Statement of research interests

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The unified theories of elementary particles, for instance the superstring theory and the supergravity theory, suggest that our universe is higher dimensional. Now many authors pay attention to the fact how to derive the four-dimensional inflation model from higher dimensional supergravity theory. I would like to construct the cosmological solution of the superstring theory based on the studies that I have ever done, and study the following issues.

(1) Construction of de Sitter solution and the stabilization mechanism in the ten-dimensional heterotic string theory

There are many works about the ten-dimensional heterotic string theory because this theory provides the gauge symmetry which is closely connected with the standard model of the elementary particle physics. However, it is little study about the solution of compactification with flux in the heterotic string theory.

Becker discovered the solution of flux compactification satisfying the anomaly cancellation condition in the ten-dimensional heterotic string theory two years ago (arXiv:hep-th/0604137). The feature of this model is that we can get not only the solution of anomaly cancellation condition with the Kalb-Ramond 3-form but also the N=1 supersymmetric theory in the four-dimensional Minkowski background. Moreover, we can derive the Becker's model from the KKLT model (arXiv:hep-th/0301240) in terms of the duality of the string theory. However, there is no study about the fact whether above solution satisfies the equation of motion or not. Then, we would like to check the cosmological (time dependent) solution of Einstein equations in the setup of Becker's model, and study the dynamics of the higher dimensional geometry. In particular, we investigate the solution that the four-dimensional spacetime is de Sitter background. If the solution of Einstein equation cannot describe the de Sitter spacetime, we try to construct again the solution after adding the contribution of the α' correction in the ten-dimensional heterotic theory.

Next, we study the evolution of the internal space. If the solution of the Einstein equation suggests the instability of the scale of internal space, we consider the instanton correction of the NS 5-brane in order to stabilize the scale of the internal

space. Then, we investigate the solution of the higher dimensional Einstein equation with the instanton correction, and check the fact whether it is possible to stabilize the scale of the internal space or not.

(2)Analysis of supersymmetry breaking

It is necessary to study how to break the supersymmetry if we investigate the early universe in the context of the superstring theory and the supergravity theory. For almost all works of the supergravity theory, we analyzed the supersymmetry breaking in the four-dimensional effective theory, and discussed in the static spacetime. In my study, we would like to analyze the supersymmetry breaking in terms of the time dependent solution that I obtain the research plan (1), and discuss the evolution of the supersymmetry breaking in the viewpoint of the higher dimensional theory.

(3) Construction of four-dimensional effective theory and relation between eleven-dimensional supergravity theory and ten dimension type II string theory

In the elementary particle physics or cosmology, we tend to carry out several analyses in the four-dimensional effective theory rather than in the original higher dimensional theory when we discuss the four-dimensional physics in the context of the higher dimensional theory. Then, we would like to construct the four-dimensional effective theory which is consistent with the solution of ten-dimensional heterotic theory obtaining in the research plan (1). I try to derive the four-dimensional effective theory under the condition which the background fields have to satisfy the higher dimensional field equation. In this case, I will check the consistency between the solution of the field equations in the higher dimensional theory and that of the field equations in the four-dimensional effective theory. I investigate the discrepancy if any inconsistency between the two.

The ten-dimensional heterotic theory can be related to the eleven-dimensional supergravity or ten-dimensional type II theory in terms of the duality of the string theory. Then, I would like to investigate the solution in the eleven-dimensional supergravity or ten-dimensional type II theory deriving from the time dependent solution in the heterotic theory that I obtain in the research plan (1). Furthermore, I check the fact whether the solution in the eleven or ten-dimensional supergravity theroy are the consistent with the Einstein equations of each theory or not. If these solutions can not satisfy the field equations, I investigate the physical reason why. In

that case, we cannot apply the string duality to the time dependent solution.

(4) Cosmological dark energy in the context of the higher dimensional supergravity

Recently, it is suggested that our universe is accelerating expansion from a variety of observational results. It is impossible in a standard model of the elementary particle and the dark matter to explain these observational facts. The source of the accelerating expansion of the universe is generically called dark energy. It is important to clarify the origin of the dark energy in the cosmology.

In the four-dimensional effective theory deriving from the higher dimensional theory, the energy density of the moduli is the same contribution as the four-dimensional vacuum energy in the Friedmann equation. Then, there is a possibility that the energy of the moduli is the origin of the dark energy. In my study, from this point of view, I would like to investigate the relation between moduli and four-dimensional cosmological constant. It is expected that the moduli energy becomes constant if the solution of the higher dimensional supergravity theory obtaining the research plan (1) describes the stabilization of the moduli. Then, we can get the candidacy of the dark energy which takes constant value in the four-dimensional universe. From this study, we can confirm the consistency of the string theory by means of cosmological observation if we can consider the moduli as the origin of the dark energy realistically.

In advancing these four studies, it is a goal of my study to give the suggestion concretely which leads to active interaction with surrounding research fields even more as well as to produce essential results with respect to each study.