

Workshop

# GLOBAL GEOMETRICAL ASPECTS OF GRAVITATION

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Organized by:

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**ABSTRACTS**

**(2+1) QD-spacetimes.**

Riccardo Benedetti

**(2+1)-spacetimes of constant curvature and projective structures.**

Francesco Bonsante

**Quantum Thurston theory and 3D geometry.**

Leonid Chekhov

Using the graph technique by Penner and Fock and its quantum version by Chekhov and Fock, we propose how to quantize the train track theory on Riemann surfaces with holes. We therefore consider the space whose points are parameterized by coordinates of the Teichmüller space plus train track parameters; the latter can be identified with a closure of the set of contractible A-cycles on the Riemann surface. Choosing this set is equivalent to choosing the continuation of the conformal metric on the boundary to the 3D handlebody. We therefore aim to describing all possible smooth continuations of 2D metrics into 3D hyperbolic space.

**Flat Lorentz 3-Manifolds and 2-Dimensional Hyperbolic Geometry.**

William Goldman

This talk will be a survey of 3-dimensional flat Lorentz space forms. In particular I will discuss the construction and classification of such structures, and their relationship to hyperbolic geometry on surfaces.

**Closed geodesics in compact spacetimes.**

Mohammed Guediri

A famous result in differential geometry asserts that there exists a shortest curve, which must be a closed geodesic, within any free homotopy class of closed curves in a compact Riemannian manifold. The aim of this talk is to present a Lorentzian analogue of this result. Namely, we will prove the following theorem and discuss some of its consequences. Let  $M$  be a compact spacetime which admits a regular globally hyperbolic covering, and  $\mathcal{C}$  a nontrivial free timelike homotopy class of closed timelike curves in  $M$ . Then  $\mathcal{C}$  contains a longest curve (which must be a closed timelike geodesic) if and only if the timelike injectivity radius of  $\mathcal{C}$  is finite; i.e.,  $\mathcal{C}$  has a bounded length.

We will also present a new class of compact spacetimes without closed non-spacelike geodesics. To the best of our knowledge, these are the first examples of geodesically complete compact spacetimes with regular globally hyperbolic coverings but without closed nonspacelike geodesics. They are obtained by making use of a result of Fried and Goldman on simply transitive affine actions of the three-dimensional Heisenberg group  $H_3$  on  $\mathbb{R}^3$ .

**Three dimensional flat Lorentzian universes with particles in 't Hooft's language.**

Zoltan Kadar

**Title to be announced.**

Kirill Krasnov

**Modules des représentations des groupes de surfaces et identités géométriques.**

Gregory McShane

**Quantization of 3D gravity using loops: pure geometry and particles.**

Karim Noui

**Applications of the cell decomposition of Riemann's moduli space to the Torelli groups and punctured solenoid.**

Robert Penner

We shall describe new work which gives combinatorial descriptions of the Torelli groups and Johnson homomorphisms (joint with S. Morita) as well as the Teichmüller space of the punctured solenoid and its mapping class group (joint with D. Saric).

**Quantization of De Sitter Chern-Simons gravity coupled to Point Particles and Dynamical Quantum Groups.**

Philippe Roche

We analyze the hamiltonian quantization of Chern-Simons theory coupled to dynamical sources for any semi-simple group. We introduce different dynamical Poisson algebras associated to this problem and proceed to the quantization of these structures and to the analysis of representation theory of some of these algebras. In particular we analyze in detail the quantization of particles coupled to  $SL(2, C)$  Chern-Simons theory following the classical analysis of E. Buffenoir and K. Noui.

This is a joint work with E. Buffenoir.

**Anti-de Sitter manifolds with convex boundary.**

Jean Marc Schlenker