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Research Article

The energy eigenvalues of the exponential cosine screened Coulomb potential with magnetic field

Murat Aygün

Bitlis Eren University, Faculty of Arts and Science, Department of Physics, TR 13000, Bitlis - Turkey
Corresponding author: maygun@beu.edu.tr & murata.25@gmail.com

Abstract

In the present study, we examine two dimensional solution of the Schrödinger equation for the exponential cosine screened Coulomb potential in a magnetic field. We apply the asymptotic iteration method to obtain energy eigenvalues. Since this equation has no analytical solution, the energy eigenvalues have been numerically obtained for different screening parameter, the Larmor frequency and the strength coupling constant. Effect of the magnetic field on the energy eigenvalues is precisely presented.

Keywords: Magnetic field; exponential cosine screened Coulomb potential; asymptotic iteration method

1. Introduction

The solution of the Schrödinger equation (SE) of a particle under magnetic field (MF) is one of the important issues in physics. If one obtain the wave function for investigated system, it can be obtained crucial information regarding the system. Thus, a large number of studies have been performed in order to solve the eigenvalue equation and to determine the correction on the energy eigenvalues (EEs) in a MF (Villalba & Pino 2001; Aygun et al. 2012; Villalba & Pino 1998; Aygun et al. 2010; Taut 1995). These studies were made possible due to the technological advances in nanofabrication technology, which has enabled the creation of low-dimensional structures such as quantum wires, quantum dots, and quantum wells in semiconductor physics (Demel et al. 1990; Zhu et al. 1997; Blanter et al. 1996; Johnson 1995; Killingbeck & Jolicard 2009). It will be very important and interesting to investigate the solution of the SE for different potentials in a MF in order to have more idea about the effect on the EEs of MF. In our study, we examine the exponential cosine screened Coulomb (ECSC) potential in constant MF.

The ECSC potential plays an important role in various fields of physics. It is used in subjects such as describing the potential between an ionized impurity and electron of a metal (Bonch-Bruevich & Glasko 1959; Takimoto 1959), a semiconductor (Bonch-Bruevich & Kogan 1960; Hall 1962), plasma physics (Shukla & Eliasson 2008), the electron-positron interaction for a positronium atom (Prokopev 1967). The ECSC potential is given by

$$V(r) = -\frac{A}{r} e^{-\delta r} \cos(\delta r) \tag{1}$$

where A is the strength coupling constant and δ is the screening parameter. So far, the bound state energies of the ECSC potential have been calculated by the approximation methods such as J-Matrix approach (Nasser et al. 2011), the algebraic perturbation theory (Fack et al. 1986), the SUSY-perturbation formalism (Ikhdair & Sever 2007), the large expansion method (Dutt et al. 1986; Sever & Tezcan 1987), the shifted large expansion method (Ikhdair & Sever 1993), the perturbation method (Dutt et al. 1985), variation methods (Lam & Varshni 1972), the dynamical group approach (de Meyer et al. 1985), asymptotic iteration method (AIM) (Bayrak & Boztosun 2007) and the hypervirial-Padé scheme (Chatterjee 1987; Lai 1982). On the other hand, up to our knowledge the behavior of a particle under the ECSC potential in the present of a constant MF has not been studied yet. In this paper, for the first time, we aim to solve the radial SE for the ECSC potential in a constant MF. We present the EEs for any n and m quantum numbers over the different δ parameter, the Larmor frequency (w_L) and the A constant within the framework of the numerical procedure of AIM (Ciftci et al. 2003) in a MF.

In the next section, we briefly outline AIM. In section 3, we apply AIM to solve the two dimensional SE in a constant uniform MF and find the EEs in arbitrary δ, w_L and A values. Then, we show the effect of the MF on the EEs. Finally, in section 6, we remark on these results.

2. The Asymptotic Iteration Method

AIM is proposed to solve the second-order differential equations of the form (Ciftci et al. 2003; Bayrak & Boztosun 2006).

$$y'' = \lambda_0(x) y' + s_0(x) y \tag{2}$$

where $\lambda_0(x) \neq 0$. The variables, $S_0(x)$ and $\lambda_0(x)$, are sufficiently differentiable. The differential Eq. 2 has a general solution (Ciftci et al. 2003). It should be noted that one can also start the recurrence relations from $k = 0$ with the initial conditions $\lambda_{-1}=1$ and $S_{-1}=0$ (Fernandez 2004).

