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SOLUTION OF THE DIRAC EQUATION FOR THE Q-DEFORMED MANNING-ROSEN POTENTIAL

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Abstract. Approximate solution for the Dirac equation with the q-deformed Manning-Rosen potential, under the condition of spin and pseudospin symmetry are obtained. Also the energy spectrum and wave functions are obtained by the Nikiforov-Uvarov (NU) method. The special cases $q = 1$, Hulthén potential ($b \to 0$) and the nonrelativistic limit are studied for the q-deformed Manning-Rosen potential, and then results are compared with the other works.

1. Introduction

A particle in a strong potential field should be described with the Klein-Gordon (KG) and Dirac equations. The solutions of the Dirac or KG equations having the spin, and pseudospin symmetry have been extensively studied in the last years. The spin symmetry arises if the magnitude of the spherical scalar potential $S(r)$ and vector potential $V(r)$ are nearly equal in nuclei (i.e., $\Delta(r) = V(r) - S(r) = C_s = \text{const}$). However, the pseudospin symmetry occurs when $S(r) \sim -V(r)$ (i.e., $\Sigma(r) = V(r) + S(r) = C_{ps} = \text{const}$) [7].

In recent years, many authors have worked on solving these equations with physical potentials including Morse potential [1], Hulthén potential [5, 10, 18], Woods-Saxon potential [4, 20], reflectionless-type potential [6, 15], Rosen-Morse potential [15, 19], Manning-Rosen potential [9, 15], five-parameter exponent-type potential [17], etc.

Various methods are used to obtain the solutions of the wave equations for this type of exponential potentials, like the supersymmetric quantum mechanics and shape invariant [8, 12], the standard methods [14], the asymptotic iteration method (AIM) [3] and the Nikiforov-Uvarov (NU) method [13], etc. Recently, the NU