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Should we take into account nontrivial spacetime topology, changes of metric signature and similar hypothetical phenomena when quantizing gravity?

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The founders of quantum geometrodynamics assumed that spacetime may have nontrivial topology: John Wheeler suggested the idea of spacetime foam; Stephen Hawking wrote that one would expect that quantum gravity would allow all possible topologies of spacetime. Later, A. D. Sakharov put forward yet more exotic hypothesis that metric signature may change. Then the question arises, do we really need to take into account all these hypothetical phenomena when quantizing gravity? Since observational data witnesses for an open flat universe, it is possible, in principle, to construct a theory of perturbations of gravitational and matter fields. However, it would not be a full quantum theory of gravity. I shall argue that the assumption about nontrivial spacetime topology, etc. leads to a new description of the Universe in which periods of unitary evolution give place to non-unitary changes of the Universe state. It gives a hope that it may shed light on an origin of irreversibility.

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