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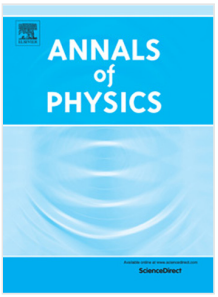

Accidental crossing of energy eigenvalues in $\mathcal{P}T$-symmetric Natanzon-class potentials

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Accidental crossing of energy eigenvalues in $\mathcal{PT}$-symmetric Natanzon-class potentials

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Abstract

The accidental crossing of energy levels is studied for a number of exactly solvable $\mathcal{PT}$-symmetric potentials in one spatial dimension. This phenomenon occurs when the potential possesses two series of bound-state levels discriminated by the $q = \pm$ quasi-parity quantum number and a potential parameter is tuned to specific values. In contrast with the coalescing of two such real-energy levels with the same n quantum number and continuing as a complex conjugate pair, corresponding to the breakdown of $\mathcal{PT}$ symmetry, accidental crossing occurs for energy levels with *different* n and q. In this case the energy eigenvalues become degenerate, and the corresponding wave functions become linearly dependent. It is shown that besides the known examples, the $\mathcal{PT}$-symmetric harmonic oscillator, Coulomb and Scarf II potentials, this phenomenon occurs for any member of the Natanzon potential class for which the q quantum number can be defined. Two such potentials are discussed as concrete examples: the $\mathcal{PT}$-symmetric generalized Ginocchio potential and a four-parameter subset of the Natanzon potential class. These potentials have been described in detail previously, however, the accidental crossing of their energy eigenvalues has not been noticed then.

Keywords: Exactly solvable potentials, $\mathcal{PT}$ symmetry, bound states, structure of the energy spectrum
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