The exact solution for the Dirac equation with the Cornell potential

Luis Augusto Trevisan[(a)], Carlos Mirez[(b)], Fabiano Manuel de Andrade[(a)]

[(a)] Departamento de Matemática e Estatística, Universidade Estadual de Ponta Grossa, 84010-790, Ponta Grossa, PR, Brazil
[(b)] UFVJM, Campus Teofilo Otoni

The Cornell potential is among the most appealing interactions in particle physics. The Cornell potential contains a confining term besides the Coulomb interaction and has successfully accounted for the particle physics data [1]. Unfortunately, to our best knowledge, the potential does not possess exact solutions under all common equations of quantum mechanics, that is, the nonrelativistic Schrödinger equation, and relativistic Dirac, Klein-Gordon, Proca, and Duffin-Kemmer-Petiau (DKP) equations. Here, we focus on Dirac equation, with equal scalar and vectorial components, because the interesting properties: avoid the Klein paradox and can be reduced to a Schrödinger like equation . This provide a reliable theoretical basis for hadronic and nuclear spectroscopy, see, for instance, the talk by Thomas, for the case with quarkonium [2] . There are many studies under various interactions within the past two decades ([3] and many references therein). Nevertheless, none of these papers has investigated the symmetry limits under the Cornell potential. This is definitely due to the complicated nature of the resulting differential equation which cannot be solved by common analytical techniques of quantum mechanics. In our study, we make use of a study based on the approach to large r, which solution tends to be the Airy function.

[1] D. H. Perkins, An Introduction to High Energy Physics, Cambridge University Press, 2000.

[2] Thomas Rosenhammer, http://einrichtungen.physik.tu-muenchen.de/T30f/Talks/thomas.pdf

[3] H. Hassanabadi, E. Maghsoodi, S. Zarrinkamar, and H. Rahimov, Dirac Equation under Scalar, Vector, and Tensor Cornell Interactions, Advances in High Energy Physics, vol. 2012, Article ID 707041, 17 pages, 2012.

E-mail: luisaugustotrevisan@yahoo.com.br