

# **Journée Résurgence**

## **Rapport sur les contributions**

ID de Contribution: 1

Type: **Non spécifié**

## A leisurely walk through the resurgence landscape

*mercredi 7 mai 2025 09:15 (1 heure)*

I shall attempt a broad brush, rather personal survey of resurgence (a theory now in its prime: it just turned 50 this year!) with special emphasis on

(i) the algebraic aspect, which all too often gets short shrift

(ii) questions of typology: sources of resurgence; patterns of resurgence; the ad hoc toolkit

(iii) some signal successes of the theory

(iv) and lastly, for good measure, three vexing open questions.

**Orateur:** ÉCALLE, Jean (CNRS, emeritus)

ID de Contribution: 2

Type: **Non spécifié**

## The resurgent structure of topological strings

*mercredi 7 mai 2025 10:30 (1 heure)*

In recent years, the ideas of resurgence have been applied to many theories arising in physics. Perhaps the clearest success story has been topological string theory. The so-called free energy of topological strings on a Calabi-Yau threefold is given by a factorially divergent series, and there is by now a partially conjectural but complete description of its full set of Borel singularities, Stokes constants and Stokes automorphisms. In particular, Stokes constants are conjecturally given by the Donaldson-Thomas invariants of the Calabi-Yau. I will present the results obtained so far and discuss some open problems.

**Orateur:** MARINO, Marcos (UniGe)

ID de Contribution: 3

Type: **Non spécifié**

## Small-N expansion in the $O(N)$ model: constructive field theory and transseries

*mercredi 7 mai 2025 12:00 (1 heure)*

Transseries are an improved version of asymptotic series that include both perturbative and non-perturbative contributions to a given problem. They play an important role in the theory of resurgence, that was developed by Jean Ecalle in the context of dynamical systems. It has been conjectured that also perturbative series in quantum field theory (QFT) can be upgraded to resurgent transseries, but proving it in a nontrivial QFT remains an open challenge. On the other hand, the study of the Borel summability of perturbative series in QFT is the subject of constructive field theory, the branch of theoretical physics devoted to rigorously proving that QFTs exist and satisfy the Osterwalder-Schrader axioms. It is somewhat surprising that resurgence in QFT and constructive field theory have so far remained two essentially separated fields of research. In this talk, I will present a first small step in trying to bridge these two areas of research. In order to do that, we have considered a trivial and extensively studied toy model: a zero-dimensional QFT with quartic interaction and  $O(N)$  global symmetry. Although most of the results are not new, the main point is to show that it is possible to obtain them by means of a constructive expansion due to Vincent Rivasseau, the so-called loop vertex expansion (LVE), that is at least in principle applicable also in genuine higher-dimensional QFT. The LVE is a repackaging of the perturbative series into a convergent expansion, and in the case of the  $O(N)$  model it can be interpreted as a small-N expansion. Using the Brydges-Kennedy-Abdesselam-Rivasseau forest formula, one can then prove rigorous results about the convergence domain of the free energy of the model in the LVE representation. Lastly, the latter allows to derive its transseries expansion. [Based on work with R. Gurau, H. Keppler, D. Lettera]

**Orateur:** BENEDETTI, Dario (CPHT, École Polytechnique)

ID de Contribution: 4

Type: **Non spécifié**

## Resurgence in quantum mechanics

*mercredi 7 mai 2025 14:45 (1 heure)*

Classical mechanics in first-order formalism, is determined by a Hamiltonian (possibly time-dependent) and two boundary conditions at the ends of the time interval, i.e. two Lagrangian subvarieties. I will describe certain data which fixes ambiguities in the formal perturbation theory of the corresponding path integral near complex classical trajectories. Also, I propose a conjecture concerning the resurgence of the path integral.

**Orateur:** KONTSEVICH, Maxim (IHÉS)

ID de Contribution: 5

Type: **Non spécifié**

## Resurgent QCD

*mercredi 7 mai 2025 16:30 (1 heure)*

QCD is a highly successful theory that underlies most of collider physics and describes a wide range of phenomena. Despite this success, a few foundational issues remain open. These issues include first principle computation of such properties of bound states as masses and parton distributions. Mathematically it is the next logical step compared to TQFT as it is explicitly sensitive to metric. We will discuss the first principle approach to QCD and the mathematical concepts involved. First principle definition of QCD requires connections to a few branches of mathematics. We will start by stating the problem in the context of doing analysis of PDEs on Banach and other related infinite dimensional manifolds. Then we will discuss certain algebraic and categorical structures suggested by perturbation theory. These structures include the relation to flat bundles with logarithmic singularities, certain generalizations of quantum groups and Grothendieck-Teichmüller spaces. Then we will discuss resurgent phenomena in QCD. The emergence of Riemann surfaces of infinite genus is inherent in any known formulations of QCD. We will discuss the current status of the theory of these surfaces and the circle of math ideas needed for successful applications to physics, emphasising connections to transcendental number theory and holomorphic dynamics. Then we discuss applications of this formalism to the theory of bound states, such as the proton, and possible ways to test this experimentally. If time permits, we will mention possible ways of resolution of the resurgence conjecture of Kontsevich and Soibelman, as well as its multiparameter generalizations, in the context of mixed Riemann Hilbert problems.

**Orateur:** SREDNYAK, Stanislav (Duke University)