

Quantum Physics as Infinite-Dimensional Geometry

The topics of this book is a vision about physics as infinite-dimensional Kähler geometry of the "world of classical worlds" (WCW), with "classical world" identified either as light-like 3-D surface X^3 of a unique Bohr orbit like 4-surface $X^4(X^3)$ or $X^4(X^3)$ itself. The non-determinism of Kähler action defining Kähler function forces to generalize the notion of 3-surface. Zero energy ontology allows to formulate this generalization elegantly using a hierarchy of causal diamonds (CDs) defined as intersections of future and past directed light-cones, and a geometric realization of coupling constant evolution and finite measurement resolution emerges.

One encounters two challenges.

1. Provide WCW with Kähler geometry consistent with 4-dimensional general coordinate invariance. Clearly, the definition of metric must assign to given light-like 3-surface X^3 a 4-surface $X^4(X^3)$ as kind of Bohr orbit.
2. Provide WCW with spinor structure. The idea is to express configuration space gamma matrices using super algebra generators expressible using second quantized fermionic oscillator operators for induced free spinor fields at $X^4(X^3)$. Isometry generators and contractions of Killing vectors with gamma matrices would generalize Super Kac-Moody algebra.

The condition of mathematical existence poses stringent conditions on the construction.

1. The experience with loop spaces suggests that a well-defined Riemann connection exists only if this space is union of infinite-dimensional symmetric spaces. Finiteness requires that vacuum Einstein equations are satisfied. The coordinates labeling these symmetric spaces do not contribute to the line element and have interpretation as non-quantum fluctuating classical variables.
2. The construction of the Kähler structure requires the identification of complex structure. Direct construction of Kähler function as action associated with a preferred extremal for Kähler action leads to a unique result. The group theoretical approach relies on direct guess of isometries of the symmetric spaces involved. Isometry group generalizes Kac-Moody group by replacing finite-dimensional Lie group with the group of symplectic transformations of $\delta M^4_+ \times CP_2$, where δM^4_+ is the boundary of 4-dimensional future light-cone. The generalized conformal symmetries assignable to light-like 3-surfaces and boundaries of causal diamonds bring in stringy aspect and Equivalence Principle can be generalized in terms of generalized coset construction.
3. Configuration space spinor structure geometrizes fermionic statistics and quantization of spinor fields. Quantum criticality can be formulated in terms of the modified Dirac equation for induced spinor fields allowing a realization of super-conformal symmetries and quantum gravitational holography.
4. Zero energy ontology combined with the weak form of electric-magnetic duality led to a breakthrough in the understanding of the theory. The boundary conditions at light-like wormhole throats and at space-like 3-surfaces defined by the intersection of the space-time surface with the light-like boundaries of causal diamonds reduce the classical quantization of Kähler electric charge to that for Kähler magnetic charge. The integrability of field equations for the preferred extremals reduces to the condition that the flow lines of various isometry currents define Beltrami fields for which the flow parameter by definition defines a global coordinate. The assumption that isometry currents are proportional to the instanton current for Kähler action reduces Kähler function to a boundary term which by the weak form of electric-magnetic duality reduces to Chern-Simons term.

5. The approach leads also to a highly detailed understanding of the Chern-Simons Dirac equation at the wormhole throats and space-like 3-surfaces and Kähler Dirac equation in the interior of the space-time surface. The effective metric defined by the anticommutators of the modified gamma matrices has an attractive interpretation as a geometrization for parameters like sound velocity assigned with condensed matter systems in accordance with effective 2-dimensionality and strong form of holography.