# TOPOLOGICAL GEOMETRODYNAMICS
# Physics as infinite-dimensional spinor geometry

**Matti Pitkänen**

**http://www.helsinki.fi/~matpitka/**

**matpitka@rock.helsinki.fi**

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# Problem

- Path integrals and canonical quantization do not work. Vacuum degeneracy and extreme nonlinearity the basic problems. Perturbation theory fails completely around canonically imbedded $M^4$.

# Outcome

- Quantum dynamics as classical dynamics for classical spinor fields in the infinite-dimensional “world of classical worlds” consisting of 3-surfaces in $H = M^4 \times CP_2$.

# Generalization of Einstein's geometrization program to infinite-dimensional context

- The world of classical worlds identified as space CH of 3-surfaces in H the arena of dynamics. Analog of Wheeler's superspace or of loop space.
- 4-D(!) General Coordinate invariance: definition of CH metric must assign to a given 3-surface four-surface as a generalized Bohr orbit. Bohr orbitology as part of configuration space geometry.
- Kähler geometry as a manner to geometrize Hermitian conjugation. Kähler function defining the metric absolute extremum of Kähler action?
- Complexification of configuration space highly non-trivial problem: effective 2-dimensionality.
- Reference: TGD: Physics as Infinite-Dimensional Geometry.

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# Infinite-dimensional geometric existence is highly unique

- Existence of Riemann connection forces infinite-dimensional symmetries: generalization of Kac-Moody symmetries of loop spaces (thesis of Dan Freed).

- Configuration space as a union of infinite-dimensional symmetric spaces. Constant curvature spaces. All points metrically equivalent.

- Symmetric spaces in union labelled by zero modes not contributing to the metric. Identifiable as classical observables crucial for quantum measurement theory. Vanishing curvature scalar: Einstein's vacuum equations satisfied from mere finiteness.

- Choice of compact Cartesian factor S of H also uniquely $S=CP_2$. Number theoretic considerations suggest this.

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# Geometrization of fermionic statistics and super symmetries

- Gamma matrices of configuration space provide geometrization of fermionic statistics.

- Gamma matrices expressible in terms of fermionic oscillator operators assignable to second quantized free induced spinor fields at space-time surface. Gamma matrices and isometry algebra combine to form a super algebra. Geometrization of super algebra concept.

- Configuration space spinor fields for which spinor components correspond to Fock states for a given 3-surface define physical states. Modes of classical spinor fields in configuration space define quantum states of the Universe. Universe a single fermion state in infinite-D sense!

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# Basic objection

- Super-conformal symmetries are crucial element of any TOE.
- Do not generalize to 3-dimensional situation in an obvious manner!
- Resolution of the difficulty: Magic properties of the boundary of 4-dimensional light-cone and lightlike 3-surfaces in general.
- Dimension D=4 for space-time and Minkowski factor of imbedding space unique!

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# Magic properties of lightcone boundary $\delta M^4_+$

- Lightcone boundary $\delta M^4_+$ metrically 2-dimensional. Generalized conformal invariance. $\delta M^4_+$ has infinite-D group of isometries realized as conformal transformations with radial scaling compensating the conformal factor! Degenerate symplectic and Kähler structures.
- Radial and transversal super-conformal algebras associated with $\delta M^4_+$ .
- !Configuration space CH union of configuration spaces associated with $H_{+/-} = M^4_{+/-} \times CP_2$ and labelled by the position for the tip of the lightcone. Connection with cosmology. Poincare invariance not lost. Also preferred $CP_2$ point as label: quantum measurement theory.
- By 4-D general coordinate invariance the construction of configuration space geometry must reduce to the boundary of $M^4_{+/-} \times CP_2$ for given $CH_h$. $Diff^4$ degeneracy.
- Non.determinism of Kähler action implies complications. Time would be completely lost without the non-determinism.
- Canonical (symplectic) transformations of $\delta M^4 \times CP_2$ act as isometries of $CH_h$. Generalization of local symmetries.

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# Lightlike 3-surfaces of $H/X^4$ as partons

- Lightlike 3-surfaces $X^3_l$ (analogous to loci of em shock waves) metrically 2-dimensional . Identification as parton orbits.

- Transformations respecting light-likeness of $X^3$ as local isometries of H are Kac-Moody type symmetries. Also conformal symmetries assignable to lightlike direction and transversal degrees of freedom.

