The new probabilistic approach to the Quantum Mechanics

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In this note I shall describe the program of the research which is already partially realized.

(Preliminary warning: this approach has nothing to do with the Quantum Probability Theory or with the Quantum Logic.)

The main goal: to find not only solution to quantum paradoxes but to find what Quantum Mechanics is.

Starting ideas:

(i) Quantum Mechanics (QM) could be understood as the new applied probability theory
(ii) The standard Classical probability theory of the Kolmogorov type cannot be used in the description of QM since it cannot model the reversible time evolution
(iii) It is necessary to use the Extended Probability Theory (EPT) developed in [1] which is the extension of Classical probability theory (it allows the reversible time evolution)
(iv) It is necessary to apply EPT to physical systems and to complete it with the reversible time evolution – the resulting theory will be called the Quadratic Probability Theory (QPT)
(v) The real (i.e. based on the field of real numbers instead of the field of complex numbers) QM will be used as a testing model (as a Laboratory, like a "toy theory") since it is sufficiently closed to QM and since QPT can be directly applied to the real QM
(vi) Then the complex structure will be introduced into QPT and the probabilistic model for the full QM will be developed (in each case QM can be represented as the real QM plus certain symmetry condition)

Some steps have already been done:

(i) The extended probability theory was developed in [1], where also the concept of the quadratic probability space was introduced. In this paper I have also introduced the idea how to solve the problem of the "which way information" (containing the problem of the superposition)

(ii) If the study of the extended probability theory is completed by the idea of the reversible time evolution using the group of orthogonal transformations then the quadratic probability theory was created in [2]

(iii) In [2] also the realization of the real QM as the quadratic probability theory was given

(iv) In [2] the analysis of the internal measurement process in the quantum theory was given and it was shown that together with the concept of the observation it can explain the measurement problem of QM.

(v) Then this theory was extended to the complex QM and it was called the modified QM.

(vi) The modified QM was expressed as an axiomatic theory in [3] where the central anti-von Neumann axiom was introduced and its role was clarified

(vii) Then the role of the von Neumann axiom was made clear and the necessity of the anti-von Neumann axiom was specified in [4]

(viii) The discussion of collateral problems was done: Bell inequalities and the logical error in their derivation [5], the meaning of Bell inequalities [6], the variants of non-realistic formulations of QM [7]

The aims of this project:

(i) To define the modified QM as the theory based on the anti-von Neumann axiom

(ii) To show that the modified QM is the applied probability theory, which is based on the quadratic probability theory instead of the classical probability theory

(iii) As a consequence of (i) to show that the concept of the state of the system can be associated, in general, only with the ensemble and that the time evolution transforms the state of an ensemble onto the state of an ensemble;

(iv) To explain the so-called quantum measurement process as the internal process in the modified QM based on the concept of the external process of an observation (partially realized in [3])

(v) To describe the collapse process as the selection process intrinsic to the modified QM creating the sub-ensemble from a given ensemble

(vi) To give the local explanation of the EPR correlations in the modified QM (partially realized in [2])

(vii) To show that the modified QM is the local theory (partially realized in [2] and [3])

(viii) To show that the modified QM has the same experimental consequences as the standard QM, so that the standard QM and the modified QM are not experimentally distinguishable (partially realized in [2] and [3])

(ix) To show that the so-called wave-particle duality is not true in the modified QM: to show that the particle properties can be associated with the individual system, while the wave properties can be associate only with the ensemble of systems

(x) To show that individual systems have only “particle” properties and not any “wave” properties and that the wave properties can be attributed only to the ensembles of systems

(xi) In conclusion to show that QM can be understood as the quadratic probability theory completed with some “complex symmetry”, i.e. to show what QM really is

The expected results:

(i) QM is the quadratic probability theory completed with the reversible time evolution satisfying certain complex symmetry
(ii) The QM state means, in general, the state of ensemble of systems, i.e. the probability distribution in QPT
(iii) In certain cases, the state of an ensemble can be homogeneous, i.e. containing systems in the same “individual” state, in such a situation the state of an ensemble will be called deterministic and the state of this individual system will be called the individual state
(iv) The evolution transforms the state of the ensemble onto the new state of an ensemble; in general, the evolution of the individual state of the system does not exists – only the evolution of the state of an ensemble exists and it has the standard meaning
(v) The internal measurement process can be described using the concept of an observation
(vi) The collapse problem will be completely explained as the selection process selecting the sub-ensemble from the given ensemble
(vii) EPR correlations will be completely explained in the local manner (this explanation is the necessary prerequisite of any consistent interpretation)
(viii) The role of the “which way information” can be rationally explained in the modified QM
(ix) The “delayed choice experiments” can be rationally explained in the modified QM; the explanation is based on the concept of the context (which is associated to a given experimental setting)
(x) On the basis of the quadratic probability theory the modified QM can be considered as the standard probabilistic system
(xi) So-called particle properties can be associated with an individual system while so-called wave properties can be associated only with ensembles. This implies that individual systems cannot have any wave properties
(xii) Individual systems are particles and not waves - wave properties are probabilistic properties of the state of an ensemble
(xiii) The complete solution of the wave-particle duality
(xiv) The answer to the question what QM is: QM is the applied quadratic probabilistic theory of many-particle systems satisfying certain intrinsic complex symmetry
(xv) The validity of QM implies that Nature has chosen the quadratic probability theory as the basic theory of Nature

References

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