23 October 2000

PHYSICS LETTERS A

ELSEVIER

Physics Letters A 275 (2000) 493–494

www.elsevier.nl/locate/pla

# Comment on: "On the problem of an electron scattering in an arbitrary one-dimensional potential field" [Phys. Lett. A 265 (2000) 294–296] ☆

V. Gasparian

*Department of Physics, University of Murcia, 30071 Murcia, Spain*

Received 7 April 2000; received in revised form 25 August 2000; accepted 31 August 2000

Communicated by L.J. Sham

In a recent article [1], Sedrakian and Khachatrian (SK) have discussed the problem of an electron in an arbitrary one-dimensional chain when the potential energy is the sum of $N$ individual potentials:

$$V(x) = \sum_{n=1}^{N} V_n(x - x_n). \tag{1}$$

Using the method of the characteristic determinant, developed in Refs. [2–7] for any kind of one-dimensional potential with and without an additional homogeneous electric field, SK showed that the recurrence relation for the inverse complex amplitude of transmission $D(x) = 1/t(x)$ can be rewritten as a second order differential equation (see Eq. (14) of Ref. [1]) ($\hbar = 2m_0 = 1$ and $E = k^2$):

$$\frac{d^2}{dx^2}D - \left(2ik + \frac{1}{V(x)}\frac{dV(x)}{dx}\right)\frac{d}{dx}D - V(x)D = 0. \tag{2}$$

This is the *central result* of the article [1].

It turns out that SK are not aware of the papers by Calogero and by Babikov (see e.g., Refs. [8–10] and references therein). Otherwise it would not make any sense in deriving Eq. (2), which is well known for almost 35 years. In the mentioned Refs. of Calogero and Babikov [8–10], using the variable phase approach to potential scattering, it was shown that the complex reflection amplitude $r(x)$ and the inverse transmission amplitude $D(x)$ of an electron incident, e.g., from the right onto an arbitrary $V(x)$ (confined to a finite segment $-L < x < 0$) obeyed the following well known first order differential equations:

$$\frac{d}{dx}r(x) = \frac{1}{2ik}V(x)\left[e^{-ikx} + r(x)e^{ikx}\right]^2, \tag{3}$$

$$\frac{d}{dx}D(x) = -\frac{1}{2ik}D(x)V(x)\left[1 + r(x)e^{2ikx}\right]. \tag{4}$$

Eq. (2) simply follows from the above equations if one takes the derivative with respect to the $x$ coordinate of (4) and makes use of (3).

Thus from the point of view of Eqs. (3) and (4), Eq. (2) is trivial and does not contain any extra information. More, for some especial cases, when the potential $V(x)$ has a infinite or finite discontinuity (e.g. when the potential is the set of an arbitrary arranged delta functions $V(x) = \sum_{n=1}^{N} V_n \delta(x - x_n)$) it is much easier to deal with the first order differen-

☆ PII of original article S0375-9601(99)00903-2

*E-mail address:* matdes@fcu.um.es (V. Gasparian).



PII: S0375-9601(00)00593-4

tial equations (3) and (4) (for details see [9]) rather than with Eq. (2).

## References

[1] D.M. Sedrakian, A.Zh. Khachatrian, Phys. Lett. A 265 (2000) 294.
[2] V.M. Gasparian, B.L. Altshuller, A. G Aronov, Z.H. Kasamanian, Phys. Lett. A 132 (1988) 201.
[3] A.G. Aronov, V.M. Gasparian, U. Gummich, J. Phys. Condens. Matter 3 (1991) 3023.
[4] V. Gasparian, M. Ortuño, J. Ruiz, E. Cuevas, M. Pollak, Phys. Rev. B 51 (1995) 6743.
[5] P. Carpena, V. Gasparian, M. Ortuño, Phys. Rev. B 51 (1995) 12813.
[6] P. Carpena, V. Gasparian, M. Ortuño, Z. Phys. B 102 (1997) 425.
[7] P. Carpena, V. Gasparian, M. Ortuño, Eur. Phys. J. B 8 (1999) 635.
[8] F. Calogero, Variable Phase Approach to Potential Scattering, Acad. Press, New York, London, 1967.
[9] V.V. Babikov, Metod Fazovikh Funktsii v Kvantovoi Mexanike, Izd. Nauka, Moscow, 1976.
[10] V.V. Babikov, Usp. Fizich. Nauk 92 (1967) 3.