Marginal dimensions for multicritical phase transitions
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The field-theoretical model with $O(n_\parallel) \oplus O(n_\perp)$ 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 $n_\parallel$-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 $O(n_\parallel + n_\perp)$ symmetry, decoupled FP at which OPs are ordering separately, and biconical FP). Their stability depend on the OPs dimensions $n_\parallel, n_\perp$ and the space dimension $d$. We are interested in the surfaces in the $n_\parallel - n_\perp - d$ space that separate the stability regions of these FPs. Applying resummation techniques to the known two-loop RG functions for $O(n_\parallel) \oplus O(n_\perp)$ model found in minimal subtraction scheme [2] we obtain these surfaces in $n_\parallel - n_\perp - d$ space from the stability exponents. Special attention was paid to the stability surface $n_\parallel^{FP}(n_\perp, d)$, which we calculate as series in $\epsilon=4-d$ up to $\epsilon^4$ and for the case $d=3$ as series in pseudo-$\epsilon$ parameter $\tau$ up to $\tau^5$ 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 $n_\parallel^{FP}(n_\perp, d)$ 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.