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Research field: Applied Mathematics
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Current Research:

I have been studying string theories and mirror symmetry of Calabi-Yau manifolds.

String theory may be regarded as a quantum theory on a loop space of a differentiable manifold X. When we consider a Calabi-Yau manifold, a compact Kaehler manifold with the vanishing first Chern class, we have the so-called N=2 supersymmetry for the quantum theory on the loop space. The mirror symmetry of Calabi-Yau manifolds is one of the mysterious symmetries which come from the path integral formulation of the quantum theory with N=2 supersymmetry, and its mathematical definition, though yet to be completed, has been one of the important problem in mathematics. Also we have seen in last decades a lot of mathematical progress in related subjects such as Gromov-Witten theory in both algebraic and symplectic geometry.

An algebraic approach to define the mirror symmetry has been proposed by Kontsevich, which is now called homological mirror symmetry. In this homological formulation, some abstract knowledge about the derived categories of coherent sheaves on Calabi-Yau manifolds are required in general. Although homological mirror symmetry provides an abstract framework, toward more concrete understanding, I'm focusing examples which come from toric geometry. In particular, I'm studying relations between Fourier-Mukai transforms and the corresponding monodromy transforms of period integrals expressed by certain hypergeometric series of multi-variables. Also I'm interested in the geometry of the moduli spaces of Calabi-Yau manifolds, or N=2 supersymmetric string theories, which are described by these period integrals.

Prerequisites

Several concepts in many branches of mathematics, such as representation theory (conformal field theory), algebraic geometry (in particular toric geometry), symplectic geometry and so on, are used in the study of string theory. It seems rather difficult for beginners to have entire picture of the string theory since it

stands between mathematics and physics. However, setting up first their firm standpoint, regardless in mathematics or in physics, it should be possible to extend their scope toward the entire picture.

The following references would be useful to see the details research:

[1] "Introduction to mirror symmetry", Sugaku seminar (in Japanese), in the volumes published 2006- 2007.
[2] D.A. Cox and S. Katz, ``Mirror Symmetry and Algebraic Geometry",
Mathematical Surveys and Monographs Vol. 68, AMS (1999).
[3] C.Vafa and E. Zaslow eds., ``Mirror Symmetry",
Clay Mathematics Monographs Volume 1, AMS (2003).