Symmetry Breaking, Quantum Protectorate and Quasiaverages in Condensed Matter Physics

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It is well known that symmetry principles play a crucial role in physics [1]. The theory of symmetry is a basic tool for understanding and formulating the fundamental notions of physics [2]. In the present work we focus on the applications of the symmetry principles to quantum solid state theory. The development and applications of the method of quasiaverages, formulated by N.N. Bogoliubov, to quantum statistical mechanics and to quantum solid state theory and, in particular, to quantum theory of magnetism, are discussed. Some physical implications involved in a new concept, termed the **quantum protectorate**, are reviewed. In addition, the interrelation of the concepts of symmetry breaking [3, 4, 5, 6], quasiaverages and quantum protectorate are analyzed in the context of quantum theory of magnetism and BCS-Bogoliubov theory of superconductivity. The detailed analysis was carried out of the idea of quantum protectorate in the context of quantum theory of magnetism. This idea reveals the essential difference in the behaviour of the complex many-body systems at the low-energy and high-energy scales. It is suggested that the difficulties in the formulation of quantum theory of magnetism at the microscopic level, that are related to the choice of relevant models, can be understood better in the light of the quantum protectorate concept [7]. We argue that the difficulties in the formulation of adequate microscopic models of electron and magnetic properties of materials are intimately related to dual, **itinerant** and **localized** behaviour of electrons. We formulate a criterion of what basic picture describes best this dual behaviour. The main suggestion is that quasi-particle excitation spectra might provide distinctive signatures and good criteria for the appropriate choice of the relevant model. A broad class of the problems of condensed matter physics [8] in the fields of the magnetism and superconductivity of complex materials are reviewed in relation to these ideas.

References

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