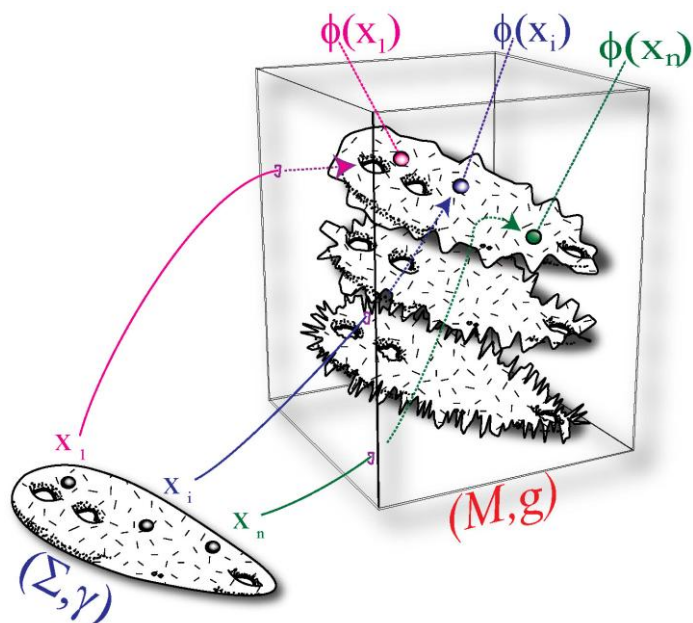# TS11 (PAVIA)

INIZIATIVA SPECIFICA TS11

Gravità, Campi e Stringhe
(Bo, Pv, Pi, RM1, Ts)

Componenti sede Pavia: *M. Carfora, A. Marzuoli, C. Dappiaggi*

Dottorandi: Francesca Vidotto (XXIV ciclo) (completed)
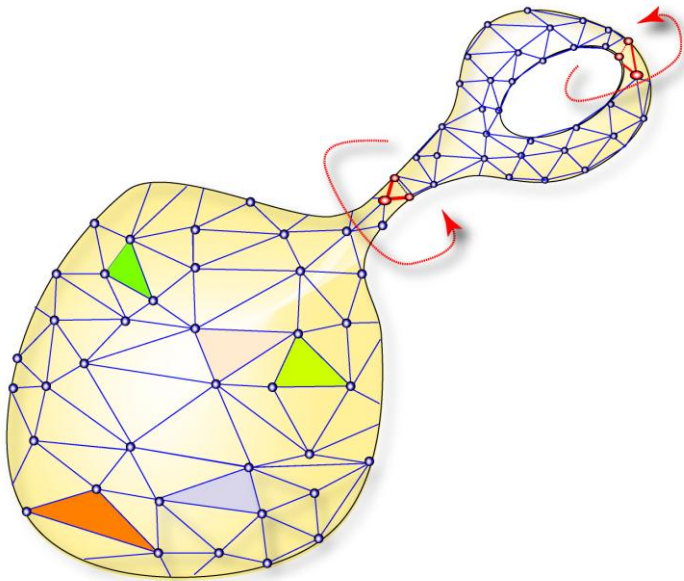   *Giandomenico Palumbo (XXV ciclo)*
        Dimitri Marinelli (XXVI ciclo)

TS11 provides a common area where problems at the intersection of gravity, field theory and string theory are investigated. The *leit motiv* of our IS is the exchange of ideas and the cross-fertilization among nearby areas of research, notably String theory, Condensed matter physics, geometric analysis, and Relativistic physics.

Research highlights for 2011/12 :

(i)   Topological Quantum Field Theory and Quantum computation:

This approach develops a scheme for quantum computation based on modular functors of Chern—Simons theory realized by the recoupling theory of N SU(2) angular momenta.

