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Approximate Solution of Schrodinger Equation for Modified Poschl-Teller plus Trigonometric Rosen-Morse Non-Central Potentials in Terms of Finite Romanovski Polynomials

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Abstract: *The energy eigenvalues and eigenfunctions of Schrodinger equation for Modified Poschl-Teller potential plus trigonometric Rosen-Morse non-central potential are investigated approximately in terms of finite Romanovski polynomial. The approximation has been made to solve the radial Schrodinger equation. The approximate bound state energy eigenvalues are given in a closed form and corresponding radial and eigenfunctions are obtained in terms of Romanovski polynomials. The polar eigenfunctions are obtained in terms of Romanovski polynomials. The trigonometric Rosen-Morse potential is considered to be perturbation factor to the modified Poschl-Teller potential since it causes the decrease of the length of angular momentum vectors.*

Keywords: *Approximate Solution, Schrodinger Equation, Modified Poschl-Teller Potential, Trigonometric Rosen Morse Non-Central Potential, FiniteRomanovski Polynomials*

I. Introduction

The exact analytical solutions of Schrodinger equations for some physical potentials are very essential since the knowledge of wavefunctions and energy contains all possible important information of the physical properties of quantum system. Recently, conciderably efforts have been paid to obtain the exact solution of the central and non-central potentials. There are only a few potentials for which the Schrodinger equation can be solved exactly. In general, one has to resort to numerical techniques or approximation schemes. For many quantum mechanical systems, most approximation methods used are shifted *1/N* expansion, WKB method, perturbation method, supersymmetric quantum mechanics and idea of shape invariance, etc. Although some methods produce eigenvalues easily but give complicated eigenfunctions.

In recent years, numerous studies have been made in analyzing the bound state of charged particle moving in a vector potential and a non-central scalar potential, such as an electron moving in a Coulomb field with simultaneously precence of Aharonov-Bohm field [1,2], or/and magnetic monopole [3], Makarov potential [4] or ring-shaped-oscillator potential [5-8], etc. In most of these studies, the eigenvalues and eigenfunctions are obtained using separation variables in spherical coordinate system. Very recently, supersymmetric quantum mechanics with the idea of shape invariance [9], factorization method [10-11], and Nikiforov-Uvarov method [12] are widely used to derive the energy spectrum and the wave function of a charge particle moving in non-central potential.

Very recently, an alternative method called as finite Romanovski polynomials, which is a traditional method, consist of reducing Schrodinger equation by an appropriate change of the variable to that of very form of generalized hypergeometric equation[12-13]. The polynomial was discovered by Sir E.J.Routhand rediscovered 45 years later by V. I. Romanovski [14,15]. The notion "finite" refers to the observation that, for any given set of parameters (i.e. in any potential) only a finite of polynomials appear orthogonal

It is known that for very limited potential, the three dimansional radial Schrodinger equation is exactly solvable only for s-wave ($l = 0$). However, the three dimensional radial Schrodinger equation for the spherically symmetric potentials can not be solved analytically for $l \neq 0$ states because of the centrifugal term $\sim r^{-2}$[16-17]. the Schrodinger equation can only be solved approximately for different suitable approximation scheme. One of the suitable approximation scheme is conventionally proposed by Greene and Aldrich.[18, 19]

In this paper we will attempt to solve the Schrodinger equation for a charged particle moving in a field governed by modified Poschl-Teller potential [20]with simultaneously presence of trigonometric Rosen-Morse potential[21]in term of finite Romanovski polynomial. The modified Poschl-Teller potential is hyperbolic potential. A class of hyperbolic potentials play the essential roles in interatomic and intermolecular forces [22-23]and can be used to describe molecular vibrations. Some of these hyperbolic potential are exactly solvable or quasi – exactly solvable and their bound state solutions have been reported[24-25]. The trigonometric Rosen-