INI hosts sell-out Science Festival talk

Dr Andrew Fitzgibbon spoke to a capacity audience at INI in March 2017.

The Isaac Newton Institute was proud to host a talk by Dr Andrew Fitzgibbon, Principal Scientist at Microsoft, this spring as part of its participation in the 2017 Cambridge Science Festival.

An Emmy-winning computer scientist, Dr Fitzgibbon spoke on the morning of Saturday 25 March to an audience of more than 130 attendees within INI's main Seminar Room. His talk focused on the mathematical tricks and techniques used for his ground-breaking work on films such as the Harry Potter series, for the Xbox games console, and in devices such as Microsoft's latest gadget, the HoloLens, the world's first fully self-contained, holographic computer.

Dr Fitzgibbon is perhaps best known for his work on 3D vision, having been a core contributor to the 3D camera tracker "boujou" and Kinect for Xbox 360, but his interests and accolades are extensive, spanning computer vision, graphics, machine learning, and neuroscience. He has published numerous highly-cited papers, and received many awards for his work, including ten "best paper" prizes at various venues, the Silver medal of the Royal Academy of Engineering, and the BCS Roger Needham award.

"This was an inspiring talk by Andrew Fitzgibbon", said one attendee when asked by INI staff about the experience, "It was just so impressive how he presented his material in a way which was as much appreciated by my 12 year old grandson as by myself, aged 70."

This talk was INI's 2017 contribution to the hugely successful Cambridge Science Festival, an annual celebration which involves more than 100 such events across the city during its two-week run. The Festival aims to provide the public with opportunities to explore and discuss issues of scientific interest and concern and to encourage young people to aspire to a career in science, technology, engineering or mathematics. INI looks forward to future successes of this kind when the Festival returns in 2018.

Kyoto and Turing Prize winner Sir Tony Hoare FRS FREng (centre) and Fields Medallist Sir Tim Gowers FRS (left) were amongst the many esteemed attendees at INI's July 2017 Big Proof workshop.

Celebrating "Women in Maths"

On 24 April, INI welcomed female A-level mathematics students to the inaugural LMS Girls in Mathematics Day. Organised in association with the Faculty of Mathematics, University of Cambridge workshops and talks within the one-day event were led by staff from the NRICH Maths Project and Underground Mathematics. A series of inspiring Cambridge-based speakers, including Professor Anne Davis (DAMTP), Dr Carola-Bibiane Schönlieb (DAMTP) and Dr Holly Krieger (DPMMS) led the audience of Year 12 girls through a stimulating introduction to advanced mathematical problem-solving, gave insight into some of the areas of maths encountered at university, and helped them to engage in interactive problem-solving workshops. Attendees were also able to put questions to a panel of current Cambridge undergraduate students.

The aim of this programme, which coincided with the "Women in Mathematics" poster campaign pictured below, was to encourage participants to develop their mathematical thinking, and to inspire take-up of further mathematical study. INI greatly looks forward to the future results of this inspiring event.