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$$y(x)=\exp\left(-\int^{x}\alpha(x')dx'\right)\left[C_2+C_1\int^{x}\exp\left(\int^{x'}[\lambda_0(x'')+2\alpha(x'')]dx''\right)dx'\right] \tag{3}$$

if $k > 0$, for sufficiently large k, we obtain the $\alpha(x)$ values from

$$\frac{s_k(x)}{\lambda_k(x)}=\frac{s_{k\text{-}1}(x)}{\lambda_{k\text{-}1}(x)}=\alpha(x),\quad k=1,\ 2,\ 3,\ldots \tag{4}$$

where

$$\lambda_k(x)=\lambda'_{k-1}(x)+s_{k-1}(x)+\lambda_0(x)\lambda_{k-1}(x)$$

$$s_k(x)=s'_{k-1}(x)+s_0(x)\lambda_{k-1}(x),\qquad k=1,\ 2,\ 3,\ldots \tag{5}$$

For a given potential, the radial SE is converted to the form of Eq. 2. Then, $S_0(x)$ and $\lambda_0(x)$ are determined and $S_k(x)$ and $\lambda_k(x)$, parameters are calculated by the recurrence relations given by Eq. 5. The EEs are obtained from the roots of the quantization condition, given by the termination condition of the method in Eq. 4. The quantization condition of the method together Eq. 5 can also be written as follows:

$$\delta_k(x)=\lambda_k(x)s_{k\text{-}1}(x)-\lambda_{k\text{-}1}(x)s_k(x)=0\quad k=1,\ 2,\ 3,\ldots \tag{6}$$

The EEs are obtained from this equation if the problem is exactly solvable. If not, for a specific n principal quantum number, we choose a suitable x_0 point, determined generally as the maximum value of the asymptotic wave function or the minimum value of the potential, and the approximate energy eigenvalues are obtained from the roots of this equation for sufficiently great values of k with iteration. The wave functions are determined by using the following wave function generator

$$y_n(x)=C_2\exp\left(-\int^{x}\frac{s_k(x')}{\lambda_k(x')}dx'\right) \tag{7}$$

where $k \geq n$, n represents the radial quantum number and k shows the iteration number. For exactly solvable potentials, the radial quantum number n is equal to the iteration number k and the eigenfunctions are obtained directly from Eq. 7. For nontrivial potentials that have no exact solutions, k is always greater than n in these numerical solutions and the approximate EEs are obtained from the roots of Eq. 6 for sufficiently great values of k by iteration.

3. The energy eigenvalues of the ECSC potential in the magnetic field

In this part, we consider a charged particle acting in a constant MF. If we want to write the Hamiltonian for this particle, we can show as following form

$$H=\frac{1}{2\mu}\left(\boldsymbol{p}+\frac{e}{c}\boldsymbol{A}\right)^2+V(r) \tag{8}$$

where μ is reduced mass of the particle, $\boldsymbol{p}$ is the momentum of the particle, e is the electric charge, c is the velocity of light, the vector potential in the symmetric gauge is $\boldsymbol{A}=\frac{1}{2}\boldsymbol{B}\boldsymbol{x}\boldsymbol{r}$ (Taut 1995). If we derive whole Hamiltonian for this system in CGS system and in atomic units $\hbar=\mu=e=1$, we obtain as

$$H=\frac{1}{2}\left(-i\nabla+\frac{1}{2}\boldsymbol{B}\ \boldsymbol{x}\ \boldsymbol{r}\right)^2+V_{ECSC}(r) \tag{9}$$

Thus, the SE becomes

$$H\varphi=\frac{1}{2}\left(-i\nabla+\frac{1}{2}\boldsymbol{B}\ \boldsymbol{x}\ \boldsymbol{r}\right)^2\varphi+V_{ECSC}(r)\varphi=i\partial_t\varphi=E\varphi \tag{10}$$

