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The three-dimensional $O(n \to \infty)$ ϕ^4 model on a strip with free boundary conditions: exact results for a nontrivial dimensional crossover HANS WERNER DIEHL, SERGEI RUTKEVICH, Univ Duisburg-Essen — The $O(2)$ ϕ^4 model on a 3D film of thickness L with free boundaries is relevant for the explanation of the thinning of wetting layers of ^{4}He caused by critical Casimir forces near and below the λ-transition. Just as its $O(n)$ analog, the model has long-range order below the bulk critical temperature T_c if $L = \infty$, but remains disordered for all $T > 0$ when $L < \infty$. A proper analysis of its scaling behavior near T_c is challenging: it involves a nontrivial dimensional crossover in addition to bulk, boundary, and finite-size critical behaviors. The $n \to \infty$ limit of the model can be solved exactly in terms of the eigenvalues and eigenfunctions of a self-consistent Schrödinger equation whose potential $v(z)$ becomes singular at the boundary planes. Complementing recent numerically exact results, we derive various exact analytical results for series expansion coefficients of $v(z)$, its $L = \infty$ scattering data for all values $m0$ of the termperature scaling field, and the low-temperature asymptotic behavior of the residual free energy and the Casimir force using a combination of boundary-operator and short-distance expansions, proper extensions of inverse scattering theory, new trace formulae, and semi-classical expansions.

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