona, Spain

Edward Mottram
Lincoln, UK

Kostas Papafitsoros
Athens, Greece

Florian Pinsker
Vienna, Austria



Kolyan Ray
Geneva, Switzerland

Bati Sengul
Brentwood, UK