Research Plan

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Construction of exact solutions to Einstein's equations with almost contact structure:

In constructing exact solutions to Einstein's equations, it is common practice to impose some kind of symmetry to assume the form of the metric and solve, or to perform transformations that map exact solutions to other exact solutions in equation systems that have been reduced by symmetry. However, real physical systems do not possess exact symmetry.

As a method for constructing exact solutions not based on symmetry, I am investigating, together with collaborators, a new approach to construct exact solutions of four-dimensional spacetimes with poor symmetry from three-dimensional spaces or spacetimes with almost contact structure. Using this method, it is possible to construct exact solutions to Einstein's equations with matter including cosmic strings such as making the Friedmann-Lemaître-Robertson-Walker metric, which is a homogeneous and isotropic cosmological model, inhomogeneous and anisotropic, or making the Schwarzschild metric, which is a static spherically symmetric black hole solution, non-spherically symmetric. In this research, I will establish a comprehensive framework for inhomogenization of exact solutions and clarify the physical properties of the obtained solutions.

Loop quantum gravity and complexity:

Loop quantum gravity (LQG) is an approach to non-perturbative and background independent quantization of general relativity. Spin-network states span the kinematic state space of LQG as an orthonormal basis. Spin-network state is labeled with spin-network, which is a graph whose edges are colored by half integers satisfying simple relations at the vertices. In LQG, Geometrical operators (area operator and volume operator) are constructed. Their eigenstates are spin-network states and they have discrete eigenvalues.

From informational viewpoint on volume operator in LQG, following conjecture is suggested: A logic gate must have finite minimum volume, and number of logic gates contained within a region of space are bounded by the volume of the region.

It seems to say "Complexity is Volume."

We want to consider the possibility of LQG as a foundation where complexity is discussed.