

Course: Statistical Mechanics/Scaling theory/Kadanoff's scaling and correlation lengths

As we have seen, Widom's static scaling theory allows us to determine exact relations between critical exponents, and to interpret the scaling properties of systems near a critical point.

However, this theory is based upon the following equation:

$$f(T, H) = f_r(T, H) + f_s(t, h)$$

but gives no physical interpretation of it; in other words, it does not tell anything about the physical origin of scaling laws. Furthermore, as we have noticed Widom's theory does not involve correlation lengths, so it tells nothing about the critical exponents ν and η .

We know (see [Long range correlations](#)) that one of the characteristic traits of critical phenomena is the divergence of the correlation length ξ , which becomes the only physically relevant length near a critical point. However, by now we are unable to tell if and how this is related to Widom's scaling hypothesis; everything will become more clear within the framework of [The Renormalization Group](#), in which we will see that Widom's assumption is a consequence of the divergence of correlation length.

Nonetheless, before the introduction of the Renormalization Group Kadanoff proposed a plausibility argument for his assumption applied to the Ising model, which we are now going to analyse. We will see that Kadanoff's argument, which is based upon the intuition that the divergence of ξ implies a relation between the coupling constants of an effective Hamiltonian and the length on which the order parameter is defined, is correct in principle but not in detail because these relations are in reality more complex than what predicted by Kadanoff; furthermore, Kadanoff's argument does not allow an explicit computation of critical exponents. We will have to wait for [The Renormalization Group](#) in order to solve these problems.



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1.1 Text

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