Speakers at the LMS Girls in Mathematics Day included: Dr Holly Krieger (second image from left), Professor Anne Davis (bottom centre) and Dr Carola-Bibiane Schönlieb (third image from left).
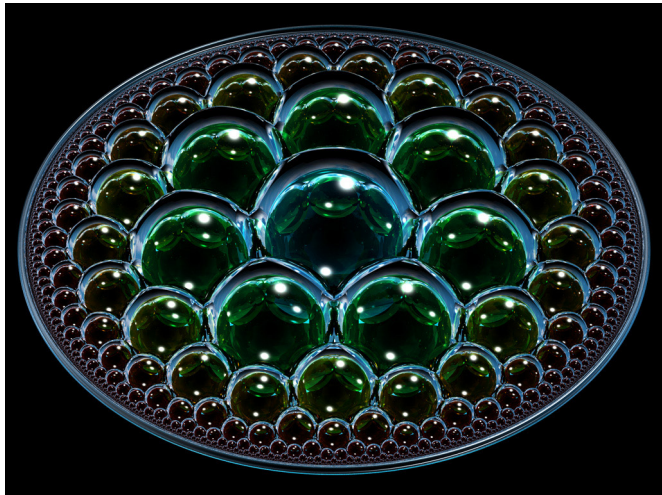
The "**Non-positive curvature group actions and cohomology**" (NPC) programme ran between January and June 2017. It comprised five major workshops, three of which were held at INI, with the remaining two being held at the University of Southampton and the Mathematical Institute, Oxford. This programme examined aspects of non-positive curvature as they occur in various research areas of contemporary mathematics. These included topics such as: the geometry of manifolds (including those arising from Lie group theory); synthetic geometry (as used notably in modern group theory); coarse geometry (a fundamental tool of contemporary topology); non-commutative geometry; and algebra. It was also notable as the first INI programme to be orchestrated by all-female organisers (see right).
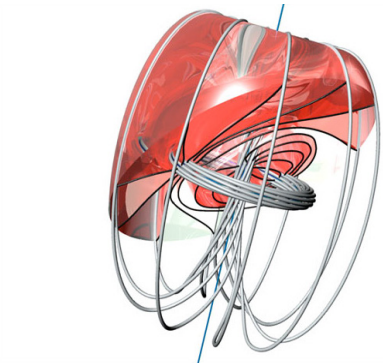
The "**Homology theories in low dimensional topology**" (HTL) programme ran between January and June 2017. This topic dates back to the work of 20th century mathematician Andreas Floer, but gained new breadth and vigour with the introduction of Khovanov homology at the start of the 21st century. Since then, these theories have had a far-reaching impact both in topology and more widely with analysts, algebraists, geometers, and physicists all contributing to and benefiting from their development. Across its four workshops, and the extensive interaction amongst participants in between, this programme helped define and further tie together the three themes of Floer homology, quantum knot homologies and quantum 3-manifold invariants inherent in the subject.
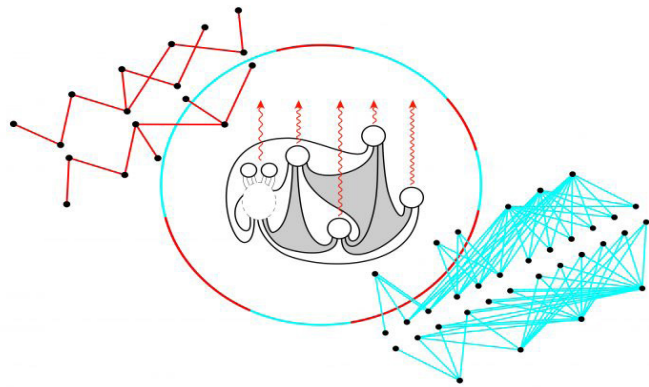
The "**Operator algebras: subfactors and their applications**" (OAS) programme ran between January and June 2017. This programme was greatly enhanced by the engagement of Organiser Sir Vaughan Jones (right), who first initiated mathematical study into subfactors in the early 1980s. Beyond the four scheduled workshops, Sir Vaughan also presented a special talk on a recent break-through in his research into the Thompson groups.
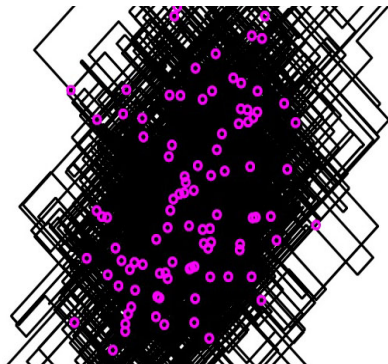

The "**Scalable inference; statistical, algorithmic, computational aspects**" (SIN) programme ran throughout July 2017. During their time at INI the participants focused upon methods associated with likelihood, its variants and approximations, taking advantage of, and creating new advances in, statistical methodology.

Proofs as constructive demonstrations of mathematical validity have been at the heart of mathematics since antiquity. The six week "**Big Proof**" programme (June - August 2017) examined the challenges of bringing proof technology into mainstream mathematical practice. A highlight of this very successful programme was Thomas Hales' (Princeton) talk on his proof of the Kepler Conjecture.

