Abstracts of Talks

Quantum field theory and arithmetic

Francis Brown
I will give an introduction to the study of Feynman amplitudes in perturbative Quantum Field Theory, which form the basis for making predictions in particle collider experiments, and discuss the relationship with multiple zeta values and modular forms.

Random matrices and L-functions

Jon Keating
I will survey the conjectural connections between Random Matrix Theory and L-functions, including recent developments and some open questions.

Periods and special functions of renormalizable quantum fields

Dirk Kreimer
The talk will discuss the mathematical structures behind the appearance of periods and the analytic structure of amplitudes in perturbative quantum field theories, with an emphasis on scalar and gauge field theories. The main tools are the Hopf algebraic structures of graphs and the structure of Kirchhoff and corolla polynomials.

Primes, polynomials over finite fields, and matrix integrals

Zeev Rudnick
The subject of the talk is the inter-relationship between the arithmetic of the integers and that of the ring of polynomials over a finite field. While several problems, such as the Riemann Hypothesis, take the same form in both theories, in some aspects the situation over finite fields is simpler and there are powerful techniques due to Weil, Grothendieck, Deligne and Katz which do not have known parallels over the integers. We have recently been able to use results over finite fields to make predictions for several classical problems in analytic number theory as well as to establish new results. New links are established with statistics of random permutations and of random matrices in the classical compact Lie groups. The lecture will give an overview of these matters, and is intended for a general audience.

Topological recursion and applications

Gaetan Borot
I will present the formalism of two flavors of the "topological recursion" and give some examples of applications. Firstly, for an initial data given by a germ of holomorphic 1-forms and symmetric
bidifferential forms, the "local topological recursion" constructs a sequence of \( n \)-differential forms \( \omega_{g,n} \) for integers \( n \geq 1 \) and \( g \geq 0 \). They can always be represented as integrals of tautological classes (defined by the initial data) over the Deligne-Mumford moduli space. When the initial data can be defined globally on a compact Riemann surface \( C \), this construction enjoys nice properties, like variational formulas when the complex structure of \( C \) change, and symplectic invariance. This structure has been shown to describe asymptotic behavior of matrix integrals of size (when it is perturbative in \( 1/N \)), and Gromov-Witten theory of toric Calabi-Yau 3-folds.

Secondly, one can also introduce extra initial conditions for \( n \)-forms for any \( n \geq 3 \). For a suitable choice of extra initial conditions, this new structure has been shown to govern the asymptotic behavior of matrix integrals (including non-perturbative effects), and it seems to appear in the asymptotics of knot invariants (especially in \( SL_2(C) \) Chern-Simons theory).

Feynman diagrams and twistor diagrams

Andrew Hodges
Recently, Arkani-Hamed et al (arxiv 1212.5605) have shown a connection between amplitudes in (supersymmetric) Yang-Mills theory and cells of the positive Grassmannian in an extended twistor space. This connection is made through a graph-theoretic formalism in which geometrical, combinatorial and physical concepts are brought together. These graphs supersede the traditional summation over Feynman diagrams. But essentially the same diagrammatic formalism was proposed by Roger Penrose in 1972. Why has it taken over 40 years for this fundamental structure to be extended and recognised as effecting an enormous computational simplification? In this talk I will outline the advances in physics and in mathematics which have been necessary for this new conceptual framework to be established.

Membranes and sheaves

Andrei Okounkov
I will discuss a conjectural correspondence (joint with Nikita Nekrasov) between K-theoretic Donaldson-Thomas invariants of 3-folds and a different curve-counting theory of Calabi-Yau 5-folds.

Non-abelian zeta functions and stable pairs on curves via wall-crossing

Marcus Reineke
Using wall-crossing in the category of triples, we derive a Zagier-type formula for the motives of moduli of stable pairs on curves, and apply it to (a motivic version of) Weng's non-abelian zeta functions of curves. This is joint work with S. Mozgovoy.

On the relative cohomology of the Hitchin fibration

Gérard Laumon
This is joint work with Pierre-Henri Chaudouard. The main tool in Ngô Bao Châu's proof of the Langlands-Shelstad fundamental lemma is a theorem on the support of the relative cohomology of the elliptic part of the Hitchin fibration. For \( GL(n) \) and a divisor of degree \( > 2g - 2 \), the theorem says that the relative cohomology is completely determined by its restriction to any dense open subset of the base of the Hitchin fibration. In the talk I would like to present in this particular case, our extension of that theorem to the whole Hitchin fibration, including the global nilpotent cone.