In the present study, while the Hamiltonian is taken in two dimensions, it is adequate to study in polar coordinates (r,ϕ) within the plane. For this purpose, we use the following wave function

$$\varphi(r)=\frac{e^{im\phi}}{\sqrt{2\pi}}\frac{R(r)}{\sqrt{r}},\quad m=0,\pm1,\pm2\ldots \tag{11}$$

If we put Eq. 11 into Eq. 10, we obtain two dimensional radial SE

$$\frac{d^2}{dr^2}R(r)+2\left[E-\frac{(m^2-\frac{1}{4})}{2r^2}-\frac{1}{2}w_L^2r^2-mw_L-V_{ECSC}(r)\right]R(r)=0 \tag{12}$$

where E is the energy eigenvalue of the particle, m is the eigenvalue of angular momentum, and w_L=B/2c is the Larmor frequency. In Eq. 12, the effective potential (U_{eff}) related to the MF strength is comprehended as follows:

$$U_{eff}(r,w_L)=V_{ECSC}(r)+\frac{1}{2}w_L^2r^2+\frac{(m^2-\frac{1}{4})}{2r^2}+mw_L \tag{13}$$

where V_{ECSC}(r) is the pure ECSC potential and second term is a harmonic-oscillator type potential and other terms are the rotational potentials creating the rotational energy levels. For the case of low vibrational (n=0, 1) and rotational (m=1) levels, the (U_{eff}) has been plotted in figure 1. As seen from both figure 1 and Eq. 13, the potential energy function is raised in energy and the bound state EEs increase as well when the MF strength increases. Furthermore, the shape of the potential energy function will change for increasing strengths of the MF. It is clearly seen that the effective potential changes gradually from the pure ECSC potential, which is a no-MF case, to a harmonic-oscillator type behavior in short potential range as the strength of the applied MF is increased.

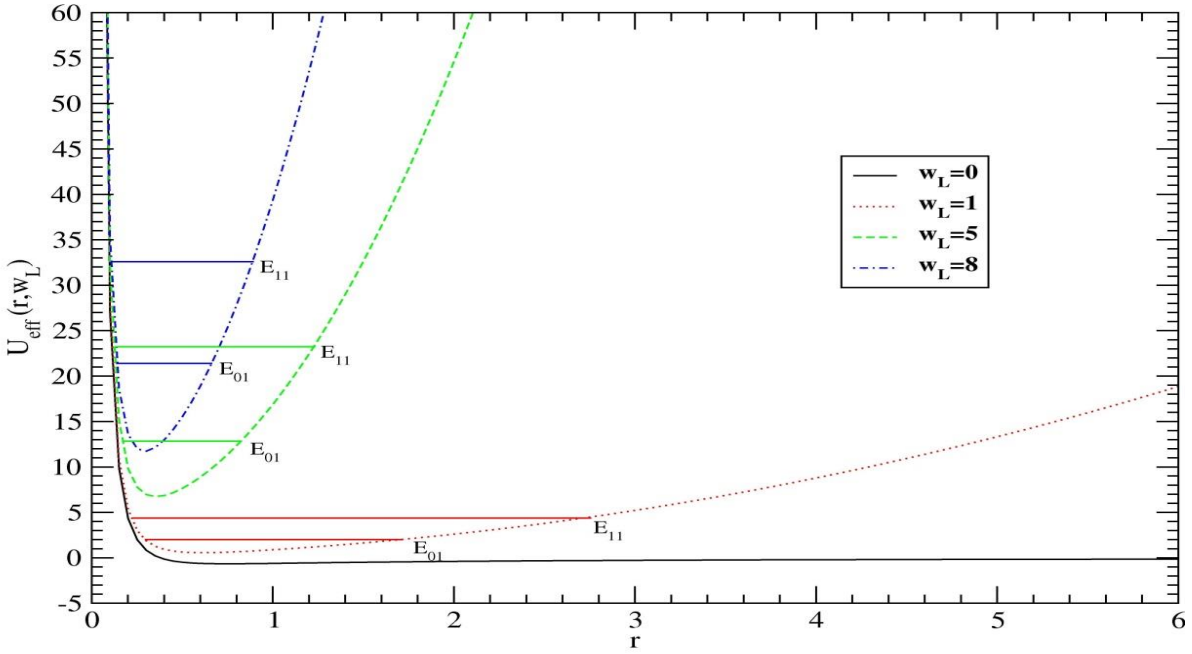

Figure 1: The effective potential energy function and corresponding bound state energy levels (E_{nm}) for m=1 with δ=0.01 and A=1.

