

Zero energy ontology (ZEO) has become gradually one of the corner stones of quantum TGD. This motivates the collection of material related to ZEO in a single chapter providing an overall view about the development of ideas. The sections are independent and reflect different views about ZEO.

The following gives a brief summary of the most recent view (2021) of ZEO.

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\item The notion of a causal diamond (CD) is a central concept. Its little cousin "cd" can be identified as a union of two half-cones of M^4 glued together along their bottoms (3-D balls). The half-cones are mirror images of each other. $CD = cd \times CP_2$ is the Cartesian product of cd with CP_2 and obtained by replacing the points of cd with CP_2 . The notion of CD emerges naturally in the number theoretic vision of TGD (adelic physics via the M^8-H duality).

\item In ZEO, quantum states are not 3-dimensional if the determinism does not fail as it actually does, but superpositions of 4-dimensional deterministic time evolutions connecting ordinary 3-dimensional states. For the strongest form of holography implied by general coordinate invariance (GCI), the time evolutions are equivalent to pairs of ordinary 3-D states identified as initial and final states of time evolution.

The failure of determinism probably implies that a given 3-surface at the passive boundary of CD (PB) corresponds to a finite number of 4-D minimal surfaces and that the minimal surface can be regarded as an analog of soap film spanned by a frame having fixed parts at the boundaries of CD and dynamically generated parts in the interior of CD. The frame can be identified as a topological analog of a Feynman diagram.

\item Quantum jumps replace this state with a new one: a superposition of deterministic time evolutions is replaced by a new superposition. The classical determinism of individual time evolution is not violated. This solves the basic paradox of quantum measurement theory. There are two kinds of SFRs: BSFRs (counterparts of ordinary SFRs) changing the arrow of time (AT) and SSFRs (analog of "weak" measurements) preserving the arrow of time that give rise to an analog of the Zeno effect. The findings of Mineev et al provide strong support for ZEO.

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