
L. B. Castro and A. S. de Castro

Citation: J. Math. Phys. 51, 034101 (2010); doi: 10.1063/1.3340896
View online: http://dx.doi.org/10.1063/1.3340896
View Table of Contents: http://jmp.aip.org/resource/1/JMAPAQ/v51/i3
Published by the AIP Publishing LLC.

Additional information on J. Math. Phys.
Journal Homepage: http://jmp.aip.org/
Journal Information: http://jmp.aip.org/about/about_the_journal
Top downloads: http://jmp.aip.org/features/most_downloaded
Information for Authors: http://jmp.aip.org/authors

ADVERTISEMENT

Give us your dirty old books!
The Niels Bohr Library & Archives is looking for book donations

L. B. Castro\textsuperscript{a} and A. S. de Castro

Departamento de Física e Química, Universidade Estadual Paulista, 12516-410
Guaratinguetá, São Paulo, Brazil

(Received 3 November 2009; accepted 8 February 2010; published online 31 March 2010)

It is shown that the paper “Wave functions for a Duffin–Kemmer–Petiau particle in a time-dependent potential” by Merad and Bensaid [J. Math. Phys. 48, 073515 (2007)] is not correct in using inadvertently a non-Hermitian Hamiltonian in a formalism that does require Hermitian Hamiltonians. © 2010 American Institute of Physics. doi:10.1063/1.3340896

In a recent paper published in this journal, Merad and Bensaid\textsuperscript{1} reported on the solution of the Duffin–Kemmer–Petiau (DKP) equation for spin-0 sector in a time-dependent linear scalar field using the Lewis–Riesenfeld (LR) invariant method.\textsuperscript{2} The purpose of this comment is point to out that this alternative method is not applicable to the DKP theory.

The concept of invariance of a system, as introduced in Ref. 2, states that

\[ \frac{dI(t)}{dt} = \frac{1}{i} [I(t), H(t)] + \frac{\partial I(t)}{\partial t} = 0, \]

where \( i \) is the imaginary unit, and \( I(t) \) and \( H(t) \) (Hamiltonian of the system) are explicitly time-dependent operators. In this context, \( I(t) \) and \( H(t) \) should be Hermitians. On the other hand, the Hamiltonian form of the DKP particle with an electromagnetic interaction is written as

\[ H_{\text{DKP}} = i[\beta^\mu \beta^\nu D_k + \frac{ie}{2m} (\beta^\mu \beta^\nu \beta^\alpha + \beta^\nu \gamma^{0\alpha}) F_{\mu\nu} + m \beta^0 - eA^0], \]

where \( D_k = \partial_k + ieA_k \) and \( H_{\text{DKP}} \) satisfies an equation of Schrödinger type,

\[ i\partial_t \psi = H_{\text{DKP}}(t) \psi. \]

At this point, it is worthwhile to mention that \( H_{\text{DKP}} \) is not Hermitian,\textsuperscript{3} as opposed to what was adverted in Ref. 4, since

\[ (iF_0 \beta^0 (\beta^0)^2)^\dagger = -(iF_0 \beta^0 (\beta^0)^2) + iF_0 \beta^0. \]

This results in

\[ H_{\text{DKP}} - H_{\text{DKP}}^\dagger = \frac{ie}{m} F_0 \beta^0 (\beta^0)^2. \]

Therefore, it is not correct to use the LR invariant method in the DKP theory. In fact, the LR invariant theory generalized in Ref. 5 for including non-Hermitian Hamiltonians in the context of the nonrelativistic quantum mechanics might be appropriate to deal with the DKP Hamiltonian.

\textsuperscript{a}Electronic mail: benito@feg.unesp.br.

0022-2488/2010/51(3)/034101/2/$30.00 © 2010 American Institute of Physics
This work was supported in part by means of funds provided by CAPES and CNPq. The authors would like to thank the referees for drawing attention to Ref. 5.