Now, we can show how to find the EEs for the ECSC potential in a MF by applying the numerical procedure of the AIM. With this goal, for the low δ parameter, we can expand the ECSC potential in the power series of the δ parameter up to the sixth term. So, $V(r)$ becomes,

$$V(r)=-\frac{A}{r}+A\delta-\frac{A\delta^3r^2}{3}+\frac{A\delta^4r^3}{6}-\frac{A\delta^5r^4}{30}+\frac{A\delta^7r^6}{630} \tag{14}$$

Substituting Eq. 14 into Eq. 12 and by rearranging it, we obtain

$$\frac{d^2}{dr^2}R(r)+\left[2(E-mw_L)-\frac{(m^2-\frac{1}{4})}{r^2}-w_L^2r^2+\frac{2A}{r}-2A\delta+\frac{2A\delta^3r^2}{3}-\frac{A\delta^4r^3}{3}+\frac{A\delta^5r^4}{15}-\frac{A\delta^7r^6}{315}\right]R(r)=0 \tag{15}$$

4. The energy eigenvalues of the ECSC potential for no magnetic field

In this part, we consider the case without MF in order to compare the case with MF. With this goal, if we take $w_L = 0$ in Eq. 15, we obtain the two dimensional radial SE as follows:

$$\frac{d^2}{dr^2}R(r)+\left[2E-\frac{(m^2-\frac{1}{4})}{r^2}+\frac{2A}{r}-2A\delta+\frac{2A\delta^3r^2}{3}-\frac{A\delta^4r^3}{3}+\frac{A\delta^5r^4}{15}-\frac{A\delta^7r^6}{315}\right]R(r)=0 \tag{16}$$

If we use the following ansatz,

$$\varepsilon=2E,\quad \Gamma_1=2A,\quad \Gamma_2=-2A\delta,\quad \Gamma_3=\frac{2A\delta^3}{3},\quad \Gamma_4=\frac{A\delta^4}{3},\quad \Gamma_5=\frac{A\delta^5}{15},\quad \Gamma_6=\frac{A\delta^7}{315} \tag{17}$$

we can easily obtain

$$\frac{d^2}{dr^2}R(r)+\left[\varepsilon-\frac{(m^2-\frac{1}{4})}{r^2}+\frac{\Gamma_1}{r}+\Gamma_2+\Gamma_3r^2-\Gamma_4r^3+\Gamma_5r^4-\Gamma_6r^6\right]R(r)=0 \tag{18}$$

In order to solve Eq. 18, we choose the following physical wave function

$$R(r)=r^{m+\frac{1}{2}}exp(-\beta r)\,f(r) \tag{19}$$

where β is an arbitrarily introduced constant to improve the convergence speed of the method (Fernandez 2004; Aygun et al. 2010). Putting this wave function into Eq. 18, we obtain the following second-order equation, which is amenable to an AIM solution.

$$\frac{d^2}{dr^2}f(r)=\left[\frac{(2\beta r-2m-1)}{r}\right]\frac{df(r)}{dr}+\left[\frac{(2\beta m-\beta^2r+\beta-\varepsilon r-\Gamma_1-\Gamma_2r-\Gamma_3r^3+\Gamma_4r^4-\Gamma_5r^5+\Gamma_6r^7}{r}\right]f(r) \tag{20}$$

