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LABORATOIRE DE PHYSIQUE THÉORIQUE DE LA MATIÈRE CONDENSÉE
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Official referee's report
on the dissertation by Shpot Mykola Adrianovych
«Critical behavior of spatially inhomogeneous systems»
submitted for the degree of Doctor of Sciences in Physics and Mathematics
in specialization 01.04.02 – Theoretical Physics.

The habilitation thesis by Mykola Adrianovych Shpot represents an original and interesting investigation of the critical behavior of several inhomogeneous statistical systems containing quenched disorder. In particular, the Author study the models with translational-invariance breaking which appears due to the boundary and finite-size effects as well as due to strong spatial anisotropy. As most of the realistic physical systems possess at least some of such features, their theoretical study is quite important. Although some of the considered problems are not new, a nice feature of the Author's work is that he followed investigations of relevant features of the previous works, and performs interesting comparisons with his own results. As the considered systems are sufficiently sophisticated, for their study the Author performs essential developments of existing standard theoretical methods, which of course is interesting in itself.

The dissertation has the standard structure: abstract, introduction, review chapter, and six sections followed by the references and appendices.

The review chapter provides a compact physical insight into the problems to be considered in the main text. Here these problems are introduced in terms of the original microscopic spin Hamiltonians, thus providing a good physical background for further studies using effective Landau-Ginzburg-Wilson approach. The relevant literature is analyzed with an emphasis of the role of the Author's contributions.

Section 2 is devoted to the study of the quenched dilute Ising model (DIM). For a given *non-integer* value of the space dimension d this system is studied in terms of the Parisi's massive field theory providing the dependence of the critical exponents on the space dimensionality d. It is interesting to note that further rather involved calculation of the universal critical amplitude combinations shows that the specific heat amplitude ratio turns out to be positive in dimensions d=3, although it has to be noted that derived here double series expansions seem to be badly divergent so that obtained numerical estimates are not very accurate.

In Section 3 the massive field theory is formulated for semi-infinite systems with a boundary. The main output of this chapter is a number of numerical estimates of surface critical exponents appropriate for two kinds of transitions: special and ordinary. It is worthing to note that these results (published in Nucl. Phys. B in 1998) have got more than 130 citations.

Section 4 contains an investigation of strongly anisotropic systems close to a special multicritical Lifshitz point (LP). Here for the first time (after numerous false approaches and incorrect results in this field), the Author obtains the correct critical exponents in this nontrivial theory. Besides, he discuss an interesting problem of a possible influence of cubic anisotropy in the modulation space on the critical behavior at LP.

In Section 5 the Author presents the results of the epsilon-expansion, for two-point correlators. He concentrates on the local scaling invariance (LSI) hypothesis by Malte Henkel which is a counterpart of the conformal invariance for the special case of the LP, and, eventually, dynamic systems. The author investigates its mathematical background, the range of validity, and compares its predictions with his own explicit results.

In Section 6 the Author derives LP critical exponents in terms of large-n expansion. The special feature of this method is that it works directly in any dimension where the phase transition exists, and does not require any dimensional expansion which makes it feasible near the upper and the lower critical dimensions. Besides the Author gives the qualitative prediction on the behavior of the LP critical exponents as a function of the space dimension d, and compare it with analogous results obtained by the other methods.

Finally, Section 7 is devoted to the so called "statistical" Casimir effect in systems constrained in one direction by two parallel boundaries (which is a counterpart of the classical effect in quantum electrodynamics). The Author argues that for anisotropic systems at the LP near the criticality the values of the Casimir forces induced by fluctuations are dependent on the orientation of the boundaries with respect to the directions of anisotropy. On the other hand, it is shown that in isotropic systems the specific infrared divergences of the epsilon-expansion series result in non-analytic contributions to the corresponding Casimir amplitudes.

In conclusion, the thesis is clearly written and contains many interesting new results. Among the drawbacks I would mention the quality of the table 2.3 which in my view is not very transparent. It is also pity that the Author did not pursue further study of the effects produced by the cubic anisotropy on the critical behavior at the Lifshitz point discussed in Section 4.

The main results contained in this dissertation are fully represented in the papers published in well-established scientific journals such as Physical Review Letters, Nuclear Physics B, etc. Besides, these works have also been presented at numerous international conferences. The Abstract of the present dissertation adequately presents its content and completely covers obtained results. The dissertation by M.A. Shpot fully meets the requirements of the «Procedure for awarding scientific degrees» approved by the resolution of the Cabinet of Ministers of Ukraine on July 24, 2013, № 567, concerning the habilitation dissertations.

The Author, Shpot Mykola Adrianovych, is a well-established scientific researcher, widely known in the scientific community. Certainly, he deserves to be awarded by the degree of Doctor of Sciences in Physics and Mathematics in specialization 01.04.02 – Theoretical Physics.

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