RECENT BREAKTHROUGHS IN MATHEMATICS 05-12-2018

The Belgian Mathematics Society is happy to welcome you to an afternoon's discussion by international and local experts on some of the more breathtaking breakthroughs in contemporary mathematics.

Programme

13h30 – 14h00 Welcome

14h00 – 14h45 Stéphane Jaffard (UPEC, Paris)

About wavelets and Yves Meyer's Abel prize in 2017

Chair: Françoise Bastin (ULiège)

Though he is mostly famous for his pivotal role in the genesis of wavelet analysis, Yves Meyer also made decisive contributions in all areas of harmonic analysis, in relation with quasicrystals, number theory, control, PDEs, singular integral operators, … We will give a panorama of these contributions, with a particular focus on those related with the construction of wavelets and their applications in signal and image processing.

14h55 – 15h40 Jean Van Schaftingen (UCLouvain)

About PDEs and Alessio Figalli's Fields medal in 2018

Chair: Bruno Premoselli (ULB)

Alessio Figalli (ETH Zürich) was awarded in August 2018 the Fields Medal "for contributions to the theory of optimal transport and its applications in partial differential equations, metric geometry and probability". He has proved regularity results for the Monge-Kantorovich optimal transport, in which one tries to minimize cost of deplacing some mass, for the related fully non-linear Monge-Ampère partial differential equation and for free boundaries of obstacle problems. He has obtained quantitative isoperimetric inequalities through which the gap from optimality in geometric inequalities can be used to bound the distance to an optimizer for the same geometric inequality.

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16h20 – 17h05 Matthew Morrow (IMJ-PRG, Paris)

About algebraic geometry, perfectoid theory and Peter Scholze's Fields medal in 2018

Chair: Wim Veys (KUL)

In this talk we will attempt to introduce the audience to some of the beautiful ideas through which Peter Scholze has spectacularly revolutionised p-adic arithmetic geometry in recent years. In particular, we will give an overview of his perfectoid spaces and their wide range of applications.

17h15 – 18h00 Gautami Bhowmik (Lille)

About number theory and Akshay Venkatesh's Fields medal in 2018.

Chair: Leo Storme

The work of Akshay Venkatesh is characterised by the use of diverse and often unusual or unexpected tools from dynamics, topology and representation theory in number theory. In this talk we will present some examples of his innovations in the advancement of classical and newer arithmetical settings. In particular we will encounter the Riemann zeta function, its generalisation to automorphic L-functions and the long-standing conjectures on their zeros which when proved will give information on the distribution of prime numbers. An equivalent formulation is the study of the bounds of these functions on the critical line where the zeros are expected to lie. The subconvexity problem, begun by Weyl using exponential sums, is to beat convexity bounds available from the functional equation. Venkatesh used ergodic theoretic techniques for equidistribution of orbits in certain homogeneous spaces to obtain subconvexity for L-functions in great generality and resolved the problem completely with Michel in 2000 for GL2. Suitable subconvexity bounds lead to insights on many other topics like the representation of integers by integral ternary quadratic forms, answering questions of the type 'how can a large integer be written as the sum of three squares?'. In fact the question of when one integral quadratic form in m variables represents another in $n \leq m$ variables is a variant of Hilbert's 11th problem and has a long and illustrious history beginning with Siegel. Using the dynamics of lattices, Venkatesh with Ellenberg made an astonishing contribution by proving a local-global principle for $n \geq m + 5$ which brings m and n much closer than had been expected. This work is a follow-up of Linnik's on $m = 1$ but the group associated to the quadratic form is no longer a torus and they now need powerful results on the flow of lattices. Another contribution came from the use of algebraic topology and algebraic geometry to study the class number of a function field. The original Cohen-Lenstra heuristics conjectured that the distribution of class groups of imaginary quadratic extensions of the rational numbers were governed by a probabilistic law on finite abelian groups. Though the computational evidence supporting this is large, rigorous proofs are missing. Venkatesh and his co-authors, Ellenberg and Westerland, very recently proved that these heuristics were exactly as predicted for quadratic extensions of rational functions over a finite field. To arrive at this they used the notion of homological stability for a class of topological objects called Hurwitz spaces which are not even connected. If time permits we will mention other contributions of Venkatesh, in particular, his on-going work on the Langlands programme.

18h00 – 19h00 Drink offered by the BMS to all registered participants.

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