Moscow International Symposium on Magnetism

Dedicated to the 80th anniversary of Magnetism Department and the Centenary of Konstantin Belov

August 21-25, 2011

Book of Abstracts

M.V. Lomonosov State University, Faculty of Physics

Main Topics

Spintronics and Magnetotransport
Magnetophotonics (linear and nonlinear magnetooptics, magnetophotonic crystals)
High Frequency Properties and Metamaterials
Diluted Magnetic Semiconductors and Oxides
Magnetic Nanostructures and Low Dimensional Magnetism
Micromagnetics
Magnetic Soft Matter (magnetic polymers, complex magnetic fluids and suspensions)
Soft and Hard Magnetic Materials
Magnetostructural Transition related effects (Shape-memory alloys and Magnetocaloric effect)
Multiferroics
Magnetism and Superconductivity
Magnetism in Biology and Medicine
Miscellaneous
Theory

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QUANTUM THEORY OF MAGNETISM AND THE PROBLEM OF MAGNETIC ORDERING IN CARBON-BASED SYSTEMS

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The development of experimental techniques over the recent years opened the possibility for synthesis and investigations of a wide class of new substances with unusual combination of properties. Transition and rare-earth metals and especially compounds containing transition and rare-earth elements possess a fairly diverse range of magnetic properties. The construction of a consistent microscopic theory explaining the magnetic properties of these substances encounters serious difficulties when trying to describe the collectivization-localization duality in the behaviour of magneto-active electrons. This problem appears to be extremely important, since its solution gives us a key to understanding magnetic, electronic, and other properties of this diverse group of substances. Quantum theory of magnetism deals with variety of the schematic models of magnetic behaviour of real magnetic materials. In paper [1] we presented a comparative analysis of these models; in particular, we compared their applicability for description of complex magnetic materials. The concepts of broken symmetry, quantum protectorate, and quasiaverages were analysed in the context of quantum theory of magnetism, especially for the low-dimensional systems, in paper [2]. As a rule, magnetic materials can be metals, semiconductors or insulators which contain the ions of the transition metals or rare-earth metals with unfilled shells. However during the last decade the search for macroscopic magnetic ordering in exotic materials has attracted big attention. In particular, the carbon-based materials were pushed into the first row of researches. Carbon materials are unique in many ways. They are characterized by the various allotropic forms that carbon materials can assume. In spite of the fact that graphite is diamagnetic, in 2001 an “observation of strong magnetic signals in rhombohedral pristine C60, indicating a Curie temperature near 400-500K” was reported. Recently a “room-temperature ferromagnetism of graphene” [3] was claimed. Some evidence that proton irradiation on highly oriented pyrolytic graphite samples may triggers ferro- or ferrimagnetism was reported. The possibility of a magnetism in grapheme nanoislands was speculated and a defective graphene phase predicted to be a room temperature ferromagnetic semiconductor was conjectured. Thus the natural question arises: can carbone-based materials be magnetic and what is the mechanism of the appearing of the magnetic state from the point of view of the quantum theory of magnetism? In the present work, these questions were analysed and reconsidered to elucidate the possible relevant mechanism (if any) which may be responsible for observed peculiarities of the “magnetic” behaviour in these systems, having in mind the quantum theory of magnetism criteria. On the basis of this analysis the conclusion was made that the thorough and detailed experimental studies of this problem only may lead us to a better understanding of the very complicated problem of magnetism of carbon-based materials.

[1] A.L. Kuzemsky, Statistical Mechanics and the Physics of Many-Particle Model Systems. *Physics of Particles and Nuclei*, 40 (2009) 949-997.
[2] A.L. Kuzemsky, Bogoliubov's Vision: Quasiaverages and Broken Symmetry to Quantum Protectorate and Emergence. *Int.J. Mod. Phys.*, B24 (2010) 835-935.
[3] Yan Wang et al., Room-Temperature Ferromagnetism of Graphene. *Nano Letters*, 9 (2009) 220-224.