Fields Medalist Sir Vaughan Jones delivers his talk on "Knots and links from the Thompson groups", a special one-off event that attracted attendees from across all three concurrent programmes.
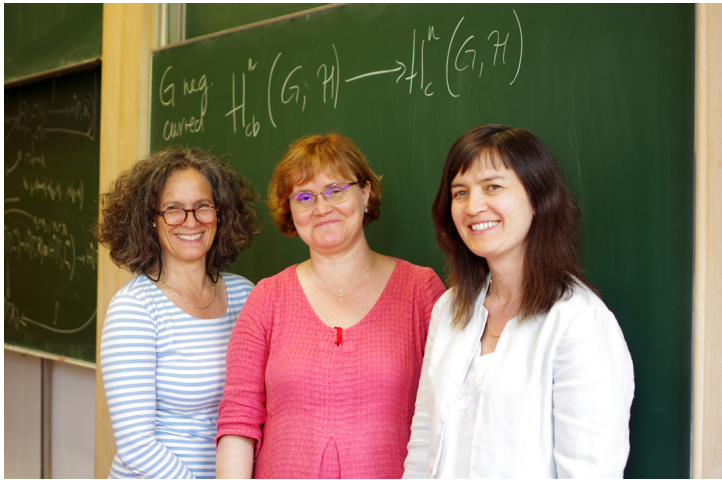
Professors Alesandra Iozzi (ETH Zurich), Cornelia Drutu Badea (Oxford, Lille) and Goulnara Arzhantseva (Universitat Wien): organisers of the NPC programme. This was the first time that INI has hosted a programme led by a team of all-female organisers.

Participants in the extremely well-attended workshop of the six-week "Big Proof" programme.

Rothschild Lectures update

Professor Richard Schwartz (Brown University)

Rothschild Visiting Distinguished Fellow Professor Richard Schwartz (Brown University) addressed "Thomson's 5 point problem" as part of the "Non-positive curvature group actions and cohomology" programme in April 2017. The problem itself asks how N points will arrange themselves upon a sphere (or other space) so as to minimise their total electrostatic potential. Using a series of colourful demonstrations, Professor Schwartz explained his rigorous, computer-assisted proof first conjectured to exist in 1977 by Melnyk-Knop-Smith.

Rothschild Visiting Distinguished Fellow Professor Stefaan Vaes (University of Leuven) delivered a talk on the "Classification of von Neumann algebras" as part of the "Operator algebras: subfactors and their applications" programme in June 2017. Addressing the dichotomy between amenability and non-amenability, he touched on the Banach-Tarski paradox, the work of Connes and Haagerup, and Sorin Popa's Deformation/ Rigidity theory. These elements were used to illustrate the gap between amenability and non-amenability for von Neumann algebras associated with countable groups, with locally compact groups, and with group actions on probability spaces.

Rothschild Visiting Distinguished Fellow Professor Cameron Gordon (University of Texas at Austin) delivered his talk "Left-orderability and 3-manifold groups" as part of the "Homology theories in low dimensional topology" programme in June 2017. In it, he discussed how the algebraic question of whether a group has a left-invariant total relates to two other properties of a manifold, one geometric, one analytic.

Professors Stefaan Vaes (left) and Cameron Gordon (right)

Grand celebrations mark INI's 25th year

July 2017 marked the 25th anniversary of INI's official opening in 1992. A range of activities were organised to celebrate this important milestone. The first event, "An audience with artist Nigel Hall RA", took place at INI on the evening of 19 July 2017. This was followed by a full day of celebrations, also at INI, on 20 July 2017.

During the former, more than 60 people were welcomed to INI for an evening's open audience and drinks reception with artist Nigel Hall RA. Hall, whose works are exhibited across the globe from New York's Museum of Modern Art (MOMA) to the Tokyo Metropolitan Art Museum, was joined by Dorothy Buck (Professor of Mathematical Biology, University of Bath; co-organiser of INI's HTL programme) and Barry Phipps (Fellow and Curator of Works of Art, Churchill College). The ensuing conversation examined the complex and inspiring relationship between art and mathematics, told via the medium of Nigel Hall's compelling geometric artworks. Many of these artworks - ranging from maquettes to framed drawings and a major outdoor sculpture - were on display at the Institute.

