*ERC Synergy grant* ***ReNewQuantum***

European Research Council
Established by the European Commission

# Phd 2022-2024 in Mathematical Physics

## *Geometry of integrable systems, topological recursion, quantum curves, asymptotic expansion and resurgence.*

**Principal investigator :** B. Eynard, IPHT CEA Saclay, CNRS UMR 3681.

**Duration : 2** years, oct 2022 – oct 2024.
**Location :** Institut de Physique Théorique, DRF/IMP UMR 3681
IPHT CEA Saclay, 91191 Gif sur Yvette, France
https://www.ipht.fr/en/index.php

**Topic:**

The goal of the ReNewQuantum ERC project is to study perturbative asymptotic expansions, and how to resum them, in various examples from integrable systems, enumerative geometry, topological strings, conformal field theory, combinatorics, random matrices... This is a very interdisciplinary topic in **mathematical physics**, at the interface between **Mathematics** and **Physics**.
**Key words :** integrable systems, algebraic and enumerative geometry, combinatorics, topological recursion, resurgence theory, random matrices, string theory, statistical physics, maps.

Quantum systems are often defined 'perturbatively', from a classical system, as an asymptotic expansion series, whose coefficients can be defined either from a differential equation (e.g. Schroedinger), deformations relations, combinatorial expression, recursion,... One goal will be to show, at least in examples, that all definitions lead to a common universal recursion known as 'topological recursion'.
And moreover that deformation relations satisfy an integrable system.
These asymptotic series are divergent, and a resummation method is needed. We shall use the 'resurgence' method.
The goal of the project is to study and prove, in examples or in general, some relations between topological recursion, integrable systems and resurgence.

An integrable system was initially defined as a dynamical system with enough conserved quantities to make it « solvable ». It was rephrased as a set of Poisson-commuting Hamiltonians, and as the existence of a « Tau-function » whose differential is generated by the commuting Hamiltonians. In physics, the Tau function is the partition function. The Tau function is characterized by some relations satisfied by its differential, and in particular a nonlinear equation called « Hirota equation ».

**Application :** send a cv, and 3 recommendation letters.

**Deadline for submission :** 28 february 2022.  Next selection: march 2022