- Partonic 2-surfaces defined as intersections $X^3_l \sum \delta H_+$ of light-like 3-surfaces and lightcone boundaries carry the data about configuration space metric and spinor structure.

- Dynamics in space-time interior corresponds to zero modes of CH metric. Fixed by quantum classical correspondence. Classical observables have same values as commuting quantum observables at partonic 2-surfaces. Geometrization of quantum measurement theory.

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# Quantum dynamics at parton level

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- Dynamics of lightlike partonic 3-surface cannot involve metric. Chern-Simons action for induced Kähler gauge potential. Partonic 3-surfaces with at most 2-D $CP_2$ projection extrema.

- The form of corresponding modified Dirac action dictated completely by the requirement that super-charges exist if Chern-Simons field equations are satisfied.

- Modified Dirac action: replace gamma matrices $\Gamma^\alpha$ by modified gamma matrices

  $$\Gamma^\alpha = (\Sigma\, \Sigma\, L/\Sigma\ h^k_{\ \alpha})\Gamma^k$$

  in massless Dirac operator D. Canonical momentum densities contracted with gammas of H. Guarantees conservation of super currents defined by solutions of modified Dirac equation.

- Generalized eigenmodes of modified Dirac operator: $D\psi = \lambda t^k \Gamma_k \psi$ , t lightlike tangent vector field for $X^3$ or its dual. The product of eigen values defines Dirac determinant defining vacuum functional of the theory. Exponent of Kähler function defined as absolute extremum of Kähler action.

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# Superconformal symmetries

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- **N=4 superconformal symmetries in question.**

- **Super Kac-Moody symmetries (SKM) respecting light-likeness of partonic 3-surface. Noether charges.**

- **Super Kac-Moody symmetries acting as $M^4$ and $CP_2$ spinor rotations.**

- **Supercanonical symmetries acting as isometries of CH define Noether charges. Gamma matrices as super-generators.**

- **Commutators of super-canonical and SKM symmetry algebras define gauge symmetries.**

- **Super conformal symmetries generated by solutions of the modified Dirac equation satisfying $t^k \Gamma_k \psi = 0$ : can be added to the generalized eigen modes of the modified Dirac operator.**

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- Breaking of superconformal symmetries by almost-TQFT property since the notion of light-likeness involves the notion of induced metric as does also generalized eigenvalue equation for modified Dirac operator D.

- Gravitational momentum as non-conserved Noether charge if Kähler gauge potential contains $M^4$ part $A_a$=constant, where a is lightcone proper time (cosmic time). Mass squared conserved. Inertial 4-momentum as time average of C-S 4- momentum for space-time sheet.

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# Isometries of the world of classical worlds

- By symmetric space property isometries of configuration space fix completely the metric and Kähler structure. What are the isometries?

- Canonical algebra for $\delta H_+ = \delta M^4{}_+ \Sigma\ CP_2$ defines isometries of the world of classical worlds.

- Noether charges of the (super) canonical algebra for C-S action define complexified configuration space (super)Hamiltonians.

- Complexification of CH from the conformal structure of partonic 2-surface much like in the case of loop spaces.

- Poisson brackets for complexified Hamiltonians inherited from Poisson brackets at level of $\delta H_+$ define matrix elements of Kähler form and metric between corresponding Killing vector fiel

# How classical dynamics emerges?

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- Definition: Dirac determinant defined as product of eigenvalues of for modified Dirac operator gives vacuum functional.
- Number theoretic finiteness: restrict the eigenvalues to the algebraic extension of rationals used. If the number of eigenvalues finite then vacuum functional algebraic number and p-adicization works also. Infinite hierarchy of physics (cognitive hierarchy).
- Does the Dirac determinant really give absolute extremum of Kähler function for a region of space-time sheet at which Kähler action density has definite sign? Encouraging finding: Absolute extrema of Kähler action possess dynamical variants of local Poincare and color isometries . These charges vanish. Generators in 1-1 correspondence with small deformations of absolute extremum. Kac-Moody symmetries act as zero modes of configuration space metric.
- Quantum classical correspondence: the exponent of Kähler function corresponds to the exponent Kähler action for Bohr orbit like space-time surface for which classical conserved charges correspond to eigenvalues for mutually commuting quantum observables.

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