Research Plan

So far I have been working on particularly the field called "string theory" in elementary particle physics. While string theory always incorporates a variety of mathematical concepts, it is really providing the latest and powerful tool for exploring the unknown physics.

As people's understanding towards string theory increases, boundaries between areas of mathematics which have been considered independent of each other become obscure eventually. For instance, it happens that two seemingly irrelevant mathematical concepts become unified through physics.

My main interests lie in exploring gauge/gravity (or gauge/geometry) correspondence which is certainly a challenging theme nowadays.

To finalize the project—regarding gravity as merely kinds of phenomena observed in gauge theory is truly an ambitious dream of Albert Einstein. Research activities towards this are conducted so extensively worldwide.

Big picture

As a unifying theory in physics has been attempted, over the past decades similar movements in mathematics as well took place. That is, people are just pursuing the belief that there exists a concept which unifies somewhat several different kinds of mathematical ideas.

For example, the mathematician Robert Langlands in the late 1960s launched what has become known as the Langlands Program aiming at relating number theory and harmonic analysis.

This insight had driven Shimura Gorou, Taniyama Yutaka and Weil to the discovery, i.e. the information encoded in Galois representations associated with elliptic curves over Q can be read off from the Fourier expansion of certain modular forms on the upper-half plane.

Quite recently, Langlands duality becomes important and accelerates its penetration into physics. Perhaps a few years later, it is likely to provide the insight even for unifying the heart of physics and mathematics. The main reason of this suggestion seems inevitably the AGT conjecture born in 2009 summer.

What is AGT hypothesis?

The framework laid down by Alday-Gaiotto-Tachikawa (AGT) states that there exists certain intimate relation between two-dimensional Liouville CFT and four-dimensional supersymmetric gauge theory (N = 2 Seiberg-Witten theory). Because both two topics were developed quite independently during the past decades, their coincidence is considered to be amazing! Nevertheless, their startling discovery overturns the traditional perception of us. This is because compared with the AdS/CFT correspondence described earlier, AGT had pointed out an all new kind of gauge/geometry duality and envisioned a way by which one can explore two sides using more different viewpoints and mathematical tools. Many parts are still under construction and many unsolved puzzles still remain.