PHYSICAL PROPOSITIONS AND QUANTUM LANGUAGES

Claudio Garola,
Dipartimento di Fisica e Sezione INFN, Università di Lecce,
Via Arnesano, 73100 Lecce, Italy.
E-mail: Garola@le.infn.it

Whenever the orthodox interpretation of quantum mechanics (QM) is adopted, the propositions of (standard, sharp) quantum logic (QL) cannot be associated with sentences of a language stating properties of individual samples of a physical system (*physical objects*) and endowed with a classical model-theoretical semantics. Within this interpretation, indeed, properties are *nonobjective*, which implies that, if a universe of physical objects and a physical property E are given, E cannot be associated with an *extension* consisting of all objects that possess E, independently of any measurement. Within the *semantic realism* (SR) interpretation propounded by the author, instead, the above association is possible. This allows one to build up a general scheme according to which a physical proposition (*i.e.* a set of states, that can be interpreted as possible worlds, but also as referents of predicates) is associated with every sentence of a classical language $L(x)$ whose elementary sentences state properties of a physical object x. Furthermore, a subset of *testable* sentences of $L(x)$ can be selected by adopting a general criterion of testability. The subset P_T^f of all testable physical propositions corresponding to testable sentences of $L(x)$ can be partially ordered by set theoretical inclusion $\subseteq$, and one can show, under reasonable physical assumptions, that $(P_T^f\ ,\subseteq)$ is a Boolean lattice in classical physics, while it can be identified with QL in QM. Moreover a quantum language $L_{TQ}(x)$ with new quantum connectives can be constructed such that its Lindenbaum-Tarski algebra can be identified with $(P_T^f\ ,\subseteq)$. The sentences of $L_{TQ}(x)$ possess both a classical and a quantum truth value (the latter of course is defined only on a subset of sentences of $L_{TQ}(x)$ depending on the state S). This shows that the classical and the quantum notion of truth can coexist within the SR interpretation, since they refer to different metalinguistic concepts (classical truth and verifiability within QM, respectively). One thus realizes an *integrated perspective* which avoids a number of problems following from admitting the existence of two incompatible notions of truth in physical reasonings (in particular, classical truth in the metalanguage, quantum truth in the object language of QM).