In order to use the AIM procedure, we compare Eq. 20 with Eq. 2 and obtain $\lambda_0(r)$ and $s_0(r)$ equations as follows

$$s_0(r)=\left(\frac{2\beta m-\beta^2r+\beta-\varepsilon r-\Gamma_1-\Gamma_2r-\Gamma_3r^3+\Gamma_4r^4-\Gamma_5r^5+\Gamma_6r^7}{r}\right)$$

$$\lambda_0(r)=\frac{(2\beta r-2m-1)}{r} \tag{21}$$

Higher $\lambda_k(r)$ and $s_k(r)$ equations are obtained by using the recurrence relations in Eq. 5. Due to the fact that Eq. 6 is not solvable at every r point, we have to choose a suitable r_0 point to solve the equation $\delta_k(r_0, \varepsilon)=0$ iteratively in order to find ε values. There are two ways to define the r_0 point: First one is to use the maximum value of the asymptotic wave function given by Eq. 19 or the second one is to determine it from the minimum point of the potential. In our study, we obtain r_0 from the maximum point of the asymptotic wave function, which is the same as the root of $\lambda_0(r)$ =0, namely r_0 = (2m+1)/2β. On the other hand, the speed of the convergence depends on the arbitrarily introduced constant β. In our calculations, we have examined the optimum values of β which give the best convergence. Thus, we have kept β =1 value.

5. The energy eigenvalues of the ECSC potential in magnetic field

In previous section, we have investigated the case without the MF. Now, let us examine the radial SE of ECSC potential with the MF. For this, if we take $w_L \neq 0$, by using the following ansatz,

$$\varepsilon=2E,\quad \Gamma_1=2A,\quad \Gamma_2=\frac{2A\delta^3}{3}-w_L^2,\quad \Gamma_3=\frac{A\delta^4}{3},\quad \Gamma_4=\frac{A\delta^5}{15},\quad \Gamma_5=\frac{A\delta^7}{315},\quad \Gamma_6=2(-mw_L-A\delta) \tag{22}$$

we can easily obtain

$$\frac{d^2}{dr^2}R(r)+\left[\varepsilon-\frac{(m^2-\frac{1}{4})}{r^2}+\frac{\Gamma_1}{r}+\Gamma_2r^2-\Gamma_3r^3+\Gamma_4r^4-\Gamma_5r^6+\Gamma_6\right]R(r)=0 \tag{23}$$

In order to solve Eq. 23, we use the same physical wave function used in no MF. Thus, we can obtain the following second-order equation, which is amenable to an AIM solution.

$$\frac{d^2}{dr^2} f(r) = \left[\frac{(2\beta r - 2m - 1)}{r} \right] \frac{df(r)}{dr} + \left[\frac{2\beta m - \beta^2 r + \beta - \varepsilon r - \Gamma_1 - \Gamma_2 r^3 + \Gamma_3 r^4 - \Gamma_4 r^5 + \Gamma_5 r^7 - \Gamma_6 r}{r} \right] f(r) \tag{24}$$

In order to use the AIM procedure, we compare Eq. 24 with Eq. 2 and obtain $\lambda_0(r)$ and $s_0(r)$ equations as follows

$$s_0(r) = \left(\frac{2\beta m - \beta^2 r + \beta - \varepsilon r - \Gamma_1 - \Gamma_2 r^3 + \Gamma_3 r^4 - \Gamma_4 r^5 + \Gamma_5 r^7 - \Gamma_6 r}{r} \right)$$

$$\lambda_0(r) = \frac{(2\beta r - 2m - 1)}{r} \tag{25}$$

In this part, we obtain r_0 from the maximum point of the asymptotic wave function, which is the same as the root of $\lambda_0(r)=0$, namely $r_0=(2m+1)/2\beta$. However, the speed of the convergence depends on the arbitrarily introduced constant β. In the calculations, we have kept $\beta=10$ value.

