

Mathematical Physics at IJCLab

Definition: *Mathematical Physics involves: i) applications of Mathematics to (understand/solve) problems in Physics as well as ii) developments of new Mathematics inspired by Physics.*

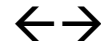
(definition borrowed from Journal of Mathematical Physics)

Examples:

- i) Math. \rightarrow Phys.: (*standard!*) Group Theory \rightarrow Symmetries, ..., Fiber bundles \rightarrow Gauge Theories, ...
- ii) Phys. \rightarrow Math.: (*not so standard*) "Particular" Gauge models \rightarrow Differential Invariants of manifolds, Quantum Gravity approaches \rightarrow new algebraic structures, ...

Summary:

Algebra, Topology, Differential Geometry, Functional Analysis, ... *almost all MCS items*



Field Theory, High Energy Physics, Quantum Gravity, ...

Mathematical Physics at IJCLab: People

<https://theorie.ijclab.in2p3.fr/en/members>

Michel DUBOIS-VIOLETTE

Samuel FRIOT

Vincent RIVASSEAU

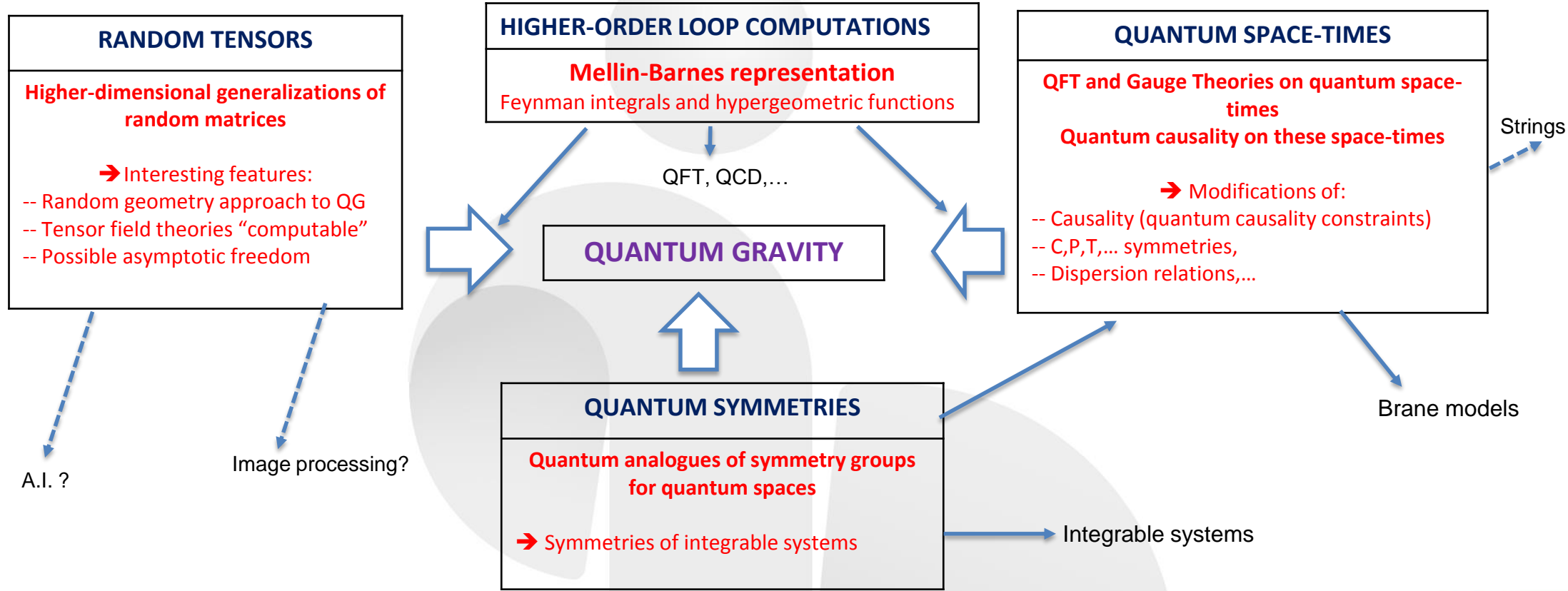
Jean-Christophe WALLET

Robin ZEGERS

Léonard FERDINAND

Kilian HERSENT

Mathematical Physics at IJCLab: Topics



Recent results (among others)

- **Classification of the irreducible representations of quantum toroidal algebras (lowest rank)**
Solves a long-standing problem in representation theory
- **Construction of the first physically suitable gauge theory on κ -Minkowski space-time**
Solves a 20 years old problem in the area of field theories on quantum spaces
- **First steps toward the construction of a renormalizable Tensor Field Theory**
Some indications of non-perturbative asymptotic freedom
- **Powerfull method to compute multiple Mellin-Barnes integrals (mixes geometry and complex functions properties)**
Mathematica package, new properties of hypergeometric functions,...
- **Exceptional Jordan algebra (octonionic 3x3 matrices) to describe the internal space of fermions in Standard Model**
New insight in the (Connes approach to the) Standard model
- **Constraints from quantum causality in κ -deformed quantum space-times**
Existence of quantum generalisation of the speed of light limit; experimental impacts
- **Review paper on Quantum gravity phenomenology in the Multi-Messenger approach**
(collab. Theory/Phenomenology/Experiment -- Prog. Part. Nucl. 125 (2022) 103948 --)
- ...

Networks

High visibility

Interactions/Collaborations:

- Dept. of Maths: *Univ. of Almeria (Spain), IHES (France), Institut for Geometry and Physics Trieste (Italy), univ. of Notre Dame Indiana (USA), univ. of Genova (Italy), Institut für Mathematik Zürich (Swiss), ...*
- Dept. of Physics: *CPhT X, CPT Marseille (France), univ. of Napoli (Italy), univ. of Roma Sapienza (Italy), Univ. of Brussel (Belgie), Jagelonian univ. Krakow (Poland), ...*

EU Programs:

→ Program CA18108 “Quantum Gravity phenomenology in the Multi-Messenger approach” (QG-MM)

*(Investigate possible signatures predicted by quantum gravity models in the observation of different cosmic messengers, by creating the conditions for a **close collaboration between theorists and the various experimental communities** involved in the detection of such cosmic messengers) -- 28 countries, ~150 scientists*

→ Program CA21109 “Cartan geometry, Lie, Integrable systems, quantum group theories for Applications” (CaListA)