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TESTING EXTRA DIMENSIONS WITH BOUNDARIES USING NEWTON'S LAW MODIFICATIONS

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Extra dimensions with boundaries are often used in the literature to provide phenomenological models that mimic the standard model. In this context, we explore possible modifications to Newton's law due to the existence of an extra-dimensional space, at the boundary of which the gravitational field obeys Dirichlet, Neumann or mixed boundary conditions. We focus on two types of extra space, namely, the disk and the interval. As we prove, in order to have a consistent Newton's law modification (i.e. of the Yukawa-type), some of the extra-dimensional spaces that have been used in the literature, must be ruled out.

Keywords: Extra dimensions; Newton's law; Yukawa corrections; modified gravity.

1. Introduction

One of the most challenging perspectives in contemporary physics is the unified description of all the fundamental forces in nature within a self-consistent theoretical framework. In this context, a vast amount of theoretical work has been carried out during the last 60 years.

A successful effort to incorporate all interactions into a unified scheme is M-theory, together with its low energy limits, the type IIA and type IIB string theories, the $E_8 \times E_8$ heterotic string theories,[1–4] and so forth. These scenarios suggest that space–time possesses additional compact spatial dimensions. Unfortunately, the corresponding compactification scale is much lower than the scales that can be experimentally examined. There are also string-inspired extensions of the four-dimensional quantum field theory, including large extra dimensions,[5] in which the compactification scale is of the order of TeV. Such models appear to incorporate