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Editorial

Editorial Conclusion for the Special Issue "Measurements in Quantum Mechanics"

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This Special Issue is devoted to the broad range of topics related to the problem of quantum measurements, which is as old as the modern concept of quantum mechanics. Understanding quantum mechanics is impossible without understanding quantum measurements. The discussion on how to interpret the quantum measurement results began long ago: Here, one should mention the Bohr–Einstein debates, which resulted in both the Einstein–Podolsky–Rosen (EPR) and Schrödinger's cat paradoxes . These interpretation problems were the result of an apparent conflict between several principles of the quantum theory of measurement. A related question is what the relationship will be between the measurement results of two different observables that lead to uncertainty relations. In general, the measurement problem is not simply an internal interpretative problem of quantum mechanics but also an inspiration for theoretical and experimental research and philosophical debate. The range of topics for research is very broad: the von Neumann model of ideal measurements, quantum models of the measurement process, single measurements (destructive or not), and many successive measurements, including continuous (quantum Zeno and anti-Zeno effects) and so-called weak measurements, as well as uncertainty relations (including entropic and generalized), experiments with measurements of an individual atomic particle (quantum dots, quantum traps, and related problems), single-slit diffraction experiments, and others.

We received eight submissions for this Special Issue and, after a comprehensive review process, accepted five high-quality works for publication. Among the accepted papers, Sayed Abdel-Khalek et al. [1] examine quantum entanglement for more general states of two-qubit systems in the context of spin-coherent states (SCSs). They consider concurrence as a quantifier of entanglement and express it in terms of SCSs. They also determine a new set of maximally entangled conditions that provide the maximal amount of entanglement for certain values of the amplitudes of SCSs for the case of pure states. Finally, they also examine the entanglement of a class of two-qubit mixed states and analyze its range.

Stefan Heusler et al. [2] ask questions: What is the origin of quantum randomness? Why does the deterministic, unitary time development in Hilbert space (the "4π-realm") lead to the probabilistic behavior of observables in space–time (the "π-realm")? To answer these questions, they propose a simple topological model for quantum randomness. They follow Kauffmann and elaborate the mathematical structures that result from a distinction (A, B) using group theory and topology. They show that the 2:1 mapping from $SL(2, C)$ to the Lorentz group $SO(3, 1)$ is responsible for the stochastic nature of observables in quantum physics: It is because this that 2:1 mapping breaks down during interactions. They argue that the entanglement leads to topological changes, such that a distinction between A and B becomes impossible. They also introduce the counterpart to distinctions, namely entanglement: Their model suggests that entanglement is increased when decreasing the number of possible distinctions. They use non-trivial formalism in their argument based on virtual Dehn twists and torus splitting; however, their resulting haptic model appears to be very simple.

Vin Le Duc et al. [3] consider two $\mathcal{PT}$-symmetric models, consisting of two or three single-mode cavities. In their both models, the cavities are coupled to each other by linear

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interactions, forming a linear chain. Additionally, the first and last of such cavities interact with an environment. The considered models are $\mathcal{PT}$-symmetric, which means that these models are described by non-Hermitian Hamiltonians that, for a specific range of system parameters, possess real eigenvalues. The authors show that the steering generation process strongly depends on the coupling strengths and rates of the gains/losses in energy in their considered models. Moreover, they find the values of parameters describing the system for which the steering appears.

Mariam Algarni et al. [4] examine the dynamical behavior of the coherence in open quantum systems using the l_1 norm. They consider a two-qubit system that evolves in the framework of Kossakowski-type quantum dynamical semigroups of completely positive maps. Considering this system, they find that quantum coherence can be asymptotically maintained with respect to the ystem parameters' values. What is more, they show that quantum coherence can resist the environmental effects and preserve even in long time regimes. Their results also show that the initially separable states can provide a finite value of coherence during the time evolution. From such properties, their results show that several states in the type of environments they consider are good candidates for incorporating quantum information and optics schemes. Finally, they compare the dynamical behavior of the coherence with the entire quantum correlation

Jake Southall et al. [5] compare Hermitian and Non-Hermitian quantum electrodynamics. They identify a non-standard inner product that implies bosonic commutator relations for local electric and magnetic field observables and leads to a natural local biorthogonal description of the quantized electromagnetic field. When comparing this description with an alternative local Hermitian, in which the states of local photonic particles, i.e., of so-called bosons localized in position (blips), are orthogonal under the conventional Hermitian inner product, they find that there is an equivalence between the two approaches. It is emphasized in this paper that careful consideration needs to be given to the physical interpretation of the different descriptions. They also determine whether a Hermitian or non-Hermitian approach is more suitable, depending on the circumstances that one wants to model.

In conclusion, I have done my best to select papers covering some topics of quantum measurements and its related problems to adequately contribute to the existing literature. As guest editor, I would like to thank the Editor-in-Chief, Prof. Dr. Sergei D. Odintsov, the editorial team, and the reviewers of *Symmetry*, who helped me on my journey to publish this Special Issue.

Conflicts of Interest: The authors declare no conflict of interest.

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