SELF-CONSISTENT DESCRIPTION OF PARTICLE -BOUND SYSTEM'S SCATTERING BY UNITARITY'S CONSERVING

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Recently a new method of self-consistent solution of the Schrödinger equation with a complex potential for quantum scattering problem has been proposed in the paper[1]. This report includes the method of Schrodinger equation's solution

$$[-\frac{\hbar}{2M}\Delta_{\vec{R}} + V(\vec{R},\vec{r})]e^{if(\vec{R},\vec{r})}\Phi_0(\vec{r}) = (E-E_0)e^{if(\vec{R},\vec{r})}\Phi_0(\vec{r}) \qquad (1)$$

in the spirit of [1] for the scattering of a particle with mass m_1 on the two-particle system (m_2,m_3) with its own ground state function $\Phi_0(\vec{r})$ of the two-particle system with energy E_0. Reality of the function $f(\vec{R},\vec{r})$ ensures the conserving of it's unitary norm. In equation (1) there are complex potential $V(\vec{R},\vec{r}) = v(\vec{R},\vec{r}) + iu(\vec{R},\vec{r})$, where

$$v(\vec{R},\vec{r}) = \mathrm{Re}V_{12}(\vec{R}-\frac{\mu}{m_2}\vec{r}) + \mathrm{Re}V_{13}(\vec{R}+\frac{\mu}{m_3}\vec{r}) + \frac{\hbar}{2\mu}[\vec{\nabla}_{\vec{r}} f(\vec{R},\vec{r})]^2,$$

$$u(\vec{R},\vec{r}) = \mathrm{Im}V_{12}(\vec{R},\vec{r}) + \mathrm{Im}V_{13}(\vec{R},\vec{r}) - \frac{\hbar}{\mu}\vec{\nabla}_{\vec{r}} f(\vec{R},\vec{r})\cdot\vec{\nabla}_{\vec{r}}\ln\Phi_0(\vec{r}) - \frac{\hbar}{2\mu}\Delta_{\vec{r}} f(\vec{R},\vec{r}),$$

$\vec{r}$ and $\vec{R}$ are Jacobi coordinates of particles relative motion in the pair (1, 2) and the motion of the particle 1 relative to the center of mass (2,3) correspondingly. μ and M are reduced masses. In the asymptotic case $\left(|\vec{R}| >> |\vec{r}|\right)$, we can write for the function $f(\vec{R},\vec{r})$ the Maclaurin series, for example, up to and including the second derivatives with respect to the coordinates of $\vec{r}(x,y,z)$

$$f(\vec{R},\vec{r}) = f_0(\vec{R}) + C(\vec{R})(x+y+z) + \frac{1}{2!}[B(\vec{R})(x^2+y^2+z^2) + 2\tilde{B}(\vec{R})(xz+xy+yz)] \ldots. (2)$$

Expanding potential also in powers of these coordinates and equating in equation (1) the coefficients of the same powers of coordinates, we obtain a system of equations, from which we find $f(\vec{R}) = \vec{Q}\vec{R}$, where $|\vec{Q}|^2 = (E-E_0)$, $C(\vec{R}) = \sqrt{-2\mu v(\vec{R},0)/3\hbar}$. The functions $B(\vec{R})$ and $\tilde{B}(\vec{R})$ are defined by $C(\vec{R})$ and also the coefficients of expansion potential. Reality of function $C(\vec{R})$ determines the sign of the potential $v(\vec{R},0)<0$.

1. N.F.Golovanova, A.A.Golovanov // Czech. J. Phys. 2006. V.56. Suppl.A. P.275.