The use of K-theory in high energy physics

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Modern high-energy physics associated with energies up to 14 teV is the theory of D-brane and superstrings, [1]. The mathematical apparatus of such a theory is algebraic geometry and topological algebra, which uses the theory of derived categories.

We will consider the case of supersymmetric string theory extended to N = (2,2) superconformal field theory with target manifold X - Calabi–Yau threefold. With this superconformal string field theory is associated central charge. On the end of the string for D-brane system lives a Ramon-Ramon (RR) charge which takes values in a two-dimensional quantum Hilbert space.

The information of RR charge can be decoded in the category of D-branes, which is considered as derived category of coherent sheaves, D(X) over X - a topological space. An open string from the D-brane associated to the locally-free sheaf E to another D-brane given by the locally-free sheaf F is given by an element of the group $Ext^q(E, F)$ which is Hilbert space. D-brane/anti-D-brane annihilation which is built in the derived category map the derived category to K-theory language for D-branes [2]. In the case of the twisted bundle D-brane charge takes values in a certain twisted version of K-theory with special type of sections as a Hilbert space [3]. With different types of the structure group of the twisted bundles are connected different K-theory groups.

References

[1] Michael B. Green, John H. Schwarz, Edward Witten. *Superstring theory: Volume 1, introduction.* Cambridge University Press, 470 p., 1988.

[2] Edward Witten. D-branes and K-Theory. *J. High Energy Phys.*, 12 : 0-19, 1998, hep-th/9810188.

[3] Alain Connes, Michael R. Douglas, Albert Schwarz. Noncommutative Geometry And Matrix Theory: Compactification On Tori. *J. High Energy Phys.*, 9802:003, 1998, hep-th/9711162.