During the main celebrations on 20 July, a guest list of over 100 esteemed mathematicians and affiliates of the Institute were welcomed to INI for a day of talks and interactions. Amongst those present were INI's founding Director Sir Michael Atiyah OM FRS FRSE FMedSci FREng, Fields Medallist Martin Hairer KBE FRS, broadcasters Dr Hannah Fry and Dr Simon Singh, and - 24 years since his completing his original proof of Fermat's Last Theorem - Sir Andrew Wiles. The talks took place in the very same room in which Sir Andrew first presented his proof of that notoriously challenging 17th century conjecture.

To see more images, and also video content of the talks from 20 July, please visit the following link: **bit.ly/ini25th**

Artist Nigel Hall RA (above, centre) is interviewed by Barry Phipps (left) and Professor Dorothy Buck (right) on 19 July.

Sir Andrew Wiles KBE FRS re-visited INI's main seminar room, 25 years since he first presented his proof of Fermat's Last Theorem in the very same space.

Speakers on INI's main 20 July day of celebrations included Dr Simon Singh (left), Fields Medallist Professor Martin Hairer KBE FRS (centre) and Dr Hannah Fry (right).

(from left to right) Previous INI Directors Professor John Toland FRS FRSE, Professor Keith Moffatt FRS FRSE, Sir David Wallace CBE FRS FRSE FREng; and current Director Professor David Abrahams.

(above) Sir Andrew Wiles and Dr Simon Singh "in conversation": this candid session was the centrepiece of the day's events on 20 July.

(above) Sir Michael Atiyah, founding Director of INI, unveils his collection of medals at the end of the festivities.
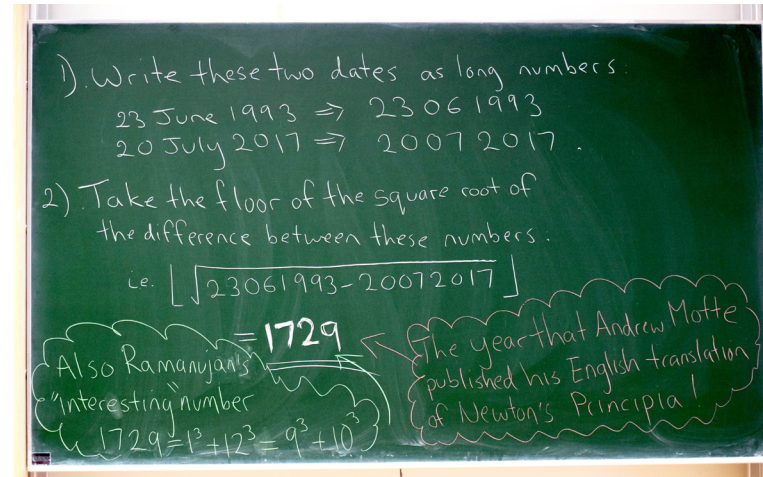

(above) INI Deputy Director Dr Christie Marr.

(above) Sir Michael Atiyah and Astronomer Royal Baron Martin Rees of Ludlow.

(right) Surprising co-incidences surround the significant dates in INI's history...

1). Write these two dates as long numbers
23 June 1993 ⇒ 23061993
20 July 2017 ⇒ 20072017.

2). Take the floor of the square root of the difference between these numbers.
i.e. $\lfloor \sqrt{23061993 - 20072017} \rfloor = 1729$

Also Ramanujan's "interesting number"
$1729 = 1^3 + 12^3 = 9^3 + 10^3$

The year that Andrew Motte published his English translation of Newton's Principia!

Can you solve the final piece of the INI 25th anniversary puzzle...?

INI's puzzle competition winners: Jack Moylan (left, Year 8) and Jack Hadley (right, Year 7). The boys' joint entry secured them a chance to see Simon Singh interview Andrew Wiles.

On 15 June 2017 INI posed the following puzzle to its online audience:

"*Can you make all of the numbers from 1 up to 100 using, for each sum, all four of the digits in 1992? You must use each digit precisely once but you can use them in any order. You may also use a combination of any of the following operators: addition, subtraction, multiplication, division, parentheses and concatenation (e.g. "29"), square root, factorial (!) and exponentiation.*"

The response was inspiring, with over 60 correct answers sent in. The randomly selected winners (left) were then invited to attend our 20 July day of celebratory talks. However, entrant Jamie Nuttall deserves special mention. Restricting for himself the generous terms given above, Jamie determinedly formed correct answers to the challenge whilst also using the digits 1,9,9,2 **in the correct order**. He managed this feat for 99 of the 100 numbers, with **69** being the only hold-out.

