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Comment on the Generation Number in Orbifold Compactifications*

Jens Erler[1] **and Albrecht Klemm**[2]

[1] Physik Department, Technische Universität München, W-8046 Garching, Germany
[2] Max-Planck-Institut für Physik, Werner-Heisenberg-Institut, Föhringer Ring 6, Postfach 40 12 12, W-8000 München 40, Germany

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Abstract. There has been some confusion concerning the number of $(1,1)$-forms in orbifold compactifications of the heterotic string in numerous publications. In this note we point out the relevance of the underlying torus lattice on this number. We answer the question when different lattices mimic the same physics and when this is not the case. As a byproduct we classify all symmetric Z_N-orbifolds with $(2,2)$ world sheet supersymmetry obtaining also some new ones.

1. Introduction

String compactifications on toroidal Z_N-orbifolds [1] are among the most intensively studied ones. They provide us with the simplest string models which have semi-realistic features. Because the one loop partition function and the couplings can be calculated explicitly in dependence of the untwisted moduli, many generic properties concerning the string moduli space and the effective low energy theory can be investigated here in detail [1]. Including all background parameters in the framework of heterotic compactifications and allowing for the most general twists, a rich class of models, with partly phenomenological very attractive features, emerges. The question is still open, whether some standard string model, which can be related in a painless manner to the known phenomenology, is contained in this class.

Toroidal orbifolds have also attracted the attention of the mathematicians, because the partition functions of $(2,2)$ models contain information, which can be interpreted as topological data of a Calabi-Yau manifold. The latter can indeed be constructed by a certain resolving process of the orbifold singularities, which establishes an exciting relation between singularity theory and the theory of modular functions.

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[1] The situation for more general compactification schemes has improved, as P. Candelas, X. De la Ossa, P. Green, and L. Parkes worked out the modulus dependence explicitly [2] for the quintic threefold in $\mathbb{P}^4$. Other Calabi-Yau manifolds were investigated in [3]