Lifshitz points: Recent theoretical progress

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Lifshitz point (LP) is a special multicritical point, which typically appears in strongly anisotropic systems. An example can be provided by the ANNNI (axial next-nearest neighbor Ising) model with competing ferro- and antiferromagnetic interactions along a singled-out direction where the uniaxial LP is realized. Such spin model systems are well suited for numerical Monte Carlo simulations. Experimentally, LPs have been observed in a number of quite different physical systems. Among them, the best studied material is the magnetic metallic compound MnP.

Recently, the physical properties associated with this special point have been the subject of extensive investigations. Our aim is to give a short review of the critical behavior at LPs and to present the new achievements of its theoretical studies.

First we show the main results of our renormalization-group analysis of the bulk properties of d dimensional systems at m-axial LPs with generic $m \in [0, d]$ by means of an $\epsilon{=}4{+}m/2{-}d$ expansion carried out up to order $O(\epsilon^2)$. LP's critical exponents could also be obtained in the $1/N$ expansion covering the whole accessible region of d, while the large number N of the order-parameter components is taken into account to order $O(1/N)$. Shown to be equivalent in the overlapping regions of validity of these two different approaches, our results resolve a longstanding controversy in a series of previous publications.

At LPs, the question of relevance of spatial anisotropies in m modulation directions is not trivial. We show that they can influence the critical behavior at LPs, in contrast to usual critical points. Another special feature discussed is that the surface properties of bounded systems are different at LPs, depending on the orientation of surfaces with respect to the modulation axes. Finally, we give a taste of fluctuation-induced forces appearing in strongly anisotropic systems at LPs.

The work has been done in collaboration with H. W. Diehl, M. Burgsmüller (Germany), Yu. M. Pis'mak, P. V. Prudnikov (Russia), R. K. P. Zia (USA).