



## DEPARTMENT OF MATHEMATICS

<http://www.royalholloway.ac.uk/mathematics/home.aspx>

<https://www.facebook.com/MathsRHUL>

## ROYAL HOLLOWAY UNIVERSITY OF LONDON

### EXPOMAT14

### A day in “Exploring Mathematics”

We are delighted to welcome so many of you to our ‘2014 Exploring Mathematics’ day. You will have a varied programme of *talks, quizzes, and mind-games* that our team hopes will challenge you and shed some light over what it is like to think as a mathematician, not only in “mathematical stuff” but also in many (all?!) other areas of human knowledge.

All activities are led by members of staff who are leaders in their respective research fields and who will be more than happy if any of you wants to ‘pop up’ one or two (not more...) challenging questions during or at the end of the sessions! You are also welcome to ask questions about what it is like to study mathematics in our department. Current mathematics students will be available during the day wearing bright orange t-shirts.

Popular demand from previous years led to one of the small afternoon sessions on “Mathematics at University” being taken on as one of the plenary sessions. Also, due to the success of last year’s small group sessions, you now have the opportunity to attend two talks as we repeat the group sessions on offer in the morning and in the afternoon.

What we really wish is that you **enjoy the day** and that it will inspire you to take a **strong interest in** developing your knowledge of **mathematics**.

Dr Francisca Mota-Furtado  
Reader in Mathematics, Schools Liaison Officer



## PROGRAMME - EXPOMAT14

### Exploring Mathematics, Monday 30th June 2014

**09.15:** Start of registration and refreshments.

(Please check that all schools travelling by car will display 'Exploring Mathematics' on the dashboard!)

**09.35: Welcome** by the Principal – *Professor Paul Layzell*

**09.45:** Quick **quiz session** with prizes – *Laurence O'Toole*

**10.20: The Mathematics of Juggling**– *Colin Wright*

**11.30–12.10: Small group sessions** on a variety of topics. Please see details in the following pages.

#### **12.10: Lunch, and tours of Campus**

We recommend that you bring your own packed lunch and enjoy our beautiful campus while eating it; otherwise you can buy sandwiches and snacks from *Crossland Café, Founder's Building*, from *Café Jules, International Building* and from the *campus shop* (please be aware that there might be queues).

Please see the campus map on the last page, where locations are shown.

**Tours of campus** lasting 30 minutes will leave from outside the Windsor Building at **12.15** and at **12.45**.

**12.45-13.15:** Special group **session for teachers** only!-Further Mathematics-  
*Ms Gill Buque*

**13.30 -14.10: Small group sessions** (repeat from the session at 11.30 so that you can attend a second session)

**14.20: Mathematics at University** – *Professor James McKee*

**15.00: The Shape of Space** – *Professor Brita Nucinkis*

**16.00:** Closing comments. End of conference

**Events are in the Windsor Building** - Main lecture theatre for all plenary sessions with most of the small group sessions running in the various other rooms in the same building. One of the small group sessions will run in the McCrea building where the Department of Mathematics is located and two others will be in the Bourne Building and in the Arts Building.

## PLENARY TALKS

### **The Mathematics of Juggling**

**Colin Wright**

Juggling has fascinated people for centuries. The skilled practitioner will keep several objects in the air at one time, and weave complex patterns that seem to defy both gravity and analysis. In this talk we develop a simple method to describe and annotate juggling patterns. We see how simple mathematics can be used to classify them, to describe those patterns that are known already, and discover a technique for creating new ones.

*While earning his PhD from Cambridge University in the 1980s, Colin also learned how to fire-breathe, unicycle, juggle and ballroom dance. He has worked as a research mathematician, a computer programmer, and an electronics hardware designer, and takes time to give talks all over the world on various mathematical topics.*

### **Mathematics at University**

**Professor James McKee**

Are you interested in studying Mathematics at University? This session will deal with the types of course available and the qualifications required, the ways in which university mathematics is different from or similar to that at A level, and the careers available.

*Professor James McKee is the Head of the Department of Mathematics. He works at the interface of number theory and combinatorics, with computational leanings. His recent work has mostly been connected with associating algebraic numbers with certain combinatorial objects.*

### **The Shape of Space**

**Professor Brita Nucinkis**

How big is the universe? Is it finite or infinite? Does it have a boundary? What is its shape? We use methods from topology to understand these questions. We will begin by exploring these questions in 2 dimensions, and will then extend this to dimensions 3 and above.

