Isaac Newton Institute for Mathematical Sciences

News September 2018

Emily Grossman delights Cambridge Science Festival crowd

The Institute hosted Dr Emily Grossman at this year's Cambridge Science festival, attracting an eager crowd for her much anticipated talk, "Lies, Damned Lies, and Newspapers: the use and abuse of statistics in the media". The event took place at INI on Saturday 17 March, and such was Dr Grossman's reputation as a broadcaster, STEM Ambassador and science communicator (with previous clients including The Royal Society, the BBC, The Sun newspaper and Sky TV) that tickets for the event had sold out within an hour of release. The audience ranged across a broad public demographic and included Cambridge statistician and fellow broadcaster Sir David Spiegelhalter. Making rich use of personal anecdote and humorous experience, Dr Grossman helped highlight common errors readers should look for in mainstream science reporting and the dangers of distorted facts.

TGM to become "Newton Gateway"

Since its formation in 2013 as the impact initiative of INI, the Turing Gateway to Mathematics (TGM) has played a vital role in communicating the Institute's research output to industry, the public sector and wider academic circles. To reinforce its identity as such, and to avoid confusion with other organisations, the TGM will from 1 January 2019 be renamed as the Newton Gateway to Mathematics.

See inside for:

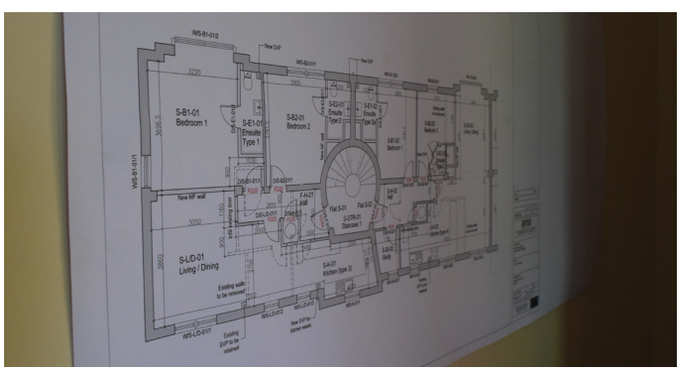
- *Current programmes*
- *Three Rothschild talks*
- *Atiyah's medals rehoused*
- *Website redesign details*
- *Green Impact award*

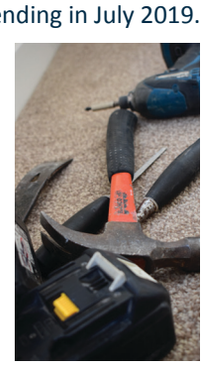
Vice-Chancellor visits INI

(above) University of Cambridge Vice-Chancellor Stephen Toope visited INI on Monday 23 April 2018. This tour of INI and TGM's facilities provided an opportunity for the V-C to meet key staff and for Director David Abrahams (right) to highlight the exciting and vital work undertaken here.

Major refurbishment project begins for Benians Court accommodation

In July 2018 work began on a major renovation project which will see the Institute's accommodation modernised and updated. In planning since 2012 the work will involve the comprehensive update of 24 apartments. Of those flats, 16 will be altered to contain two double rooms with en-suite facilities, with improved kitchen facilities and standardised quality throughout the furnishings. The remaining eight apartments will receive a similar level of updates, with two of them being fully renovated to ensure complete disabled access. Four will keep a configuration better suited to housing families. The project will take place in four 3-month phases ending in July 2019.





Recent Programmes Update

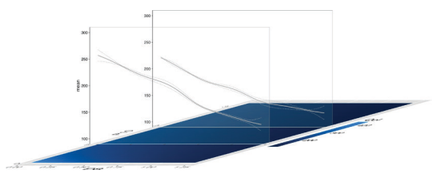
The "**Homotopy harnessing higher structures**" (HHH) programme began in July 2018 and runs until the end of this year. Set within the context of a renaissance within algebraic topology that has occurred over the past 15 years, the programme will highlight four related themes. These are: the new algebraic topology of differentiable manifolds, derived representation theory and equivariant homotopy theory, the interplay between arithmetic geometry and stable homotopy theory, and the analysis of foundations in these new contexts "the homotopy theory of homotopy theory". The intent is to develop the community of scholars from these diverse, but overlapping, areas of algebraic topology, both through a programme of long-term visitors and a sequence of workshops, one each for the various themes.

The "Random geometry" (RGM) programme, which took place in 2015, returned to INI from 9-20 July 2018 with a follow on workshop. The subject of random geometry had evolved considerably during the intervening period and there was much for the participants to discuss. Subjects included: the unification of the discrete and continuous perspectives for random surface models (e.g. random planar maps and Liouville quantum gravity) which had been greatly advanced; new methods in the study of disordered systems and their phase transitions, and new directions of research which had emerged such as a rigorous investigation of Yang-Mills models. The goal of the two-week workshop was to allow researchers worldwide and from all career stages to catch up on these developments, and to plan for future research directions of the subject.

The "**Scaling limits, rough paths, quantum field theory**" (SRQ) programme begins in September 2018 and runs until the end of the year.

The "**Statistical Scalability**" (STS) programme began in January 2018 and ran until June of this year. The programme involved well over 300 participants, coming from diverse areas such as statistics, machine learning and theoretical computer science. Activity was structured around four workshops, each with different themes and two "open for business" days. Key scientific challenges addressed during the programme included: how to reliably quantify uncertainty in big data applications; understanding the impact of unavoidable model misspecification on statistical procedures; developing greater insight into the fundamental trade-offs between computational versus statistical efficiency across an increasing range of statistical problems; and how to adapt statistical methods to streaming applications, where we need to be able to update our inferences as data arises at high frequency.