Modelli di gravità quantistica discretizzata e applicazioni.
-Nella monografia LN Physics sono riportati risultati sulle applicazioni di metodi originariamente utilizzati in modelli 3d di gravità discretizzata -triangolazioni decorate, SU(2) state sums di Turaev-Viro e associate osservabili quantistiche- finalizzate a stabilire una descrizione microscopica unificata delle fasi topogiche di sistemi 2d di interesse per la condensed matter e la computazione quantistica.
-In collaborazione con D Marinelli e Università di Perugia: analisi semiclassica di 'spin networks' con metodi geometrici-combinatorici e applicazioni allo schema di Askey-Wilson dei polinomi ipergeometrici.
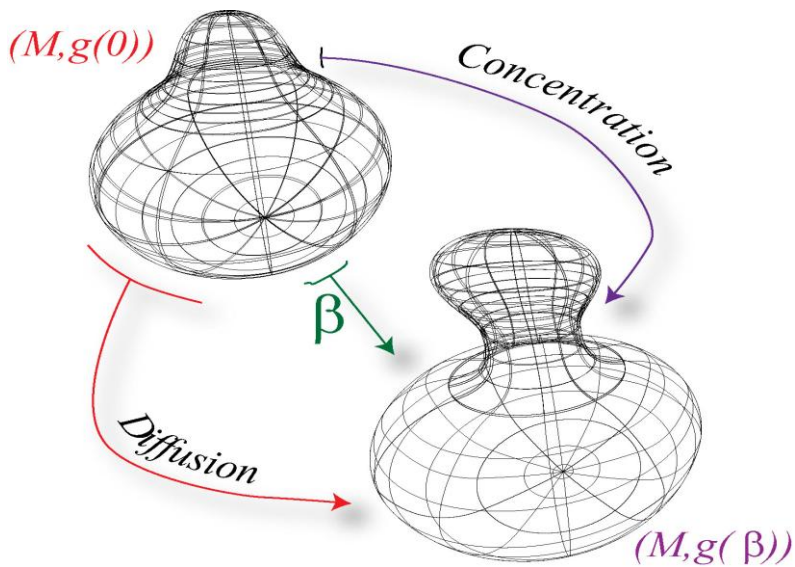
Computazione quantistica topologica
In collaborazione con G Palumbo:
-Teorie di campo di tipo BF come azioni azioni effettive per il grafene ((2+1)d) e gli isolanti topologici ((3+1)d), versioni miscroscopiche, teorie di bordo discretizzate e loro applicazioni alla 'anyonic' quantum computation.
-Proposta di protocolli crittografici basati sulla teoria topologica dei nodi.
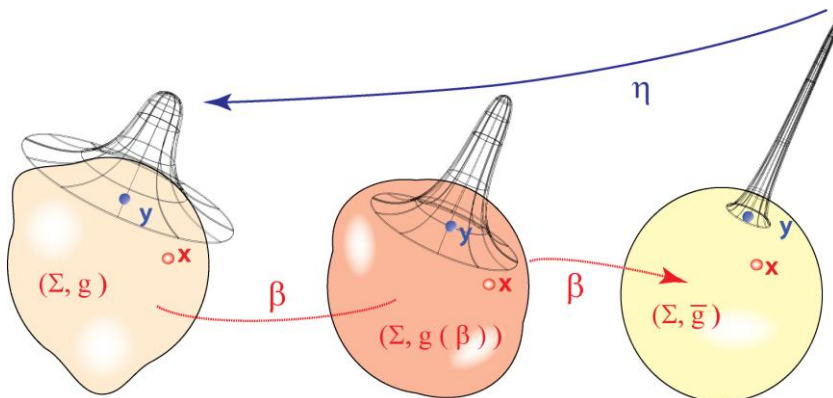
(ii)   Renormalization group, Quantum Field Theory Landscaping and Geometric flows:

