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ON THE POLARIZATION OF GRAVITATIONAL WAVES

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Abstract. Physical properties of gravitational waves, belonging to the larger class of exact solutions of Einstein field equations which are invariant for a non-Abelian two-dimensional Lie algebra of Killing fields, are described. It is shown that in the would be quantum theory of gravity they correspond to spin $-$ 1 massless particles. The gravitational interaction of two pencils of light is analyzed.

Introduction

The aim of this talk is to illustrate some interesting and, in a sense, surprising physical properties of special solutions of Einstein field equations, belonging to the large class of Einstein metrics invariant for a non-Abelian two-dimensional Lie algebra of symmetries, which throw new light on the following problem.

A long time ago Tolman, Ehrenfest and Podolsky [30] and later Wheeler [33] analyzed the gravitational field of light beams and the corresponding geodesics in the linear approximation of Einstein equations. They discovered that null rays behave differently according whether they propagate parallel or antiparallel to a steady, long, straight beam of light, but they did not provide a physical explanation of this fact. The result was clarified in part by Faraoni and Dumse [14] using an approach based on a generalization to null rays of the gravitoelectromagnetic Lorentz force of linearized gravity. They also extended the analysis to the realm of exact *pp*-wave solutions of the Einstein equations.

Since the problem of the gravitational interaction of two photons is still unsolved, it appears necessary to take into full account the nonlinearity of Einstein's equations when studying the generation of gravitational waves from strong sources [12, 29].