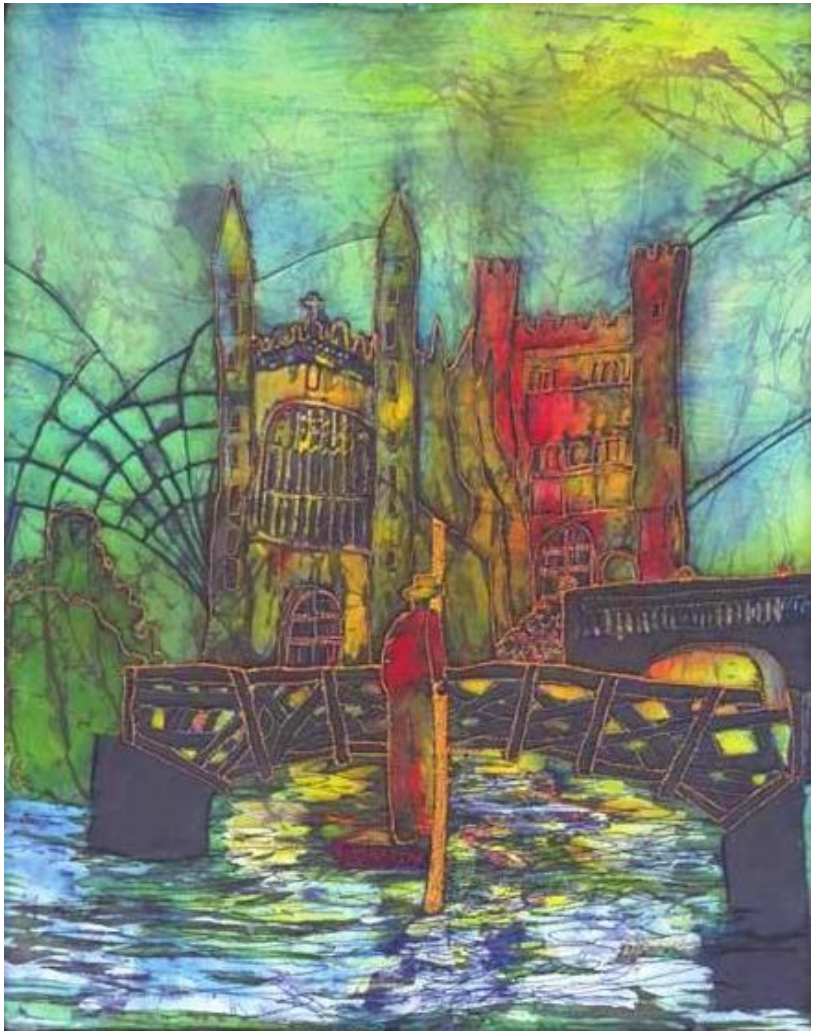
Supergravity, Strings and Dualities:

A Meeting in Celebration of Chris Hull's 60th Birthday

2002

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Flux compactifications of string theory on twisted tori

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Global aspects of Scherk-Schwarz dimensional reduction are discussed and it is shown that it can usually be viewed as arising from a compactification on the compact space obtained by identifying a (possibly non-compact) group manifold $\mathcal{G}$ under a discrete subgroup Γ, followed by a truncation. This allows a generalisation of Scherk-Schwarz reductions to string theory or M-theory as compactifications on $\mathcal{G}/\Gamma$, but only in those cases in which there is a suitable discrete subgroup of $\mathcal{G}$. We analyse such compactifications with flux and investigate the gauge symmetry and its spontaneous breaking. We discuss the covariance under $O(d,d)$, where d is the dimension of the group $\mathcal{G}$, and the relation to reductions with duality twists. The compactified theories promote a subgroup of the $O(d,d)$ that would arise from a toroidal reduction to a gauge symmetry, and we discuss the interplay between the gauge symmetry and the $O(d,d,\mathbb{Z})$ T-duality group, suggesting the role that T-duality should play in such compactifications.

1 Introduction

In [1], Scherk and Schwarz proposed two related forms of dimensional reduction of field theories, both of which led to non-abelian gauge symmetries, a scalar potential and mass terms. Somewhat confusingly, both have been referred to as Scherk-Schwarz reductions in the literature. In one type, a theory with a global duality symmetry is reduced on a circle or torus with a duality twist or monodromy around each circle. Following [2], we will refer to these as reductions with a duality twist.