Ricci flow techniques and QFT landscaping are used for analyzing   the geometrical landscape of non linear sigma model in the strong curvature regime, addressing also the role of KPZ scaling in 2-dimensional quantum gravity.
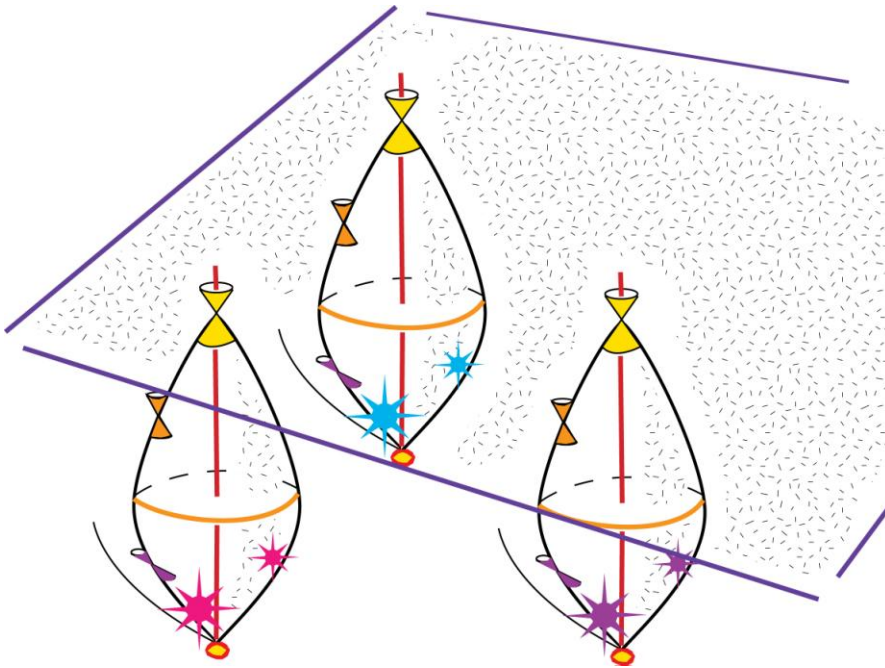

(iii)   Quantum Field Theory on Curved SpaceTime:

We focused on the construction, by means of an holographic procedure, of quantum states of physical relevance for free field theories. The   procedure has been applied particularly to cosmological spacetimes, as a   tool to construct approximate solutions of the semiclassical Einstein's   equations. The comparison with experimental data has been attempted   showing promising preliminary results.
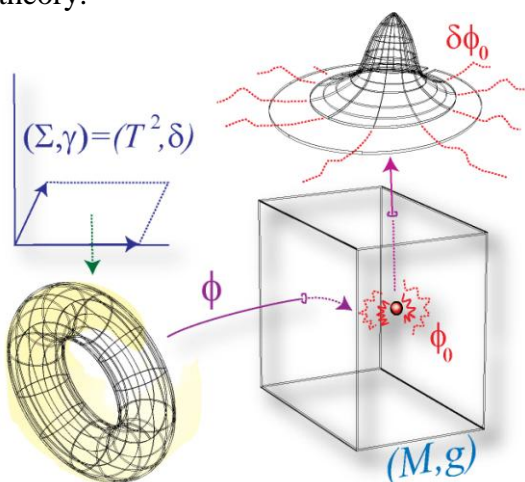
(iv)   Relativistic Cosmology and the dark energy problem:

By exploiting Ricci flow techniques as well as QFT on curved background it is possible to discuss (conservative) scenarios for the dark energy problem. In particular we have provided a full-fledged averaging scheme for the constraint sets of Einstein equations. In such a scheme one is able to estimate backreaction terms in Friedmannian Cosmologies which mimic a dark energy contribution.
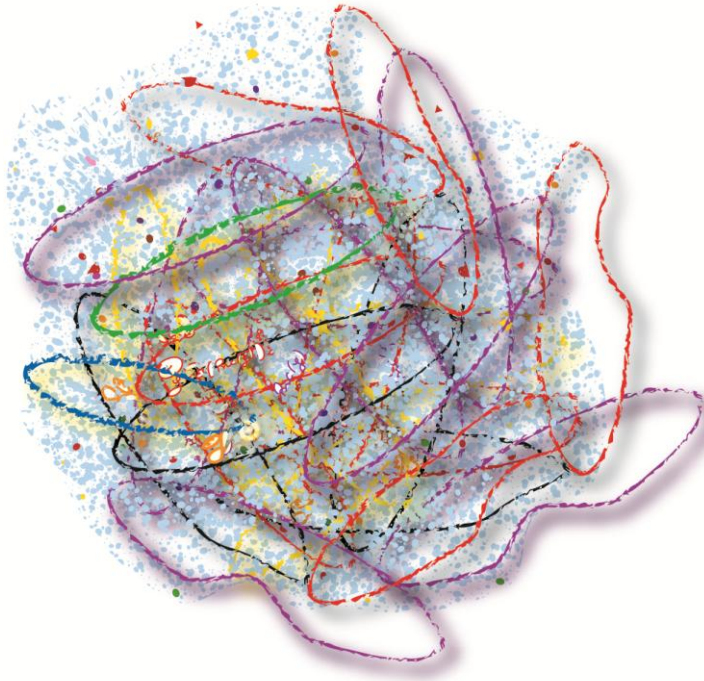

