

Combinatorics and Arithmetic for Physics

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Abstracts.—

Florian Fürnsinn

Speaker: Florian Fürnsinn (INRIA)

Title: Galois Groups of D-finite Series modulo Primes.

Abstract: A D-finite series is a power series over the rational numbers that satisfies a linear differential equation with polynomial coefficients. Reducing a D-finite series modulo a prime number, one often obtains an algebraic power series in positive characteristic. For diagonals of multivariate rational functions, this was observed by Furstenberg in 1967; for hypergeometric functions, it can be deduced from results of Christol and was made precise in recent work of Vargas-Montoya. In these cases, one can consider the Galois group of the reduction over the field of rational functions.

In this talk, I will present many examples of D-finite series of various kinds for which we can (almost) compute these Galois groups for all but finitely many primes for which the reduction is defined: generating functions of binomial sums and of Apéry-like sequences, as well as some hypergeometric functions. Then, building on these observations, I will raise questions about the general behavior of these groups: Is there some uniformity in the Galois groups as the prime varies? Is there an object in characteristic zero governing their behavior, such as the differential Galois group of the minimal differential equation of the series? In the spirit of the Grothendieck p-curvature conjecture, we are looking for a local-global principle; however, we are concerned with only a single solution of a differential equation rather than a full basis of solutions.

This talk is based on joint work with X. Caruso, D. Vargas-Montoya and W. Zudilin.

Keywords: -

Domains: -

Robert Penner

Speaker: Robert Penner (IHES)

Title: Geometric and Quasi-Thermodynamic Principles of Protein Dynamics.

Abstract: Predicting the three-dimensional folds of proteins is a celebrated problem at the crossroads of molecular dynamics and artificial intelligence. Our novel approach sets aside amino-acid sequence information and focuses instead on the geometry of protein backbones. An empirical density on $SO(3)$ is determined from experimental protein structures, and a Boltzmann-like construction yields approximations to free energies directly from backbone geometry. This provides a new approach to predicting protein function from structure, with diverse applications across biophysics and biology. Two new physico-geometric quantities are introduced: Fragility, which measures the intrinsic susceptibility of a protein to perturbation, and Lability, which measures its response to a specific perturbation. A remarkable empirical law emerges: regions of high native backbone Fragility tend to exhibit greater Lability under structural perturbations, reminiscent of the fluctuation–dissipation theorem of statistical mechanics.

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