On a new concept of truth in empirical theories

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Abstract.

We introduce a new concept of truth in empirical theories based on the experience in the study of quantum mechanics. In this concept a statement can be true, false or undecidable.

1. Introduction

It was found (see [2, 3]) that it is necessary to introduce a new concept of truth in quantum mechanics (QM) with respect to the fact that there exists theories which are empirically equal to QM but which are different from QM.

In [3] there were defined concepts of true statements, false statements and undecidable statements in QM. The undecidable statement cannot be considered as true statement and it is thus scientifically unfounded. The consequences for QM are quite important: the individual superposition principle, the Bell's theorem and the nonlocality are undecidable statements. There are also consequences for the Schroedinger's cat paradox and for the measurement problem.

In this paper we generalize these considerations from QM to the situation of the general empirical theory. Under the concept of an empirical theory we mean the theory which truth depends exclusively on the comparison of the empirical predictions of this theory to the reality (as found in experiments).

Below we shall introduce corresponding concepts and we shall consider their consequences for the description of truth in empirical theories.

2. A new concept of truth in empirical theories

We shall generalize the basic notions from [1].

Definition 1. Two theories are empirically equivalent if their empirical predictions are identical.

Let us consider an empirical theory T.

Definition 2. A Tversion is each theory which is empirically equivalent to the theory T.

It is important to understand that both definitions do not use the concept of the experimental verification. Only the concept of the empirical predictions of a given theory is used. This means that the concept of empirically equivalent theories depends only on these theories and does not depend on any experiments.

Tversions are empirically indistinguishable among them so that we can define a new concept of truth in T.

Definition 3.

(i) The statement S is true in T if S is true in each Tversion.
(ii) The statement S is undecidable in T if S is true in some Tversion and S is false in some other Tversion.
(iii) The statement S is false in T if S is false in each Tversion.

It is evident that every empirical prediction of T is the true statement in T.

There are following basic consequences of these concepts.

Definition 4.

(i) The statement S is well-founded in T if it is true in every Tversion.
(ii) The statement S is unfounded in T if it false in some Tversion.

Theorem

(i) The statement S is well-founded in T if and only if S is true in T.
(ii) The statement S is unfounded in T if and only if either S is undecidable in T or S is false in T

Proof. (i) The statement S is true in all Tversions so that S cannot be undecidable in T and S cannot be false in T. (ii) In this case the statement S is false in some Tversion so S cannot be true in all Tversions.

This means that only well-founded statements can be considered as really true.

Undecidable statements are not true and not false.

This means that we are not able to choose the “right” Tversion (i.e. the choice based on the empirical evidence is impossible) since all Tversions are empirically equivalent.

3. The principle of objectivity and the completeness

At first we consider the principle of objectivity**.**

The principle of objectivity

(i) No undecidable statement in T can be considered as a true statement or as a false statement.

(ii) The idea that there exists certain (currently unknown) Tversion which is "really true" should be rejected (i.e. the idea of the preferred Tversion should be rejected).

We think that from the principle of objectivity it follows that all Tversions must be considered as equivalent and no Tversion can be preferred.

It can be mentioned the so-called Occam`s razor saying that the simplest variant should be chosen. But in science Occam`s razor cannot be used: the Wikipedia says "In science, Occam's razor is used as a heuristic technique (discovery tool) to guide scientists in the development of theoretical models, rather than as an arbiter between published models." – see [4] and also the discussion in [2]. (In general, it is by no means clear that Nature prefers the simplest variant.)

Concepts introduced here can be applied only in the situation where there exist two Tversions W and W' such that W and W' are theoretically different (i.e. there exists a statement S which is true in W and is false in W'.

Definition.

A theory T is called empirically complete if there do not exist two Tversions W and W' which are theoretically different (i.e. there exists a statement S such that S is true in W but S is false in W').

In other words, theory T is empirically complete if there do not exist undecidable statements in T.

The theory T is empirically incomplete if there exists at least one undecidable statement in T.

Empirical completeness thus means that all Tversions are theoretically identical.

Evidently there exist theories which are empirically incomplete, e.g. quantum mechanics, so that the considerations proposed here are non-trivial.

We do not know other examples of empirically complete or empirically incomplete theories.

4. Conclusion

The basic consequence of our considerations is the fact that there exist situations where the theory is not determined uniquely by its empirical content. There exists a case of this situation – quantum mechanics.

In such a situation it is natural to introduce the concepts of a true statement, a false statement and an undecidable statement. As a consequence we obtain that the set of true statements is more limited than supposed previously and that some statements considered before as true can be not true.

The question whether this behavior is common or rear is at the moment unclear and it needs more detailed study. All this discussion must be limited to empirical theories.

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