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Static Spherically Symmetric Solutions of the Einstein-Yang-Mills Equations

Peter Breitenlohner, Peter Forgács*, Dieter Maison

Max-Planck-Institut für Physik, Werner-Heisenberg-Institut, Föhringer Ring 6,
D-80805 Munich, Germany

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Abstract: We study the global behaviour of static, spherically symmetric solutions of the Einstein-Yang-Mills equations with gauge group $SU(2)$. Our analysis results in three disjoint classes of solutions with a regular origin or a horizon. The 3-spaces (t = const.) of the first, generic class are compact and singular. The second class consists of an infinite family of globally regular, resp. black hole solutions. The third type is an oscillating solution, which although regular is not asymptotically flat.

1. Introduction

The interest in the study of solutions of the coupled Einstein-Yang-Mills (EYM) equations has recently received considerable impetus by the discovery of a class of nonsingular ("particlelike") [1] and nonabelian black hole solutions [2, 3]. The results of Bartnik and McKinnon obtained by numerical integration indicate the existence of a discrete family of globally regular, static, spherically symmetric solutions of a *SU(2)* Yang-Mills field coupled to gravity. The members of this family can be characterized by the number n of zeros of the gauge potential W parametrizing the spherically symmetric ansatz. For each value of $n \geq 0$ there seems to be exactly one regular solution.

The first rigorous existence proof of a globally regular solution with one zero was given in [4]. More recently it has been extended to both globally regular [5] and black hole solutions [6] with an arbitrary number of zeros.

In the present paper we classify the global behaviour of solutions regular at the origin $r = 0$ or with a horizon at some r_h and find in both cases three different classes. The first class contains the generic solutions describing singular space-times of the "bag of gold" type [7] with compact 3-spaces. Next there are the globally regular, resp. black hole solutions with an arbitrary n. Finally there are oscillating

* Present address: Research Institute for Particle and Nuclear Physics, P.O.Box 49, H-1525 Budapest 114, Hungary