*Brita Nucinkis is professor of pure mathematics at Royal Holloway, University of London. She studied for her Ph.D at the University of London. Before starting at Royal Holloway in 2012 she worked at the ETH in Zuerich and at the University of Southampton. She started her mathematical life as an algebraist, but has become more and more fascinated by the fact that one can use algebra to answer questions in topology and vice versa.*

## **SMALL GROUP SESSIONS, with room location**

### **1- Primes, Perfect Numbers and Amicable Numbers**

**Dr Rainer Dietmann – (Windsor Building, Room 002, ground floor)**

Primes are amongst the most fascinating objects in mathematics. In this session we want to discuss some of their basic properties such as the fact that there are infinitely many prime numbers. This can for example be demonstrated by using so called Fermat numbers, which were conjectured to be all prime until Euler found a counterexample in 1732. Another interesting class of primes, Mersenne primes, are closely connected to so-called perfect numbers which are subject to many interesting unresolved conjectures and are related to so-called amicable numbers.

### **2- The Liar Game**

**Dr Mark Wildon – (Windsor Building, Room 103, first floor)**

Ask a friend to think of a secret number between 1 and 15. How many questions with yes/no answers do you need to discover your friend's number? How many questions would you need if your friend is permitted to lie in one answer? We will answer these questions and learn how to play these games optimally, using the mathematics of coding theory to detect lies.

### **3- How to really share a secret**

**Professor Keith Martin – (Windsor Building, Room 003, ground floor)**

Let's face it, we all have secrets and just occasionally we need to share them. However, the security of our modern digital world relies on crucially important secrets that really do need to be shared. We will discuss some mathematical techniques for sharing secrets, some of which will require you to draw elegant pictures. Along the way we will learn how to look after the keys to a bank vault.

### **4- The MU Puzzle**

**Professor Ruediger Schack – (Windsor Building, Room 104, first floor)**

Starting from a given sequence of letters and four simple rules, can one arrive at the word MU? We will show that this simple mathematical puzzle leads to surprising insights into the nature of mathematical proof and the limitations of computers. And, of course, we will also solve the puzzle.

### **5- Cryptography – Everywhere!**

**Professor Kenny Paterson – (Windsor Building, Room 102, first floor)**

Cryptography was once the preserve of emperors and generals but now we all use it (without knowing it) every time we make a mobile phone call, log in to Facebook or buy groceries using a debit card. In this talk, I will try to explain how cryptography uses many different kinds of mathematics to make our world more secure.

### **6- The Mathematics of Matches**

**Professor Simon Blackburn – (Windsor Building, Room 004, ground floor)**

Who wins when two good players play a game? What is the winning tactic? There is often some beautiful and surprising mathematics behind these questions. This session explores one particular game (often played with piles of matches) to illustrate some of the mathematics involved.

## 7- Pi : A Fundamental Constant of the Mathematical Universe

**Pavlo Yatsyna**–(Arts Building, room 024, ground floor, opposite to the main entrance)

When one divides the length of the perimeter of a circle by the length of its diameter one gets the number 3.141592653589793... , independent of the size of the circle. Somewhat surprisingly the same number appears when one divides the area of a circle by the square of its radius as Archimedes has shown about 2300 years ago. This "circle number" is called Pi ( $\pi$ ). Amazingly enough,  $\pi$  is somehow omnipresent, even if we don't see any circles. For instance, the infinite alternating sum of the reciprocals of all odd positive integers  $\frac{1}{1} - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \dots$  yields  $\frac{\pi}{4}$  , or the infinite sum of the reciprocals of all squares  $\frac{1}{1} + \frac{1}{4} + \frac{1}{9} + \frac{1}{16} + \dots$  is  $\frac{\pi^2}{6}$  , and  $\frac{6}{\pi^2}$  in turn can be interpreted as the probability that two positive integers are relatively prime. We will discuss a few interesting facts about  $\pi$  , and, how little we actually know about one of the most fundamental constants in mathematics.

## 8- The Mathematics of Sudoku-Like Problems

**Professor Sean Murphy** – (Windsor Building, Room 005, ground floor)

Many sudoku-like logic problems can be described as problems in algebra and geometry. We examine this relationship and explore connections with other branches of mathematics, such as cryptography, statistics and possibly complex numbers.

## 9- Introduction to Smart Cards

**Professor Keith Mayes** – (McCrea Building, room 201, same level as you enter the left main entrance door of the building, at the left end of the corridor)

Smart cards are becoming increasingly important in our day to day lives. For example they are found in mobile phones, banking cards, identity cards, electronic-tickets etc. Their general capabilities are quite surprising but a most fundamental feature is tamper-resistant security, which is vital as security systems are often subject to a range of sophisticated attacks. The smart card security defences are provided by a mixture of cryptographic and engineering techniques aimed to stay one step ahead of the hackers.

## 10- Traffic Jams

**Dr Alastair Kay** – (Bourne Building, Lecture Theatre2-BLT2, down any of the ramps)

Have you ever been sat in a really long traffic jam and then, when you get to the front of the queue, there's no apparent reason for why it took so long? This talk will attempt to explain how that happens.

## 11- Looking for Patterns in Finance

**Dr Andrew Sheer** – (Windsor Building, Room 105, first floor)

Can you make money by predicting how share prices or currency rates will move in the future? To what extent are they random?