The energy levels over the various values of δ, w_L and A of the ECSC potential without and with a constant MF have been calculated and given in Tables. Firstly, in Tables 1 and 2, we have shown the E_{nm} values for various δ with $w_L=1$ and $A=1$ values. The E_{nm} take negative values for $n=0$ in $m=0$. Then, by increasing of n values, E_{nm} values increase and take positive values. For $m=1$, while E_{nm} take positive values for all the n values, like $m=0$, E_{nm} increases with

Table 1: The energy eigenvalues (E_{nm}) for various δ parameters of a particle under the ECSC potential field with $w_L=1$ and $A=1$ values in atomic units.

m=0					
δ	*n=0*	*n=1*	*n=2*	*n=3*	*n=4*
0.01	-1.82620753	1.58689478	3.83838683	5.97313551	8.06262332
0.02	-1.81620822	1.59688953	3.84837681	5.98312088	8.07260416
0.03	-1.80621006	1.60687543	3.85835004	5.99308193	8.08255331
0.04	-1.79621363	1.61684831	3.86829876	6.00300758	8.09245654
0.05	-1.78621949	1.62680411	3.87821559	6.01288745	8.10230068
0.06	-1.77622818	1.63673896	3.88809357	6.02271184	8.11207356
0.07	-1.76624024	1.64664910	3.89792609	6.03247173	8.12176398
0.08	-1.75625620	1.65653094	3.90770694	6.04215870	8.13136167
0.09	-1.74627658	1.66638103	3.91743024	6.05176496	8.14085726
0.1	-1.73630189	1.67619603	3.92709045	6.06128330	8.15024220

Table 2: The same as Table 1, but for $m=1$

m=1					
δ	*n=0*	*n=1*	*n=2*	*n=3*	*n=4*
0.01	2.04962893	4.20112661	6.28386820	8.33958598	10.38099906
0.02	2.05962535	4.21111839	6.29385542	8.34956871	10.39097734
0.03	2.06961571	4.22109638	6.30382136	8.35952281	10.40091977
0.04	2.07959712	4.23105416	6.31375626	8.36943537	10.41081041
0.05	2.08956679	4.24098560	6.32365095	8.37929437	10.42063456
0.06	2.09952199	4.25088486	6.33349682	8.38908868	10.43037877
0.07	2.10946009	4.26074639	6.34328581	8.39880800	10.44003072
0.08	2.11937855	4.27056494	6.35301037	8.40844284	10.44957923
0.09	2.12927490	4.28033549	6.36266347	8.41798448	10.45901417
0.1	2.13914675	4.29005333	6.37223858	8.42742494	10.46832640

Table 3: The energy eigenvalues (E_{nm}) of a particle for various w_L and δ values with $A=1$ for $m=0$

	w_L=0		*w_L=1.0*		*w_L=5.0*		*w_L=8.0*	
δ	*n=0*	*n=1*	*n=0*	*n=1*	*n=0*	*n=1*	*n=0*	*n=1*
0.01	-1.99000	-0.21222	-1.82620	1.58689	0.19484	11.89358	2.18061	20.09823
0.03	-1.97000	-0.19234	-1.80621	1.60687	0.21484	11.91358	2.20061	20.11823
0.05	-1.95001	-0.17276	-1.78621	1.62680	0.23483	11.93356	2.22061	20.13822
0.07	-1.93004	-0.15364	-1.76624	1.64664	0.25482	11.95352	2.24060	20.15819
0.08	-1.92006	-0.14429	-1.75625	1.65653	0.26482	11.96349	2.25060	20.16817
0.1	-1.90011	-0.12610	-1.73630	1.67619	0.28480	11.98341	2.27059	20.18812

Table 4: The same as Table 3, but for m=1

	w_L=0		w_L=1.0		wL=5.0		w_L=8.0	
δ	n=0	n=1	n=0	n=1	n=0	n=1	n=0	n=1
0.01	-0.21222	-0.07002	2.04962	4.20112	12.95913	23.24296	21.43496	37.78369
0.03	-0.19231	-0.05071	2.06961	4.22109	12.97913	23.26295	21.45496	37.80369
0.05	-0.17264	-0.03300	2.08956	4.24098	12.99912	23.28293	21.47495	37.82367
0.07	-0.15332	-0.01757	2.10946	4.26074	13.01909	23.30288	21.49494	37.84364
0.08	-0.14383	-0.01088	2.11937	4.27056	13.02907	23.31284	21.50492	37.85361
0.1	-0.12526	0.00049	2.13914	4.29005	13.04902	23.33272	21.52489	37.87354

