quantum space-times*

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This is a contributed topic on quantum space-times viewed from general relativistic and quantum gravity standpoints, and includes, for example, quantum geometry fundamental notions.

1 Quantum Space-times (QST)

The concept of *quantum space-times (QST)* is fundamental to the development of relativistic quantum theories and at this point it can only be broadly defined as a *class of mathematical spaces that allow the construction of quantum physical theories in a manner consistent with both relativistic principles and quantum gravity*. There is no universal agreement amongst either theoretical physicists or mathematicians who work on Physical Mathematics about either a specific definition of such quantum space-times or how to develop a valid classification theory of quantum space-times. However, several specific definitions or models were proposed and a list of such examples is presented next.

1.1 Specific Definitions for Models of Quantum Space-Times (QSTs) and Quantum Geometry

- QSTs represented by posets or causal sets
- QSTs represented by so-called quantum topoi (QTs) with Heyting logic algebra as a subobject classifier
- QSTs represented by Topological Quantum Field Theories (TQFTs) or Homotopy QFTs
- QSTs represented as spin foams of spin networks
- QSTs represented as a noncommutative, algebraic– and/or "geometrical"–quantized space as in noncommutative geometry models for SUSY
- QSTs represented as generalized Riemannian manifolds with quantum tangent spaces
- QSTs represented as presheaves of local nets of quantum operators in Algebraic QFT
- QSTs represented as quantum fields (QF) on a (physical) lattice of geometric points
- QSTs represented as consisting of quantum loops
- QSTs represented as fractal dimension spaces
- QST represented as a quantum category of locally compact grpoupoids
- QSTs represented as categories or spaces of quantized strings as in string theories
- Twistor representations in quantum gravity (QG) (introduced by Sir Roger Penrose).

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