

## DEPARTMENT OF MATHEMATICS

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## ROYAL HOLLOWAY UNIVERSITY OF LONDON

### EXPOMAT13

#### A day in “Exploring Mathematics”

We are delighted to welcome so many of you to our ‘2013 Exploring Mathematics’ day. You will find a varied programme of *talks, quizzes, short talks 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 morning plenary sessions.

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

## PROGRAMME - EXPOMAT13

### Exploring Mathematics, Thursday 27th June 2013

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

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

**09.35: Welcome** by the Vice-Principal – *Professor Paul Hogg*

**09.45:** Quick **quiz session** with prizes – *Professor Jason Crampton*

**10.30: The Maths of TV Gameshows** – *Rob Eastaway*

**11.30: Break**

**11.40: Mathematics at University** – *Professor Glyn Harman*

**12.40: Lunch, and tours of Campus**

If you bring your own packed lunch enjoy our beautiful campus while eating it; otherwise you can have hot and cold meals in the *Founder's Dining Hall* or buy sandwiches/snacks from the *Founder's Crossland Café* or the *campus shop*.

Please see the [campus map on the last page](#), where locations are shown.

*Tours of campus* lasting 40 minutes will leave from outside the Windsor Building at 13.15.

**13.15-13.55:** Special **session for teachers** only!-Further Mathematics-  
*Ms Gill Buque*

**14.00: Small group sessions** on a variety of topics. Please see details in the following pages (announced on the day as well).

**15.00: Alan Turing's Cryptographic Legacy** – *Professor Keith Martin*

**15.55:** Closing comments

**16.00:** End of conference

**Events are in the Windsor Building** - Main lecture theatre for the morning sessions with the small group sessions running in various other rooms in the same building. Three of the afternoon group sessions will run in rooms in the McCrea building where the Department of Mathematics is located and one will be in the Bourne Building.

## PLENARY TALKS

### **The Maths of TV Gameshows**

**Rob Eastaway**

TV gameshows are an industry worth billions of pounds, and in some of the most famous shows maths plays a vital role in the strategy. And far from being a trivial distraction, the decision-making in many games is great training for decisions made in business, government and other walks of life. In this talk, Rob Eastaway will explain the maths behind some of the most famous and successful TV games, from Million Pound Drop to The Weakest Link – with tips on how to win.

*Rob Eastaway is the author of numerous books, including the bestselling Why do buses come in threes?, The Hidden Maths of Sport and Maths for Mums and Dads – The Teenage Years.*

*He has appeared frequently on BBC Radio 4 and 5Live to talk about the maths of everyday life. He is a former President of the Mathematical Association, and is Director of Maths Inspiration, a national programme of lecture shows for older teenagers.*

### **Mathematics at University**

**Prof. Glyn Harman**

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.

### **Alan Turing's Cryptographic Legacy**

**Prof. Keith Martin**

How often do you use cryptography in a typical day? Alan Turing was a mathematician, a cryptographer and a pioneer of the modern computer. Some sixty years later we will look at how computing technology has developed and how important cryptography has become in our everyday lives. We will explore Alan Turing's cryptographic legacy and, along the way, will discover whether there is any cryptography in Dan Brown's Da Vinci Code.

*Prof. Keith Martin is Director of the Information Security Group at Royal Holloway, University of London. He began life as a mathematician and discovered, through cryptography, that some aspects of mathematics are far more useful than he ever dared imagine. He is author of the book Everyday Cryptography.*

## 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 Shape of Space

Professor Brita Nucinkis – (Windsor Building, Room 003, ground floor)

How big is the universe? Is it finite or infinite? Does it have a boundary? These and other questions lead us to an area of mathematics called Topology. In this session we will explore these questions, first in dimension 2, and will then extend this to dimensions 3 and above.

### 3- The Liar Game

Dr Mark Wildon – (Windsor Building, Room 104, 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.

### 4- Counting Infinity

Dr Yiftach Barnea – (Bourne Building, Lecture Theatre 2-BLT2, down any of the ramps)

Often people talk about infinity as the “biggest number”. We will explore the idea of infinity as a number. In particular, we will try to see whether infinite objects may have different sizes.

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

Dr Martin Widmer – (McCrea Building, room 336, level 3, up the steps)

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

$\frac{1}{1} + \frac{1}{4} + \frac{1}{9} + \frac{1}{16} + \frac{1}{25} + \dots$  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.

## **6- Looking for Patterns in Finance**

**Dr Andrew Sheer – (Windsor Building, Room 004, ground 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.

## **7- The Mathematics of Doodles**

**Dr James McKee – (Windsor Building, Room 005, ground floor)**

We'll learn (and play) the game of Sprouts, and explore the mathematics of the resulting doodles.

## **8- The Mathematics of Knots**

**Dr Iain Moffatt – (McCrea Building, room 219, same level as you enter the building)**

Take a piece of string. Tie a knot in it. Now glue the ends together to get a knotted loop. You now have what mathematicians call a knot. In this session we'll explore the mathematics of knots. We'll consider what it means for two knots to be the same, how we can tell knots apart, and why we should care.

## **9- The Mathematics of Sudoku-Like Problems**

**Professor Sean Murphy – (Windsor Building, Room 102, first 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.

## **10- Introduction to Smart Cards**

**Professor Keith Mayes – (Windsor Building, Room 103, first floor)**

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.

## **11- How is Doing Mathematics in 21st Century Different from that in “The good old days”?**

**Dr Alexey Koloydenko and Mr U. Mat – (McCrea Building, Room 103, down the steps)**

You will have an opportunity to experiment with Matlab, a powerful computer environment which helps us to bridge abstract and concrete. Have in mind a math problem your teacher said could take a century to compute the solution for? See what Matlab thinks about that!

## **12 - A special session for teachers only! – (from 13.15 to 13.55)**

**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.

## EXPOMAT13 – 27<sup>th</sup> June 2013 – 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 Monday 24th 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 3 (St Peter's Hospital-Englefield Green), 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

<http://www.rhul.ac.uk/visitors-guide/>

<http://www.rhul.ac.uk/Shared/Maps/>

type in the postcode: TW200EX. Egham station is to the right (East).

## 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. 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. For lunch, you can bring your own food, or use one of the food outlets that will be open on campus. These are,

- *Dining Hall, Founder's Building* (1 on the map). Hot and cold meals, open between 12.30 and 14.00. Take the Founder's entrance opposite to the Windsor Building and go up the steps, turning left. Go past the two sets of doors and turn right. Half way on your left is the Dining Hall
- *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

These will be from 14.00 to 14.55 and will include a variety of topics across pure and applied mathematics to choose from.

This year we will again run a special **teachers** session at a different time: 13.15 – 13.55! This will allow 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 13.15.

## LINKS

The final programme can be found on the webpage:

<http://www.ma.rhul.ac.uk/exploringmaths>

The Maths Department phone numbers are: 01784 443091 or 93 instead of 91. On the day please use 01784 443085.

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.**