Power laws and critical exponents in n-vector models

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Goldstone mode singularities and critical exponents in the φ^4 model and corresponding n–vector models are considered within the approach called the GFD (grouping of Feynman diagrams) theory [1,2], which is proposed as an alternative to the perturbative renormalization group (RG) treatment. Monte Carlo (MC) evidences [3,4], completed by the most recent simulation results, support the statement of the GFD theory [2] that the Goldstone mode power–law singularities below the critical point are described by certain nontrivial exponents. We have tested also the critical–point singularities and critical exponents found within this approach [1]. A non-perturbative proof concerning corrections to scaling in the two–point correlation of the φ^4 shows that predictions of the GFD theory rather than those of the perturbative RG theory can be correct. We find that the recent MC data for the 3D Ising model ($n = 1$) on very large lattices (up to linear size $L = 1536$) can be well fit with the critical exponents $\eta = \omega = 1/8$ and $\nu = 2/3$, proposed by certain general conjecture made within the GFD theory. We demonstrate also that the known very accurate experimental specific heat data, obtained in zero–gravity conditions very close to the λ–transition point in liquid helium, can be well described by an expansion in powers of $t^{-\alpha}$ with the critical exponent $\alpha \approx -1/13$, estimated as a fit parameter at very small reduced temperatures t. It confirms our conjecture at $n = 2$.

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