In the other type of reduction introduced in [1], the dependence of fields on the internal coordinates y^i is through a matrix $\sigma^i_m(y)$, so that for example the internal components of the metric $g_{ij}(x,y)$ lead to scalar fields ϕ_{mn} depending only on the remaining external coordinates x through the ansatz

$$g_{ij}(x,y) = \phi_{mn}(x)\sigma^m_i(y)\sigma^n_j(y) \tag{1}$$

where $\sigma^m_i(y)$ is the inverse of $\sigma^i_m(y)$. This leads to a reduced theory in which the y-dependence drops out completely provided the matrices $\sigma^i_m(y)$ satisfy the constraint that the coefficients

$$f^m_{np} = -\sigma^i_n\sigma^j_p(\partial_i\sigma^m_j - \partial_j\sigma^m_i) \tag{2}$$

are constant. Then the one-forms $\sigma^m = \sigma^m_i(y)dy^i$ satisfy the structure equation

$$d\sigma^m + \frac{1}{2}f^m_{np}\sigma^n\wedge\sigma^p = 0 \tag{3}$$

and the integrability condition for this is that the constants f^m_{np} satisfy the Jacobi identity and so are the structure constants for a Lie group $\mathcal{G}$. In (1), the ansatz $g_{ij}(x,y) = \phi_{ij}(x)$ that would be used for a toroidal reduction is 'twisted' by the matrices $\sigma^i_m(y)$ and so the reduction is sometimes referred to as reduction

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Flux compactifications of M-theory on twisted tori

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Abstract: We find the bosonic sector of the gauged supergravities that are obtained from 11-dimensional supergravity by Scherk-Schwarz dimensional reduction with flux to any dimension D. We show that, if certain obstructions are absent, the Scherk-Schwarz ansatz for a finite set of D-dimensional fields can be extended to a full compactification of M-theory, including an infinite tower of Kaluza-Klein fields. The internal space is obtained from a group manifold (which may be non-compact) by a discrete identification. We discuss the symmetry algebra and the symmetry breaking patterns and illustrate these with particular examples. We discuss the action of U-duality on these theories in terms of symmetries of the D-dimensional supergravity, and argue that in general it will take geometric flux compactifications to M-theory on non-geometric backgrounds, such as U-folds with U-duality transition functions.

Keywords: Flux compactifications, Compactification and String Models, Supersymmetry and Duality, Superstring Vacua.

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Gauge symmetry, T-duality and doubled geometry

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Abstract: String compactifications with T-duality twists are revisited and the gauge algebra of the dimensionally reduced theories calculated. These reductions can be viewed as string theory on T-fold backgrounds, and can be formulated in a 'doubled space' in which each circle is supplemented by a T-dual circle to construct a geometry which is a doubled torus bundle over a circle. We discuss a conjectured extension to include T-duality on the base circle, and propose the introduction of a dual base coordinate, to give a doubled space which is locally the group manifold of the gauge group. Special cases include those in which the doubled group is a Drinfel'd double. This gives a framework to discuss backgrounds that are not even locally geometric.

Keywords: String Duality, Flux compactifications.

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Non-geometric backgrounds, doubled geometry and generalised T-duality

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Abstract: String backgrounds with a local torus fibration such as T-folds are naturally formulated in a doubled formalism in which the torus fibres are doubled to include dual coordinates conjugate to winding number. Here we formulate and explore a generalisation of this construction in which all coordinates are doubled, so that the doubled space is a twisted torus, i.e. a compact space constructed from identifying a group manifold under a discrete subgroup. This incorporates reductions with duality twists, T-folds and a class of flux compactifications, together with the non-geometric backgrounds expected to arise from these through T-duality. It also incorporates backgrounds that are not even locally geometric, and suggests a generalisation of T-duality to a more general context. We discuss the effective field theory arising from such an internal sector, give a world-sheet sigma model formulation of string theory on such backgrounds and illustrate our discussion with detailed examples.

Keywords: String Duality, Flux compactifications, Space-Time Symmetries

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- Work a problem from both ends:

  Big picture & simple, concrete examples.

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- Networking = having a beer with friends.

- Work a problem from both ends:
  Big picture & simple, concrete examples.

- Networking = having a beer with friends.

- Keep true to the dreams of thy youth!
  (Don’t give up on String/M-Theory)

Thank you and Happy Birthday