

Second-order supersymmetric partners of the trigonometric Rosen-Morse potential

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The trigonometric Rosen-Morse (TRM) potential

$$V(x) = \frac{a(a+1)}{2} \csc^2(x) - b \cot(x), \quad a > 0, b \in \mathbb{R}$$

is defined on the finite domain $(0, \pi)$, it is exactly solvable and its Hamiltonian has an infinite discrete spectrum whose energy levels do not have a polynomial dependence in the index labeling them. These properties make it ideal as a toy model for studying nonlinear algebras and supersymmetric quantum mechanics (SUSY QM) [1, 2]. Hence, in this work we will implement the second-order SUSY transformations for the TRM potential.

In the first place, the stationary Schrödinger equation will be solved in order to find both, the bound states as well as the non-physical solution which will depend on the parameters of the potential and the associated factorization energies. These expression will make easy to study the solutions behavior, particularly for the non-physical case.

Then, we proceed to choose carefully the solutions to be used as the seeds for implementing the SUSY transformations, which will depend also of the two constants involved in the general linear combination of the two linearly independent solutions chosen to expand the solution space.

These results are used to study next the second-order SUSY transformations, by exploring all the possible combinations of the two factorization energies that lead to a real final potential, namely, the so-called real, complex and confluent cases [1, 2]. From these, only the real case has been partially analyzed in the past [3], leaving unexplored the situation when the factorization energies do not belong to the spectrum of the TRM potential.

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We not only will reproduce the results reported in [3], but we will go beyond to complete the study for the real case, we will develop the complex case in full and we will study partially the confluent case, by considering only the situation when the factorization energy belongs to the energy spectrum in the last case.

At the end we will study some properties of the second-order SUSY partners of the TRM potential, as their corresponding spectra and associated eigenfunctions. This is the main goal of this work, namely, the generation of exactly solvable potentials departing from the TRM potentials.

- [1] D. J. Fernández, Supersymmetric quantum mechanics, *AIP Conf. Proc.* **1287** (2010) 3–36
- [2] D. J. Fernández and N. Fernández-García, Higher-order supersymmetric quantum mechanics, *AIP Conf. Proc.* **744** (2005) 236–273
- [3] S. Domínguez-Hernández and D. J. Fernández, Rosen-Morse potential and its supersymmetric partners, *Int. J. Theor. Phys.* **50** (2011) 1993–2001

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