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Editorial

Special Issue: "Symmetries in Quantum Mechanics and Statistical Physics"

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Symmetry is a fundamental concept in science and has played a significant role since the early days of quantum physics. In physics, symmetry characterises the invariance of a system under certain transformations, being either discrete like mirror symmetry or continuous like rotational symmetry. In mathematics, symmetries are described by group theoretic means.

Symmetry methods are still powerful tools in contemporary problems of quantum mechanics and statistical physics and go beyond the classical Lie groups and algebras. Examples are the so-called supersymmetric quantum mechanics and the PT–invariance of non-Hermitian Hamiltonians, but also include duality concepts, besides others. This Special Issue presents recent contributions to such new fundamental symmetry concepts.

The work by Znojil [1] investigates non-Hermitian PT-symmetric extensions of Bose–Hubbard-like models. Particular focus is made on perturbations near so-called exceptional points, that is, points within the real spectrum of non-Hermitian Hamiltonians exhibiting degeneracy, and its stability under perturbations.

This special issue also contributes several new results on various topics related to supersymmetric quantum mechanics (SUSY QM). The work by Quesne [2] increases the number of exactly solvable quantum models by extending the shape-invariance concept of SUSY QM to deformed SUSY QM models. Gadella et al. [3] present a thorough and complete study of the various supersymmetric partners of the one-dimensional infinite square-well model, with particular focus on self-adjoint extensions. The contributions by the editor discuss the SUSY QM structure of relativistic Hamiltonians. In [4], generic relativistic Hamiltonians for an arbitrary spin are considered, and a SUSY QM structure is obtained under certain conditions. In a second contribution [5], the Klein–Gordon oscillator is discussed explicitly, and SUSY is utilised to find a closed form expression for the eigenvalues and eigenfunction, as well as for the corresponding Green's function.

The contributions by Inomata et al. [6] and Zhao et al. [7] reconsider joint transformations of space and time, mapping different physical systems onto each other. In [6], the well-known Newton–Hooke duality and its generalization to arbitrary power-law potentials is reviewed. Here, duality is viewed as a symmetry concept. The contribution [7] reconsiders space–time transformations, mapping a quadradic system onto that of a free particle. The close relation of this transformation with the time-dependent Bargmann-conformal transformation is established and illustrated.

Finally, the contribution by Schulman [8] takes a fresh look into the spreading of wave packets. Whereas wave packets spreading in a Gaussian-like manner may be localized due to scattering, it is argued that this localization may not happen for wave packets spreading faster than in a Gaussian manner.

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