The local explanation of EPR correlations in the modified Quantum Mechanics

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Abstract. In this note we shall give the simple formulation of the local explanation of EPR correlations [1] based on [2]. We also show that Bell inequalities cannot be derived in the modified Quantum Mechanics (QM).

Let us consider systems **S** and **R** which are in the standard entangled singlet state and the measuring systems **A** at the area of Alice and **B** at the area of Bob.

The measuring system **A** has the basis |A+>, |A-> where these two states are individual states and let us assume that in the standard (von Neumann) measurement the state |A+> is linked to the state |Sφ+> of the measured system **S** and the state |A-> is linked to the state |Sφ->. The system **S** has individual states |S+>, |S-> and states |Sφ+>, |Sφ-> are not individual states but collective states, i.e. states of ensembles. The same for Bob, i.e. |B+>, |B->, |Rφ+>, |Rφ-> and Bob`s measurement links |B+> with |Rφ+> and |B-> with |Rφ->.

I shall describe at first the situation in terms of ensembles. The state of an ensemble is homogeneous if all systems in this ensemble are in the same individual state, say an ensemble of **A**`s can be in the homogeneous state |A+> in which each individual system **A** is in the individual state |A+>.

Let us assume that Alice has made her measurement and that she has found the system **A** in the individual state |A+>. In terms of ensembles this means that Alice should consider the new ensemble (a sub-ensemble) such that in this sub-ensemble the system **A** is in the state |A+>. The ensemble of whole systems **A**+**S**+**R**+**B** will then be in the state

$$|A+\rangle \otimes |S\varphi+\rangle \otimes |R\varphi-\rangle \otimes |B-\rangle$$

since there are correlations between **A** and **S**, **S** and **R**, **R** and **B**.

Let us now consider the individual run of the experiment, say the first run. This individual experiment must be considered as an element of the ensemble of experiments. This is the consequence of the "Principle of virtual ensemble" (see [2]) which is the hidden assumption of any probability theory: every event can be considered as a member of an ensemble of events (i.e. probability can be associated only with an ensemble, not with the individual event).

Bob`s ensemble will be in the homogeneous state |B-> and thus in the first run Bob obtains that his system **B** will be in the individual state |B->. The point is that after the Alice`s measurement systems **A** and **B** are in the homogeneous states |A+> and |B->, while the states of systems **S** and **R** are in non-homogeneous states |Sφ+> and |Rφ->.

The main fact: states of systems **A** and **B** are correlated individually while states of systems **S** and **R** are correlated collectively, i.e. as ensembles.

There is no correlation between individual states of **S** and **R** in the sub-ensemble. Thus the "nonlocal" correlation between **A** and **B** is mediated by the correlation between ensembles of **S**`s and **R**`s but ensembles are generally nonlocal objects.

Thus the information of the result of Alice`s measurement is transferred to Bob through the virtual ensemble of whole systems. The content of this information is expressed in the fact that Alice`s system **A** is a member of the sub-ensemble. This information need not be transferred to Bob since the unique important information for Bob is the fact that his system **B** is in this sub-ensemble, but this is the consequence of the fact that both Alice and Bob are considering the first run of the experiment.

Simply speaking the point is in the fact that systems **S** and **R** are correlated (after Alice has made her measurement) only collectively, not individually.

From the anti-von Neumann axiom (each two different individual states must be orthogonal) follows simply why Bell inequalities cannot be derived. The derivation is based on the considerations containing individual systems. Each derivation must consider at least two different bases. But there is in disposition only one base containing individual states. Thus in the modified QM there are no Bell inequalities and nonlocality of QM cannot be deduced.

In fact, we have no general proof of the locality of the modified QM, we can only assert that standard proofs of the nonlocality cannot be applied and that EPR correlations can be explained locally.

References

[1] A. Einstein, B. Podolsky, and N. Rosen, “Can quantum-mechanical description of physical reality be considered complete?,” Phys. Rev. 47, 777–780 (1935)

[2] J. Soucek, The principle of anti-superposition in QM and the local solution of the Bell's inequality problem, http://www.nusl.cz/ntk/nusl-177617, available also at http://vixra.org/abs/1502.0088