The five-day workshop "**Beyond I.I.D. in information theory**" took place at INI from 23-27 July 2018. A follow-on to the 2013 programme "**Mathematical challenges in quantum information**" (MQI), its content brought together the classical and quantum Shannon theory communities working on one-shot and finite block length information theory, with coding theorists, researchers into quantum thermodynamics and other resource theories, and mathematical physicists, whose work provides insights into entropic quantities and their properties.



The "**Uncertainty quantification for complex systems: theory and methodologies**" (UNQ) programme began in January 2018 and ran until June. The programme aimed to bring together leading applied mathematicians and statisticians to develop theories and methodologies for reducing the cost of model inversion, increasing the level of tractable complexity in modelling, and enabling efficient risk assessment and decision making.

Nilanjana Datta (Cambridge) and Andreas Winter (UAB), organisers of the July 2018 follow on workshop "Beyond I.I.D. in information theory".

Participants in the "Homotopy harnessing higher structures" (HHH) programme's first workshop, which took place during the early stages of the summer heatwave.

Ulrike Tillmann (Oxford), co-organiser of the HHH programme.

Rothschild Lectures update

Peter Bühlmann (ETH Zürich) distributes supplies during his lecture.

Rothschild Visiting Distinguished Fellow **Professor Andrew Stuart** (Caltech) addressed "The legacy of Rudolph Kalman" as part of the UNQ programme on 5 April 2018. Aimed at "anyone with an interest in quantitative science" Professor Stuart focused on a 1960 paper by Kalman which, he argued, was "the first... to develop a systematic, principled approach to the use of data to improve the predictive capability of the mathematical models developed to understand the world around us. The lecture went on to describe the paper and developments that have stemmed from it, which influenced fields such as space-craft control, weather prediction, oceanography, oil recovery, medical imaging and artificial intelligence.

Rothschild Visiting Distinguished Fellow **Professor Peter Bühlmann** (ETH Zürich) addressed "Causality, invariance and robustness" as part of the STS programme on 22 June 2018. Addressing the question, "Is it a cause or an effect?", Professor Bühlmann argued that "this simple but fundamental question has a long history in science and society". Randomised studies, he explained, serve as the gold standard for inferring causality but they are often expensive or even impossible to do due to ethical reasons. Perhaps surprisingly, he argued, heterogeneity in potentially large-scale data can be beneficially exploited for causal inference and novel robustness, with wide-ranging prospects for various applications. The key idea relies on a notion of probabilistic invariance: it opens up new insights with connections to frameworks used in robust optimisation and economics.

Andrew Stuart (Caltech) was Rothschild speaker for the UNQ programme.

Art & Artefacts update: Atiyah's medals rehoused

The collected medals of INI founding Director Sir Michael Atiyah have been gifted to the Institute on long-term loan, and are now available - alongside selected mathematical artefacts and works by artists including Grenville Davey, Nigel Hall RA and Mark Francis - on public display. Part of a grouping of 15 awards and diplomas, included within the collection are Sir Michael's 1996 **Fields Medal** (below centre), 1988 **Royal Society Copley Medal** (below left) and 1968 **Royal Society Royal Medal** (below right). During its 25 year history the Institute's collection of art and artefacts has grown considerably with this latest addition being made possible by the generosity of Sir Michael himself. Elsewhere, the remainder of the Institute's art and artefacts have recently been re-photographed (above right, see **newton.ac.uk/about/art-artefacts**), with examples including (clockwise from top left): the Brunsviga Machines, the "Eight Beautiful Horses" Chinese Silk coffee table, "Infinity" by Dick Onians and a copy of Sir Godfrey Kneller's 1689 portrait of Sir Isaac Newton.

INI scoops Green Impact Award

The Institute took its first step towards environmental excellence with the June 2018 award of the University's Bronze Green Impact award. Criteria addressed included food waste, efficient energy use and recycling systems. Silver and Gold awards will be targeted in future years.

(above) Green Team members Giovanna Aveiro (INI) and Clare Merritt (TGM) with the Bronze Green Impact award.

Upcoming events

1 October 2018

One-off Event **Fermat's Last Theorem: a celebration 25 years on.** The Institute is delighted to be hosting an event marking the 25th Anniversary of Sir Andrew Wiles announcing his proof of this most enduring theorem.

6 November 2018

TGM Conference **Artificial Intelligence and Machine Learning in Clinical Imaging Research: Progress and Promise.** This one day event will aim to review scientific and policy developments in Artificial Intelligence and Machine Learning when applied to clinical imaging.

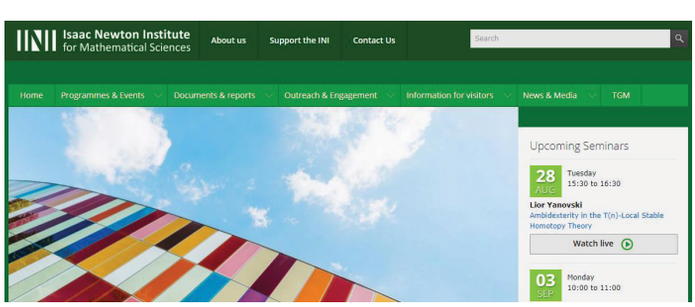
7-11 January 2019

Workshop **Flexible operation and advanced control for energy systems.** Providing an overview of recent developments and open questions in these areas.

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

Institute website in menu system overhaul

The Institute's website (**www.newton.ac.uk**) has undergone a major structural redesign, with numerous subsections being subsumed or redirected to improve user experience. Visitors to the site will now find key sections more clearly labelled, including a "News & Media" tab, a drastically simplified "Information for Visitors" section and a clearly presented "Outreach & Engagement" area detailing INI's activities in the wider world. Live streaming links and details of current, past and future programmes, workshops and other events are now clearly accessible from the homepage.



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