PAFT 2016 - Problemi Attuali di Fisica Teorica

Current Problems in Theoretical Physics

XXII Edition - March 18 - 23, 2016
Lloyd's Baia Hotel - Vietri sul Mare (Italy)

Loop Quantum Gravity and Group Field Theory

Chairperson: D. Oriti

Monday, 21st March

15:00

Loop Quantum Gravity

Emanuele Alesci

Warsaw University

LQG is a candidate theory to finally quantize General Relativity. In this talk I will introduce the main ideas of its canonical and covariant formulation, focusing on its physical interpretation, main results with related areas of investigation and future perspectives.

15:45

Group field theory: foundations and emergent cosmology

Daniele Oriti

MPI, Potsdam

I give an introduction to the basic elements of the group field theory formalism for quantum gravity, and explain its relation to loop quantum gravity, but also to lattice quantum gravity (matrix and tensor models, simplicial gravity path integrals). I then overview the main challenges that researchers in this area are facing and the key developments that have taken place in recent years. Finally, I focus on the issue of the extraction of continuum physics from the microscopic models and in particular on the derivation of cosmological dynamics from group field theory condensate states.

16:30 **Coffee break**

17:00

Black hole entropy in loop quantum gravity

Daniele Pranzetti

Erlangen - Nuremberg University

After introducing the main ingredients of the loop quantum gravity (LQG) approach, I show how this can applied to the calculation of black hole entropy. I review some well known results and open issues resulting from the application of Chern-Simons theory techniques; in particular, the fixation of the Immirzi parameter value in order to recover the semiclassical Bekenstein-Hawking entropy formula. I then present two new approaches, one relying on the Group Field Theory formalism and one the interplay between LQG and CFT techniques, which provide ways to overcome this issue.

17:50

Round table and general discussion on Quantum Gravity

Tuesday, 22nd March

9:30

Exploring the pre-geometric quantum texture of space-time with entanglement

Goffredo Chirco
MPI, Potsdam

Loop quantum gravity, spin-foam gravity and group field theory, share a microscopic picture of space-time geometry described by discrete, pre-geometric degrees of freedom, of combinatorial and algebraic nature. This picture formally translate in a kinematic Hilbert space defined by spin-network states corresponding to a superposition of graphs labelled by group or Lie algebra elements. We study the possibility to reconstruct the geometry of quantum space-time by looking at the correlation structure and entanglement properties of such spin network states, within a quantum informational theoretic setting.

10:15

Cosmological implications of quantum geometry in LQG

Francesco Cianfrani
University of Wroclaw

I will outline the main features of a cosmological model derived from LQG, with a special emphasis on the implications of the adopted quantum tools on the global Universe dynamics.

11:00 **Coffee break**

11:30

Effective Spacetimes from Quantum Cosmology

Andrea Dapor
Erlangen - Nuremberg University

We will present a general mechanism for the emergence of an effective classical spacetime from a fundamental theory of quantum cosmology coupled to matter. This idea is based on QFT on quantum spacetime, and the emergent classical metric is not just the naïve expectation value of a ``metric operator'' on the quantum state of geometry. In fact, if the matter sector consists of as simple a species as a massive real scalar field, then the emergent classical metric appears differently to different modes of the field: specifically, the emergent metric depends on the energy of the particle used to probe it. This is a realization of the concept known in the literature as ``rainbow metric'' (the name comes from the analogy with propagation of light in crystals, where photons of different colors move along different paths). As an example of this general mechanism, we will present the case of isotropic Loop Quantum Cosmology. Time permitting, we will also sketch some preliminary results in the context of anisotropic cosmologies.

12:15

Functional Renormalisation Group analysis of Tensorial Group Field Theories

Riccardo Martini
Università di Bologna

Tensorial Group Field Theories (TGFTs) are a non-local field theory framework for the dynamics of discrete geometries and their quantum fluctuations.
One of the main tasks is, thus, to prove the emergence of a continuous manifold in some limit.
I will present an application of Functional Renormalisation methods to two models of Tensorial Group Field Theories on R^d, differentiated from the presence of a projection on the gauge invariant dynamics. This study is performed to investigate the existence of a transition from a discrete state to a continuous one in terms of a phase transition for a many body system.
Because of the non-compact nature of the underlying group, we tackle the problem of infra-red divergences and define a proper thermodynamic limit for Tensorial Group Field Theories, which turns out to be crucial to define the scaling properties of the coupling constants of the both models and to obtain the correct form of the beta functions of the systems.
The existence of phase transitions is indeed suggested from the discovering of IR fixed points for both models. Also, asymptotic freedom is proven in both cases.