Gauged Linear Sigma Model on Supermanifold

Kyoto University Shigenori Seki
E-mail: seki@gauge.scphys.kyoto-u.ac.jp

The correspondence between a topological string in a super twistor space $\mathbb{CP}^{3|4}$, which is a Calabi-Yau supermanifold, and an $\mathcal{N}=4$ super Yang-Mills theory was pointed out by [1], and a lot of related works have been done. We shall consider a gauged linear sigma model (GLSM) on a supermanifold. This talk is based on the work [2].

First we construct an $\mathcal{N}=(2,2)$ $U(1)$ GLSM on a target space $\mathbb{CP}^{m-1|n}$, which is a supermanifold with m Grassmann even homogeneous coordinates and n Grassmann odd ones. It is characteristic that two types of chiral superfields are introduced. They are usual Grassmann even chiral superfields Φ^I $(I=1,2,\cdots,m)$ and new Grassmann odd chiral superfields

$$\Xi^A = \xi^A + \sqrt{2}(\theta^+ b_+^A + \theta^- b_-^A) + 2\theta^+\theta^-\chi^A + \cdots \quad (A=1,2,\cdots,n),$$

where ξ^A and χ^A are Grassmann odd and $b_\pm^A$ are Grassmann even. $U(1)$ charges Q_I and q_A are assigned to Φ^I and Ξ^A respectively.

Next we study the structure of classical vacua. When a superpotential $W(\Phi,\Xi)$ is factorised as $W_b(\Phi)W_f(\Xi)$, the vacuum manifold is reduced to three typical phases: (1) the hypersurface $W_b=0=W_f$ in the weighted projective space $\mathbb{WCP}^{m-1|n}_{(Q_1,Q_2,\cdots,Q_m|q_1,q_2,\cdots,q_n)}$; (2) the bosonic $\mathbb{Z}_q$ orbifold with only Grassmann even coordinates, if $\forall q_A \equiv q$; (3) the fermionic $\mathbb{Z}_Q$ orbifold with only Grassmann odd coordinates, if $\forall Q_I \equiv Q$. From (2) and (3), we conjecture that there might exist a transition between bosonic and fermionic manifolds.

We also calculate the one-loop correction to a D-field. Then we can confirm that the condition for vanishing of the one-loop divergence agrees with the Ricci flatness (naively Calabi-Yau) condition of supermanifold shown in [3].

Taking the two-dimensional worldsheet with a boundary, we consider A-type and B-type supersymmetric boundary conditions. For the A-type condition, we find a A-brane wrapped on a real $(m|n)$-dimensional subsupermanifold embedded in the target space $\mathbb{C}^{m|n}$. For the B-type condition, we obtain a real-even-dimensional B-brane wrapped on a complex subsupermanifold.

As an extension, we can also construct an $\mathcal{N}=(0,2)$ GLSM on a supermanifold.

References

[1] E. Witten, "Perturbative Gauge Theory as a String Theory in Twistor Space," Commun. Math. Phys. 252 (2004) 189, hep-th/0312171.
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[3] S. Sethi, "Supermanifolds, Rigid Manifolds and Mirror Symmetry," Nucl. Phys. B430 (1994) 31, hep-th/9404186.