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Classical and Quantum Scattering on a Spinning Cone*

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Abstract. Solutions are presented for the Klein–Gordon and Dirac equations in the $2+1$ dimensional space-time created by a massive point particle, with arbitrary angular momentum. A universal formula for the scattering amplitude holds when a required self-adjoint extension of the Dirac operator is specified uniquely. Various obstacles to a consistent quantum mechanical interpretation of these results are noted.

I. Introduction

There has been completed recently a quantum-mechanical analysis of two-body scattering in $2+1$-dimensional [planar] gravity [1, 2]. This generally covariant theory has no propagating gravitational degrees of freedom, because in the absence of sources it is solved uniquely by flat space-time. Curvature is created by sources, but only locally at their position; elsewhere space-time remains flat. Consequently there are no gravitons, and forces are not mediated by graviton exchange; rather, they are geometrical/topological in origin, arising from global properties of space-time, which is not Minkowskian in the large, even when it is locally flat. For this reason, planar quantum gravity gives us the opportunity for examining the inter-relation between geometrical and quantum concepts, without the complication of graviton propagation. Moreover, the theory is physically realized in the presence of infinite cosmic strings [3].

The quantum mechanical results that have been established concern relative motion in a two-body, spinless system [1], and equivalently [1] motion of a spinless test particle in the presence of a [heavy] spinless source [2]. In this paper, we extend the results about test-particle motion by allowing the source and/or the test particle to carry spin, i.e. we solve the Klein–Gordon and Dirac equations. In Sect. II, we recall the space-time of a spinning source [4], and discuss classical motion. Our strategy for studying quantum scattering on a cone is presented in

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