Marginal dimensions for multicritical phase transitions

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The field-theoretical model with $O(n_\|)\oplus O(n_\perp)$ symmetry is known to describe multicritical phase transitions in different physical systems like magnets, superconductors and ^{4}He (see [1]). The phases are described by two order parameters (OPs), a $n_\|$-component one coupled to another one with $n_\perp$ components. Within renormalization group (RG) approach scaling properties of the critical properties of the model are governed by one of three fixed points (FPs) (*isotropic Heisenberg* FP of $O(n_\|+n_\perp)$ symmetry, *decoupled* FP at which OPs are ordering separately, and *biconical* FP). Their stability depend on the OPs dimensions $n_\|$, $n_\perp$ and the space dimension d. We are interested in the surfaces in the $n_\|-n_\perp-d$ space that separate the stability regions of these FPs. Applying resummation techniques to the known two-loop RG functions for $O(n_\|)\oplus O(n_\perp)$ model found in minimal subtraction scheme [2] we obtain these surfaces in $n_\|-n_\perp-d$ space from the stability exponents. Special attention was paid to the stability surface $n_\|^{\mathcal{D}}(n_\perp, d)$, which we calculate as series in ϵ=4−d up to ϵ^4 and for the case d=3 as series in pseudo-ϵ parameter τ up to τ^5 using results for $O(n)$-symmetric model [3,4]. We analyze the obtained results by resummation methods. We also consider the dependence on the space dimension d of another stability surface $n_\|^{\mathcal{H}}(n_\perp, d)$ as well as of the multicritical behavior for the $O(1)\oplus O(2)$ symmetric model relevant for anisotropic antiferromagnets in an external magnetic field.

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