Table 5: The energy eigenvalues (E_{nm}) of a particle with various A and δ values for w_L=1

m=0

	A=1		A=2		A=4		A=8	
δ	n=0	n=1	n=0	n=1	n=0	n=1	n=0	n=1
0.02	-1.81620	1.59688	-7.91370	0.20126	-31.90829	-3.06556	-127.83707	-13.94902
0.04	-1.79621	1.61684	-7.87370	0.24120	-31.82829	-2.98562	-127.67707	-13.78905
0.05	-1.78621	1.62680	-7.85370	0.26114	-31.78829	-2.94568	-127.59707	-13.70909
0.06	-1.77622	1.63673	-7.83371	0.28104	-31.74829	-2.90577	-127.51707	-13.62914
0.08	-1.75625	1.65653	-7.79373	0.32075	-31.66830	-2.82605	-127.35707	-13.46931
0.1	-1.73630	1.67619	-7.75376	0.36028	-31.58832	-2.74651	-127.19708	-13.30959

Table 6: The same as Table 5, but for m=1

m=1

	A=1		A=2		A=4		A=8	
δ	n=0	n=1	n=0	n=1	n=0	n=1	n=0	n=1
0.02	2.05962	4.21111	0.93099	3.35459	-2.16158	1.44863	-12.97516	-3.30146
0.04	2.07959	4.23105	0.97095	3.39448	-2.08162	1.52846	-12.81519	-3.14163
0.05	2.08956	4.24098	0.99090	3.41435	-2.04167	1.56827	-12.73522	-3.06182
0.06	2.09952	4.25088	1.01084	3.43417	-2.00173	1.60799	-12.65526	-2.98210
0.08	2.11937	4.27056	1.05062	3.47360	-1.92195	1.68711	-12.49539	-2.82300
0.1	2.13914	4.29005	1.09027	3.51268	-1.84230	1.76569	-12.33561	-2.66445

increasing of n values. In order to see the change of E_{nm} with w_L, E_{nm} values calculated for different w_L values for both m=0 and m=1 are displayed in Tables 3 and 4. Like δ change, we have seen the increased values with MF. Finally, we have calculated the E_{nm} for various A constants with different δ values in w_L =1 and have displayed the results in Tables 5 and 6. For m=0, in general sense, E_{nm} have negative values and are increasing with MF. On the other hand, E_{nm} take positive values for A=1 and 2 in m=1. Then, by increasing of A values, E_{nm} takes negative values. However, E_{nm} values increase with δ. Eventually, if these results are examined, one can see that the EEs in any n value are increasing for both m=0 and m=1 with increasing w_L. Also, the EEs for the bigger δ parameter take the bigger values.

6. Conclusion

In the present study, we have examined the solution of two-dimensional radial SE for the ECSC potential with a constant MF. Firstly, in order to make comparative study, we have calculated E_{nm} values for the case without MF (w_L=0). Then, we have investigated two dimension solution of the SE for ECSC potential in a constant MF (w_L≠0). Since the solution of the SE for ECSC potential with MF can not be obtained analytically, we have applied an iterative approach within the framework of AIM. We have calculated E_{nm} values for arbitrary δ, w_L and A parameters and have given the results in Tables 1-6. We have observed that E_{nm} values increase with increasing of δ values. This behavior is valid for both m=0 and m=1. Then, we have examined the effect on the EEs values of MF for different w_L values. We have found that the E_{nm} values increase when the MF strength increases. Finally, we have investigated the change of the E_{nm} with various A constants. We have seen that a rapid change in E_{nm} results occurs in various A constants. Especially, this situation is very clear in A=8 value. Also, we have plotted the effective potential and corresponding energy levels with increasing w_L in order to show the effect on the EEs of a constant MF. We have observed that the potential energy function and corresponding energy levels are raised in energy when the MF strength increases. In the short potential range, we have seen that the effective potential changes gradually from the pure ECSC potential to a harmonic-oscillator type behavior as the MF applied increases.

The importance of this the study denotes to its providing an insight into the behavior of the ECSC potential in a MF that has not been studied so far in literature. The method presented in this study is a systematic one and it is very practical and efficient in obtaining the eigenvalues for the Schrödinger type equations in a MF.

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