We consider simple ways of looking at this, and see that a major factor is human behaviour.

## 12 - A special session for teachers only! – (from 12.45 to 13.15)

**Further Maths for Teachers**–Ms Gill Buque–(Windsor Build, Room 105, first floor)  
(Regional Coordinator for the South East Further Mathematics Support Programme)

This is an informal opportunity for current or potential teachers of Further Maths to share ideas and to find out how the Further Maths Network can support them. It will also provide an opportunity for teachers to get together and discuss different aspects of Further Maths teaching.



## EXPOMAT14 – 30<sup>th</sup> June 2014 – General Information

### HOW TO GET TO THE COLLEGE

**By rail:** Egham Station is on the line from London Waterloo to Reading, and (at the time of writing) trains leave Waterloo at 20 and 50 minutes past the hour, calling at Clapham Junction, Richmond and Feltham, and taking about 40 minutes; there are also slower trains available. Trains also run every 30 minutes from Reading and from Weybridge to Egham. Useful connecting points are Waterloo (for SE London and Kent, Bakerloo, Jubilee, and Northern lines), Clapham Junction (for Victoria, S and SW London, and Sussex), Richmond (for the District and North London Lines), Feltham (for Heathrow Airport), and Reading (for points westwards).

The College is about a mile from Egham Station and it takes approximately 25 minutes to walk. Turn right out of the station along Station Road and walk about 100 yards to the T-junction and the traffic lights. Turn left at the junction and follow the road up to the large roundabout; go left up Egham Hill. The main College entrance is on the left immediately after the second footbridge (web-links to local streetmaps below).

If anyone with a physical disability registers with us (email: [jenny.lee@rhul.ac.uk](mailto:jenny.lee@rhul.ac.uk) phone: 01784 443091), by Wednesday 25th June, noon, saying on which train he/she will arrive, and with the number of the mobile phone she/he will carry, we will arrange to pick him/her up.

**By road:** The College is on the A30, about one mile south-west of Egham, and close to the junction with the A328. The only entrance for vehicles is just by a footbridge across the A30: the second footbridge if you are going uphill, the first if you are going downhill. We have reserved some room for parking for cars and buses at Car Park 12, near the tennis courts and alongside the exit road. All vehicles must display “Exploring Mathematics” on the dashboard! (After entering the college turn right.)

Buses 71 (Heathrow Terminal 5-Slough), 441 (Heathrow Airport-Englefield Green), and 500 (Staines-Frimley) all pass the College.

Further info, like regional maps, campus maps can be found on

<https://www.royalholloway.ac.uk/aboutus/ourcampus/home.aspx>

<https://www.royalholloway.ac.uk/aboutus/locationmap/home.aspx>

## ARRIVAL

On arrival please go to the information point in the Windsor Building (2 on the map), where you will be given your information pack, by our administrators (in blue turquoise t-shirts). Refreshments are available and you can talk to some Maths students (in orange t-shirts). The Windsor Lecture Theatre 'where the action is happening' is just there!

## MEALS

Coffee, tea, soft drinks and biscuits will be available (free of charge) near the lecture room at about 9.15am. We recommend you bring your own packed lunch. Failing that you may use one of the food outlets that will be open on campus. These are,

- *Café Jules, International Building* (15 on the map, up the outside steps). Snacks, drinks and a variety of sandwiches and salads.
- *Crossland Café, Founder's Building* (1 on the map). Sandwiches, snacks (including baked potatoes) and drinks.
- *College Shop* (6 on the map). Take-away sandwiches, snacks, drinks, confectionery.

## SMALL GROUP SESSIONS

There will be two sets of small group sessions covering a variety of topics across pure and applied mathematics. The first set will run from 11.30 to 12.10. These will be repeated from 13.30 to 14.10, so that you can attend two different talks during the day.

**Teachers Session**– Please note that we run this special session at a different time: 12.45 – 13.15. This allows teachers (if they want) to go to one of the other small sessions.

## FACILITIES

The **College Shop** (6 on the plan) is right beside the Windsor Building and sells a wide variety of things (including Royal Holloway souvenirs). It is open 09.00 - 17.00. The **Santander Bank** (7 on the plan) is just nearby.

## CAMPUS TOURS

There will be campus tours during the lunch break if you want a guided visit with some of our students. Groups leave from the front of the Windsor Building at 12.15 and 12.45.

## LINKS

The final programme can be found on the webpage:

<https://www.royalholloway.ac.uk/mathematics/informationforschools/exploringmaths.aspx>

The Maths Department phone numbers are: 01784 443093 or 91 instead of 93. On the day please use our mobile number 07743331479.

Finally, the College asks us to include the following

**The College accepts no responsibility for death or injury to yourself or for any loss or damage to your personal effects while on College premises. Vehicles and their contents are left in car parks at the owners' risk.**