Gauge theories of weak and strong gravity

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Abstract. A review of some recent papers on gauge theories of weak and strong gravity is presented. For weak gravity, SL(2, C) gauge theory along with tetrad formulation is described which yields massless spin-2 gauge fields (quanta gravitons). Next a unified SL(2n, C) model is discussed along with Higgs fields. Its internal symmetry is SU(n). The free field solutions after symmetry breaking yield massless spin-1 (photons) and spin-2 (gravitons) gauge fields and also massive spin-1 and spin-2 bosons. The massive spin-2 gauge fields are responsible for short range superstrong gravity.

Higgs-fermion interaction can lead to baryon and lepton number non-conservation. The relationship of strong gravity with other forces is also briefly considered.

Keywords. Gauge theories; strong gravity; symmetry breaking; unification of forces.

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1. Introduction

It is well known that Einstein’s general theory of relativity (GTR) (in a sense phenomenological theory of gravity) is based on a geometrical approach. However, there are other ways of looking at gravity. Through the work of Utiyama (1956), Kibble (1961) and others (e.g. Eguchi et al 1980; Ivanenko and Sardanashvily 1983), it has been realised that gravitational field can be regarded as a non-Abelian gauge field of Yang-Mills (1954) type. This field is self-interacting and the equations are nonlinear. While some authors (Salam 1977) consider Einstein’s equations as gauge theory par excellence, others (e.g. Yang) contend that this is based on an unnatural interpretation of gauge fields. Nevertheless, the concept of gauge theory pervades GTR in the form of covariant derivatives.

In gauge theories, auxiliary fields appear when one considers invariance of the field equations under space-time dependent transformations. In GTR the role of these fields are played by Christoffel symbols for the group of coordinate transformations which are, in fact, space-time dependent. Over the last 15 years some important developments in the field of gravity have taken place. These are: (i) Superstrong short range gravity mediated by massive spin-two gauge bosons (Sivaram and Sinha 1979) in addition to weak gravity mediated by massless gravitons. (ii) Quantization of gravity: It had been hoped that like all other fields, gravity will also be quantized. Although there have been many interesting approaches to this greatest challenge of theoretical physics (for reviews see Isham et al 1981; Narlikar and Padmanabhan 1983), we do not have a solution to this problem as yet. (iii) Supergravity invokes supersymmetry between pairs of bosons and fermions, they being manifestations of the same super particle. Supersymmetry generalised to a local gauge invariance leads to a gravitational model as