(v)   Open/closed string duality:

Techniques of hyperbolic geometry and moduli space theory have been used to investigate some elementary examples of Open/Closed string dualities in connection with Riemann moduli space theory.

(vi)   Loop Quantum Gravity:

Techniques of Loop quantum gravity have been used to discuss the singularity issue in quantum cosmology.

Research program for 2012: The planned research program will continue on the research highlits of 2011. In particular:
(i) Topological Quantum Field Theory and Quantum computation
(ii) Renormalization group, Quantum Field Theory Landscaping and Geometric flows
(iii) Quantum Field Theory on Curved SpaceTime
(iv) Relativistic Cosmology and the dark energy problem
(v) Open/closed string duality

Richieste Finanziarie 2012

Missioni all'interno………………..3.000

Missioni Estero……………………6.000

RECENT PUBLICATIONS (late 2011-early 2012)

M. Carfora, A. Marzuoli, *QUANTUM TRIANGULATIONS: Moduli Spaces, Strings, and Quantum Computing*, (266 + xviii pp.), Lecture Notes in Physics 845, Springer Verlag, Heidelberg (2012) .

M. Carfora, *Ricci Flow Conjugated Initial Data Sets for Einstein Equations*,
In press in Advances in Theoretical and Mathematical Physics (2012), arXiv:1006.1500

A. Marzuoli, G. Palumbo, *Post Quantum Cryptography from Mutant Prime Knots*, in Press in International Journal of Geometric Methods in Modern Physics, (2011), arXiv:1010.2055

C. Dappiaggi, B. Lang, *Quantization of Maxwell's equations on curved backgrounds and general local covariance* arXiv:1104.1374 To appear on Lett. Math. Phys. (2012)

C. Dappiaggi, *Remarks on the Reeh-Schlieder property for higher spin free fields on curved spacetimes* arXiv:1102.5270 Rev. Math. Phys. 23 (2011) 1035

C. Dappiaggi, T-P. Hack, N. Pinamonti, *Approximate KMS states for scalar and spinor fields in Friedmann-Robertson-Walker spacetimes* , arXiv:1009.5179 Ann. Henri Poincaré 12 (2011) 1449

C. Dappiaggi, G. Lechner, E. Morfa-Morales, *Deformations of quantum field theories on spacetimes with Killing vector fields*, Commun.Math.Phys.305:99-130, 2011 arXiv:1006.3548

C. Dappiaggi, N. Pinamonti, M. Porrmann, *Local causal structures, Hadamard states and the principle of local covariance in quantum field theory*, Commun.Math.Phys. 304:459-498,2011 arXiv:1001.0858

F. Vidotto, E. Bianchi, T. Krajewski, C. Rovelli, *Cosmological constant in spinfoam cosmology*, Phys.Rev.D83:104015, 2011, arXiv:1101.4049

F. Vidotto, P. Singh , *Exotic singularities and spatially curved Loop Quantum Cosmology*, Phys.Rev.D83:064027, 2011 , arXiv:1012.1307

F. Vidotto, A. Henderson, C. Rovelli, E. Wilson-Ewing, *Local spinfoam expansion in loop quantum cosmology*, Class.Quant.Grav.28:025003, 2011 arXiv:1010.0502

