Women at the Intersection of Mathematics and High Energy Physics

February 18-20, 2019 - Villa Batelle (UNIGE)

Colloquium Talks – invited Speakers

1. *Symmetry and duality*

Marta MAZZOCCO

Title:

Symmetry and duality for orthogonal polynomials and the underlying algebras

Abstract :

In this talk we will discuss symmetry and duality for a special case of Macdonald polynomials called Askey–Wilson polynomials and their degenerations. We will start from classical orthogonal polynomials and move to the basic hypergeometric polynomials, i.e. polynomials expressed in terms of the q-Hypergeometric series (the q-difference version of the classical hypergeometric series), of which the Key Wilson are the most general one variable ones. We will discuss the algebras of symmetries of these polynomials and the concept of duality in this context.

Anastasia VOLOVICH

TBA

2. *Topological, algebraic and geometric invariants*

Sofia LABROPOULOU

Title :

Topological surgery in the small and in the large

Abstract :

Topological surgery is a mathematical technique used for creating new topological manifolds out of known ones. It roughly, consists in removing some bounded submanifold from the interior of a given space and replacing it by another submanifold with the same boundary. Since few years we have observed that surgery also occurs in natural phenomena of all scales. For example, 1-dimensional surgery happens during chromosomal crossover and when cosmic magnetic lines reconnect, while 2-dimensional surgery happens in the formation of tornadoes and in the phenomenon of Falaco solitons. Further, we connect 3-dimensional surgery with cosmic phenomena, such as wormhole formation and the formation of black holes from cosmic strings, offering a conjectural explanation for the existence of a black hole's singularity. Inspired by phenomena exhibiting surgery and in order to model them topologically, we introduce new theoretical concepts enhancing the formal definition. Namely, we introduce the notions of solid topological surgery and that of embedded surgery, for the appearance of knotting and for describing phenomena where the cause and the effect of the process lie beyond the initial manifold. We also describe surgery as a continuous, dynamic process caused by local forces, modeled by the local form of Morse functions, so as to provide an algebraic formulation of the temporal evolution and for proposing a potential energy function. Our topological model indicates where to look for the forces causing surgery and what deformations should be

observed in the local submanifolds involved. These predictions are significant for the study of phenomena exhibiting surgery. Also, phenomena exhibiting the type of surgery reminiscent of 'hole drilling' are related to a chaotic dynamical system. Our work widens the bridge between topology and natural sciences and creates a platform for using the general language of topology in the study of physical phenomena.

Chenchang ZHU

Title:

Higher groups in higher gauge theory (arising from topological orders)

Abstract:

There has been much recent development on higher symmetries in topological orders as the study of topological phase of maters has become a very active field in condensed matter physics. In this talk, we will carry out the mathematical foundation of a recent joint project with Tian Lan and Xiao-Gang Wen in the above direction, in details. Higher groups are group objects in a higher category. In a very concise way, they can be realised as a simplicial object satisfying suitable Kan conditions. We will give a more explicit algebraic model to realise some of them. This model is between the target of Dold-Kan functor and the skeleton case. Higher groups and higher group cohomology theory are then used in the sigma model as the target space to realise various physical meaningful phases.

3. Locality and singularities

Fay DOWKER

Title :

Why is the geometry of the physical world Lorentzian and not Riemannian?

Abstract :

According to General Relativity, the geometry of our physical world is a four dimensional Lorentzian, not Riemannian, manifold. That is, as a quadratic form, at every point, the metric has signature (3,1). To answer the question "why?" we need a successful physical theory that is deeper than General Relativity from which the Lorentzian manifold emerges as an approximation to a deeper level of physical reality. I will describe one approach to the problem of finding a theory of quantum gravity that suggests that the Lorentzian nature of the world arises because the fundamental structure of spacetime, at the deeper level, both is discrete and takes the form of a partial order.