Research Summary

Overview

Publication list [6] gave a new example of 3D AdS/CFT correspondence. [7] derived in a conformal field theoretical way the entropy of five-dimensional rotation BMPV black holes.
[4] reproduced the gravitational correction to four-dimensional
N = 2 Seiberg-Witten prepotential via a kind of Hermitian matrix models perfectly.
These three together are pioneering works in the world.
A series of papers [1-3] were written against the backdrop of a recently-developed major trend--AGT conjecture (as will be detailed in Research Plan).
Topics ranging from "hypergeometric functions and four-dimensional S-duality," "classical level of AGT conjecture and Klein-Koebe-Poincare uniformization theorem" to "deriving Seiberg-Witten prepotential from Wess-Zumino-Witten (WZW) model" are seminal.

New AdS/CFT correspondence

For instance, let us talk about the all new 3D AdS/CFT correspondence discovered in 2008 summer by four physicists, Aharony-Bergman-Jafferis-Maldacena (ABJM). In short, in 1997 Maldacena proposed that (1+3)D Anti de-Sitter (AdS) supergravity has to be equivalent to (1+2)D conformal field theory (CFT). His proposal sounds quite amazing because the behavior of strongly-coupled gauge theory can thus be captured by knowing its dual classical gravity background.
That is, in the strong coupling regime where the usual method of perturbative analysis get invalid one expect that the classical theory of gravity may bring in new insights!
Since then, thousands of research papers have been worked out in order to not only find more evidence but support or verify Maldacena's proposal. As a matter of fact, the major reason for this surprising development is that through a stringy object called D-brans discovered in 1995 many known gauge theories can be constructed geometrically.
Let us return to our 3D case. Traditionally, people believed that three-dimensional CFT cannot have supersymmetry more than N = 3 when Chern-Simons terms get necessarily included. However, the model of ABJM realized N = 6 and meanwhile the dual gravity background was figured out. Until then, interests towards 3D CFT are so limited but the trend is just altered completely now due to ABJM. Recently, Maldacena's proposal in the context of these developed 3D conformal theories with their gravity duals is even expected to be experimentally verified. This opens a new area bridging between purely theoretical string theory and condense matter physics.
The result of my research was being able to construct a new N = 3 CFT and its gravity dual implemented by an eight-dimensional internal space, known in mathematical literatures as Eschenberg space. Technically, this is achieved by adding many massless flavors into the so-called N = 4 elliptic model. It is relatively easy to find the corresponding gravity dual solution.
Although there was a proposed CFT dual to Eschenberg spaces, it is not correct. Here, beginning with constructing the CFT first we noticed what its correct gravity dual should be accidentally. In addition, by examining our finding from various kinds of angles, we claim the duality is established.