Can you form this final number and complete the puzzle? If so, email us at communications@newton.ac.uk*!*

A two-day tribute to Joe Keller

On 2-3 March 2017, INI hosted a programme of talks and presentations in honour of applied mathematician Joe Keller, who passed away on 7 September 2016.

The aim of this informal meeting was to bring together friends, colleagues and associates of Keller, and other interested researchers, to honour his memory and to acknowledge his legacy and the support he offered all applied mathematicians stretching over many decades.

Joe Keller is broadly perceived to have been the most influential applied mathematician residing in the West over the second half of the 20th Century. He published over 400 articles since his first appeared in 1947 – his originality, creativity, mathematical dexterity and physical insight shine through in all of these works. He remained as alert and passionate about research in later years as he did when leading the legendary Courant Institute Group in the 1950s and 1960s. Perhaps the most significant aspect of Keller's professional life was the sheer number of people who worked with him or who were influenced directly by his efforts. He was selfless in offering his ideas and energies to benefit both early career and established researchers, and was always encouraging and enthusiastic when sitting through lectures given by students.

The event was entertaining, informal and with as wide a range of topics as possible to span Keller's vast research output.
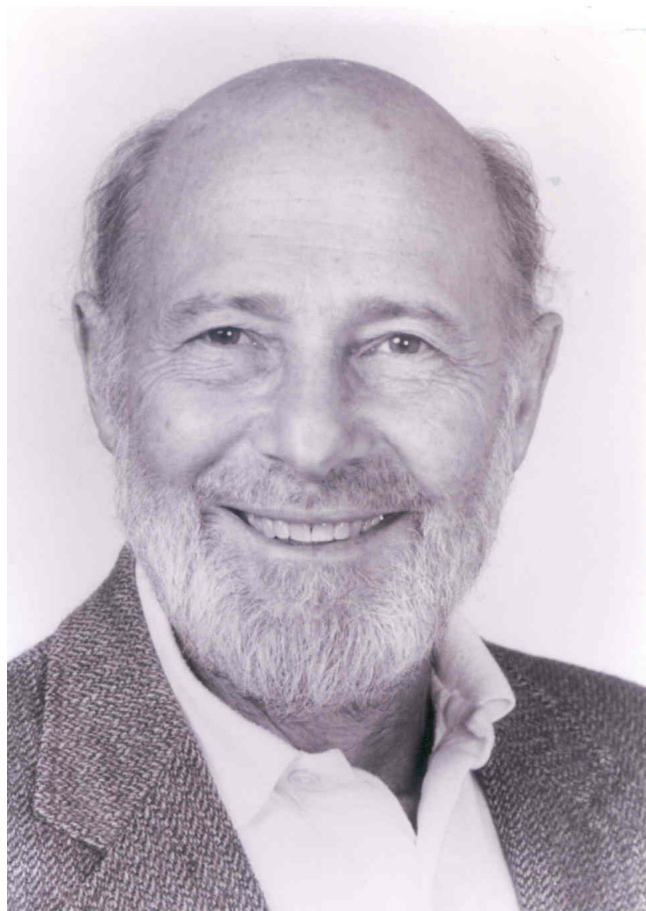
Upcoming events

11 - 15 September 2017
Workshop Multi-scale modelling of ice characteristics and behaviour. This workshop will address sea ice processes across a wide range of length and time scales, with an emphasis on understanding emergent and scale–invariant phenomena. It also includes this year's meeting of the UK Sea Ice Group.

18-22 September 2017
Workshop Form and deformation in solid and fluid mechanics. This workshop will focus on fluid and solid mechanics systems whose dynamics governs growth and determines form.

2-3 October 2017
Workshop Image analysis and processing in the life sciences. This workshop aims to facilitate discussion between life sciences researchers and mathematicians analysing methodology in image analysis.

A full listing of all scientific events at INI is available via **www.newton.ac.uk/events**

Office conversion ups INI capacity

Rooms F5 and F6 at the Institute (previously occupied by the IT suite) have now been merged into a single combined working space for programme participants. This brings the working desk capacity to a new high of 59 individual spaces.

This Newsletter is published twice per year.