Aspects of Duality In String Theory

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Plan Of Work: All the four basic physical interactions of nature are united in superstring theory. There were five perturbative formulations of it. Relating five, at least in non-perturbative region, brought about hectic activities in recent years. Search was for symmetries. Those appeared as T-duality, mirror symmetry, S and U-dualities [1] respectively. These duality symmetries not only related compactified versions of various string theories, five string theories indeed have been replaced by three sets of theories. These are self-dual type IIB, S-dual Heterotic $SO(32)$, type I $SO(32)$ and M-theory. Low energy limit of M-theory is eleven dimensional supergravity [2]. Non-perturbative formulations of M-theory and type IIB have been proposed in the name of Matrix theories [3]. Lot of activities are going on to study these two[4].

Method Of Study: Supergravity theories of various dimensions were known to contain duality symmetries[5]. Julia et al got it from current construction. As supergravity theories got replaced due to its non-renormalizability by string theories which provide the former in low energy limit, microscopic derivation of these dualities was looked into[6]. Method in work was constructing duality symmetry groups of massless supergravity from T, S-duality symmetries of string theories. In particular, given two models whether their massless sectors map one to one, once the unique set of moduli parameter(s) labelling the
two are found\cite{7}. By now almost all the duality symmetries of string theories are found, tested. Aftermath is the replacement of string theories by moduli spaces of theories in different dimensions and debut of matrix theories to give unified description of moduli spaces as much as possible. These matrix theories have already passed through the initial eligibility tests. These give perturbative string theories in appropriate limits and found to contain many duality symmetries also.

Aim and Objective of Study: Requirement of duality symmetry gave rise to discovery of D-branes\cite{8} in string theory. Unification of moduli space has led to M-theory. Mathematical formulation of M-theory and its like distinguishes DO-branes, D-instanton compared to other branes as well as brought non-commutativeness of space-time into light. D-branes gave microscopic description of a certain class of extremal(near) black holes correctly, thereby giving an evidence that string theory is a correct theory of quantum gravity. From M-theory sprang up MQCD, Harova-Witten superpotential trying to describe phenomenological aspects in field theory limit. DO-brane, D-instanton are being considered as fundamental constituents of higher dimensional branes. It boosts the belief that renormalizibility is not a problem. In this way, study in duality symmetries in string theory surpassed its initial aim of getting to non-perturbative theory to large extent and has broadened the objective of explaining the observable and unobservable things of the Universe.

References


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