F. Vidotto, C. Rovelli, *Single particle in quantum gravity and Braunstein-Ghosh-Severini entropy of a spin network*, Phys.Rev.D81:044038, 2010 arXiv:0905.2983

RELAZIONI SU INVITO (selezione)

Carfora M*: Ricci flow conjugation and Initial data sets for Einstein Equations*
Conference at University of California, San Diego, May 2, 2011

Carfora M: *Glimpses of Lorentz Geometry and Physics*
Invited talk at: 87ème rencontre entre physiciens théoriciens et mathématiciens :
"Lorentz Geometry in Mathematics and in Physics", 16-18 juin 2011, Institut de Recherche
Mathématique Avancée (IRMA), Strasbourg, France

Marzuoli A: *Topological Field Theories, Geometric Topology and Quantum Complexity*
Invited talk at: XVI National Conference on Statistical Physics and Complex Systems, 22-24 June
2011, Parma

Carfora M: *Polymerization of Quantum Geometries*
Invited talk at: "Spin Networks in Atomic and Molecular Physics, Quantum Chemistry and
Quantum Computing" organized by the CECAM (Centre Européen de Calcul Atomique et
Moléculaire), 27-29 June 2011, CECAM-ETHZ, Zurich

Marzuoli A: *Spin networks, quantum Computing and Automata*
Invited talk at: "Spin Networks in Atomic and Molecular Physics, Quantum Chemistry and
Quantum Computing" organized by the CECAM (Centre Européen de Calcul Atomique et
Moléculaire), 27-29 June 2011 CECAM-ETHZ, Zurich

Carfora M: *Ricci flow: A theoretical Physics Perspective*
General Address at: Numerical Ricci flow in computer science, Geometry, and Physics
At the same conference also an invited talk on: *Ricci flow and Einstein equations*
13-16 July 2011 , Univ. of British Columbia,Vancouver

Carfora M: *Ricci flow and quantum field theory landscaping*
Invited talk at: International workshop on Geometry and Physics
31 August- 3 September 2011-07, ICMAT, Madrid

 Dappiaggi C. : *On the quantization of Maxwell's equations on curved backgrounds* 26/09/2011
Workshop ``Rigorous Quantum Field Theory in the LHC Era'' - Erwin Schr\"odinger Institute
(Vienna)

Dappiaggi C. : *Deformation of quantum field theories and curved backgrounds* 24/05/2011
Workshop "Noncommutativity and Physics: Spacetime Quantum Geometry" - Bayrischzell
(Germany)

Organizzazione di convegni internazionali e Progetti

Carfora M.: Organizzatore (insieme a Eric Woolgar (University of Alberta), Zindine Djadli (Institut Fourier, Université Grenoble 1), Gerhard Huisken (Max-Planck-Institute for Gravitational Physics), Lei Ni (University of California, San Diego)) del workshop (11w5010)

Geometric flows in mathematics and physics

Presso il BIRS (Banff International Research Station), Banff (Canada) 17-22 Aprile 2011.

Carfora M: Membro dell' Advisory Board della XXXV International Conference of Theoretical Physics "Matter to the Deepest 2011
Date: September 12-18, 2011
Location: Ustron, (Poland)

Marzuoli A : Organizzatrice (insieme a A. Lombardi, R. Littlejohn, V. Aquilanti, R. Anderson) del Workshop: "Spin Networks in Atomic and Molecular Physics, Quantum Chemistry and Quantum Computing" organized by the CECAM (Centre Européen de Calcul Atomique et Moléculaire).
Date: 27-29 June 2011
Location: CECAM-ETHZ, Zurich

Dappiaggi C : Organizzatore (insieme a K. Fredenhagen e N. Pinamonti) del Workshop "Modern Trends in Algebraic Quantum Field Theory"
Date: 14-16 September 2011
Location: Department of Theoretical and Nuclear Physics, Pavia

COLLABORAZIONI

-Politecnico e ISI Foundation (Torino)
-Dipartimenti di Fisica e di Chimica, Università di Perugia
-Physics Department, University of California, Berkeley
-Department of Mathematics, University of California, San Diego
-Université Lyon 1, Centre de Recherche Astrophysique