PT-symmetric quantum mechanics concerns the reality of the spectrum of the considered Hamiltonian. First we consider the general spectral property of the spectrum of $L(q)$ and prove that the main part of its spectrum is real and contains the large part of $[0;\infty)$. Using this we find necessary and sufficient condition on the potential for finiteness of the number of the nonreal arcs in the spectrum of $L(q)$. Moreover, we find necessary and sufficient conditions for the equality of the spectrum of $L(q)$ to the half line and consider the connections between spectrality of $L(q)$ and the reality of its spectrum for some class of PT-symmetric periodic potentials. Finally we give a complete description, provided with a mathematical proof, of the shape of the spectrum of the Hill operator with optical potential $4\cos^2 2x + 4iV\sin 2x$.

Analytical forms of deuteron wave function

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The radial deuteron wave function in publications can be presented as a table: through respective arrays of values of proper radial wave functions. It is sometimes quite difficult and inconveniently to operate with such arrays of numbers at numerical calculations. And the program code for numerical calculations is huge and overloaded. Therefore, it is feasible to obtain simpler analytical forms of deuteron wave function (DWF) representation [1]. Cap's [2] and Dubovichenko [3] parameterizations can be generalized for the DWF approximation as such analytical forms:

$$\chi(r) = r^n \sum_{i=1}^{N} C_i \exp(-c_i r^3), \tag{1}$$

Given number N=11, search for an index of function of a degree r^n has been carried out, appearing as a factor before the sums of exponential terms of (1). The factors before the sums (1) can be chosen as $r^{3/2}$ and r^1 [4]:

$$u(r) = r^{3/2} \sum_{i=1}^{N} A_i \exp(-a_i r^3); \quad w(r) = r \sum_{i=1}^{N} B_i \exp(-b_i r^3). \tag{2}$$

Coefficients and DWFs (2) for NijmI, NijmII, Nijm93, Reid93 and Argonne v18 potentials it is resulted in papers [1, 4, 5]. A detailed comparison of the obtained values of deuteron tensor polarization $t_{20}(p)$. Calculated based for scattering angle θ=70^0. For these potentials with the up-to-date experimental data of JLAB t20 and BLAST collaborations.

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Dissipative model of vortex motion in the rotation Bose–Einstein condensate

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We study a Bose–Einstein condensate in the presence of a strongly anisotropic trapping potential $V_{ext} = \frac{1}{2}m(\omega_r^2 r^2 + \omega_z z^2)$ with $\omega_r \ll \omega_z$. In this case the trapped BEC has a nearly planar pancake shape and can be consider in the frame of 2D model in the plane (x, y).

The non-dimensional Gross–Pitaevskii equation for the BEC rotating with the angular velocity Ω can be written as [1]

$$(i-\gamma_0)\frac{\partial\psi}{\partial t} = -\frac{1}{2}\nabla^2\psi + \frac{\Omega_{tr}^2}{2}r^2\psi + g^2\psi|\psi|^2 - \mu\psi + i(\mathbf{\Omega}\times\mathbf{r})\cdot\nabla\psi. \quad (1)$$

where $\Omega_{tr} = \omega_r/\omega_z$, g is the interaction parameter, μ is the chemical potential and $\gamma_0 > 0$ is the temperature dependent parameter describing the dissipation. We suppose that there are N vortices with intensities n_j that are situated at the points $\xi_j = \xi_j(t) = (\eta_j, \zeta_j)$, $j = 1...N$, and can move. The equations of this motion can be written in the form of system

$$\dot{\eta}_j - \Omega\zeta_j = -S_{kj} + \frac{\Omega_{tr}^2}{2\Xi_j^2}\zeta_j n_j \omega_j - n_j\gamma_0\dot{\zeta}_j\omega_j,$$

$$\dot{\zeta}_j + \Omega\eta_j = C_{kj} - \frac{\Omega_{tr}^2}{2\Xi_j^2}\eta_j n_j \omega_j + n_j\gamma_0\dot{\eta}_j\omega_j. \quad (2)$$

Parameters C_{kj}, S_{kj} depends on the positions of all N vortices, Ξ_j and ω_j are the functions of $\{\eta_j, \zeta_j\}$ and $j = 1...N$. To obtain these equations we use the method of matched asymptotic expansion of the core and far field solutions that was proposed by Rubinstein and Pismen in 1994 [2]. We are looking for a solution of Eq. (1) in the form of an expansion in the parameter ε, that is the vortex core size, in two different space scales.