EXACT BRANE SOLUTIONS IN CURVED BACKGROUNDS

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Abstract. We consider the classical null \( p \)-brane dynamics in \( D \)-
dimensional curved backgrounds and apply the Batalin–Fradkin–
Vilkovisky approach for BRST quantization of general gauge theories.
Then we develop a method for solving the tensionless \( p \)-brane equa-
tions of motion and constraints. This is possible whenever there exists
at least one Killing vector for the background metric. It is shown that
the same method can be also applied for the tensile \( 1 \)-branes. Finally,
we give two examples of explicit exact solutions in four dimensions.

1. Introduction

The \( p \)-brane is a \( p \)-dimensional relativistic object, which evolving in space–
time describes a \((p + 1)\)-dimensional worldvolume. In this terminology, \( p = 0 \)
corresponds to a point particle, \( p = 1 \) corresponds to a string, \( p = 2 \) corresponds
to a membrane and so on. Every \( p \)-brane characterizes by its tension \( T_p \) with
dimension of \((\text{mass})^{p+1}\). When the tension \( T_p = 0 \), the \( p \)-brane is called null
or tensionless one. This relationship between the null branes and the tensile
ones generalizes the correspondence between massless and massive particles
for the case of extended objects. Thus, the tensionless branes may be viewed
as a high-energy limit of the tensile ones.

As is known, there exist five consistent string theories in ten dimensions: Type
IIA with \( N = 2 \) non-chiral supersymmetry, type IIB with \( N = 2 \) chiral super-
symmetry, type I with \( N = 1 \) supersymmetry and gauge symmetry \( SO(32) \) and
heterotic strings with \( N = 1 \) supersymmetry with \( SO(32) \) or \( E_8 \times E_8 \) gauge
symmetry.

The superstring dynamics unify all fundamental interactions between the ele-
mentary particles, including gravity, at super high energies. The \( p \)-branes arise