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Divergent series

by

Michael Berry
Department of Physics, Bristol

Colloquium talk at the LMS Undergraduate Summer School
Loughborough, July 2015

Following the discovery by Bayes in 1747 that Stirlings series for the factorial is divergent, the study of asymptotic series has today reached the stage of enabling summation of the divergent tails of many series with an accuracy far beyond that of the smallest term. Several of these advances sprang from developments of Airys theory of waves near optical caustics such as the rainbow. Key understandings by Euler, Stokes, Dingle and calle unify the di erent series corresponding to di erent parameter domains, culminating in the concept of resurgence: quantifying the way in which the low orders of such series reappear in the high orders.

Making light of mathematics

by

Michael Berry
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Colloquium talk at the LMS Undergraduate Summer School
Loughborough, July 2015

Many mathematical phenomena nd application and sometimes spectacular physical illustration in the physics of light. Concepts such as fractals, catastrophe theory, knots, in nity, zero, and even when 1+1 fails to equal 2, are needed to understand rainbows, twinkling starlight, sparkling seas, oriental magic mirrors, and simple observations on interference, polarization and focusing. The lecture is intellectual but nontechnical, and strongly visual.

Geometry and undecidability

by

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Colloquium talk at the LMS Undergraduate Summer School
Loughborough, July 2015

Representations of the symmetric group

by

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Colloquium talk at the LMS Undergraduate Summer School
Loughborough, July 2015

A fundamental problem in algebra is to understand the symmetric groups. After all, Cayley proved that every nite group is isomorphic to a subgroup of some symmetric group, so in a sense the problem includes all of nite group theory. One way to address this is through the representation theory of the symmetric group, a central theme of representation theory every since its birth. Early work of Frobenius and Schur dealt with a great deal of what happens with representations in characteristic 0, but more than 100 years later many mysteries persist. In fact, even in the last couple of years, there have been spectacular developments for representations in positive characteristic, confounding long-standing conjectures and leaving the ground wide open. Ill present some of this story, and its connections with combinatorics, geometry and even possibly physics.

Frieze patterns

by

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Colloquium talk at the LMS Undergraduate Summer School
Loughborough, July 2015

Frieze patterns are beautiful combinatorial objects, introduced by Coxeter. Recently they have attracted much attention due to their relation to the theory of cluster algebras. I shall introduce frieze patterns and prove the theorem of Conway and Coxeter that relates arithmetical frieze patterns with triangulations of polygons. There is an intimate and somewhat unexpected relation between three object: frieze patterns, 2nd order linear difference equations, and polygons in the projective line. Time permitting, I shall mention some recent work on frieze patterns and their ramifications.

Mathematics from a sheet of paper

by

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Colloquium talk at the LMS Undergraduate Summer School
Loughborough, July 2015

From just a sheet of paper, by folding, crumpling, tearing, we will explore a rich variety of science, from a magic trick and geometry to elasticity and the traditional Japanese art of origami. Most of the lecture consists of actual table-top demos, which you can later share at home with friends and family.

Geometry: A secret weapon in the fight against viruses

Reidun Twarock, Department of Mathematics, University of York

Colloquium talk at the LMS Undergraduate Summer School

Loughborough, July 21, 2015

Viruses are remarkable examples of order at the nanoscale. The protein containers that encapsulate the viral genomes self-assemble from their component parts into structures that in the majority of viruses exhibit icosahedral symmetry. Techniques from group, graph and tiling theory can therefore be used to better understand virus architecture and the principles underpinning the assembly process. In this talk I will demonstrate that group theoretical techniques developed in my research group reveal a previously unappreciated interdependence of genome organization and capsid structure and thus enable a deeper understanding of how viruses form and infect their hosts. In particular, in combination with bioinformatics, biomolecular simulation and experiment, our mathematical approach has led to the discovery of a sequence/structure-based instruction manual hidden in the viral genome of RNA viruses, that underpins efficient and specific genome packaging during virus assembly and provides a promising new drug target for antiviral therapy.

Magical Markov tree

by

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Colloquium talk at the LMS Undergraduate Summer School
Loughborough, July 2015

At the end of XIX-th century Andrei A. Markov discovered a remarkable connection between the Diophantine equation

$$x^2 + y^2 + z^2 = 3xyz$$

and the most irrational numbers. The integer solutions of this equation can be naturally associated with the vertices of certain trivalent tree called Markov tree. Recently the same equation surprisingly appeared in the theory of Teichmüller spaces, Painleve equations, cluster algebras and enumerative geometry. I am planning to explain at least some of these remarkable links and properties of Markov tree and its generalisations.