Research Plan

Recently string theory and the AdS/CFT correspondence (also called the gauge/gravity correspondence or holography) have been tightly connecting particle theory with various research areas of physics and mathematics, for example, information theory and condensed matter theory. Since I have been studying various topics as I mentioned in "Research History", I shall engage myself in interdisciplinary researches. Here I should like to show some concrete topics that I am now interested in.

(1) Quantum entanglement

- Entanglement of strings

  Using S-matrix theory, Peschanski and I [20,21] found the formula for the Entanglement Entropy (EE) of two particles in an elastic scattering process at high energy. The S-matrix theory is also historically in close relation with string theory. Therefore I should like to study the entanglement between strings. I consider a scattering process of strings in which two strings appear in a final state. Since I can obtain the S-matrix by calculating the string scattering amplitude, I apply the formulation developed by [20,21] to this S-matrix, and compute the EE between two strings in the final state. I shall clarify a stringy property of the EE in the string scattering, comparing with the EE in the particle scattering by [20,21].

  Extending this research, I should like to study the process in which a light string is emitted from a heavy string. How are the heavy and light strings entangled in the final state? This emission process is an analogy for black hole radiation. Hence to study the entanglement of such strings might shed light on several issues about the entanglement between black hole and radiation.

- Entanglement of D-branes

  A D-brane also plays a fundamental role in string theory. I should like to understand the entanglement between two D-branes separately located. Since D-branes have interaction caused by the exchange of closed strings, one can naturally guess that this interaction generates the entanglement of D-branes. In order to analyze the EE of D-branes I may use boundary states which describes the D-branes.

(2) String amplitudes

- 2, 1, 0-point amplitude in open string theory

  So far it has been trusted that the two-point amplitude of open strings vanishes, because the volume of residual gauge symmetry diverges. However, Erbin *et al.* have pointed out that this divergence is canceled by the infinity, $\delta(0)$, which originates from the energy-momentum conservation, and they have obtained a non-zero two-point string amplitude. They have proved it in the path integral formalism. On the other hand, Takahashi and I have derived the same non-zero amplitude of open strings in the operator formalism. In this derivation we introduced a novel mostly BRST exact operator for gauge fixing. In this research plan, firstly I shall study whether one can obtain usual n-point amplitudes ($n \geq 3$) by the use of this operator. Then, following the n-point amplitudes, I shall consider one and zero-point amplitudes.

- 2-point amplitude in closed string theory

  Although we have tried a simple application of the mostly BRST exact operator in the open string theory to the closed string theory, currently we have not succeeded in obtaining a non-zero two-point amplitude of closed strings. I should like to find some other operators for gauge fixing in the closed string theory and derive a non-zero two-point amplitude of closed strings.