**Self Consistent Theory**

We can go beyond first order PT by using the same self-consistent technique that was used to evaluate the diffusion pole in the density-density propagator. This will include contributions in all orders of 1/kFℓ (which are all the same order in the strong localization limit), and is equivalent, it seems, to some sort of mean field theory. We get the following results in the thermodynamic limit (what about backing up from the limit? but we technically can’t, right?, because the Kubo formula technically presumes we’re already at L = ∞, because of the infinitesimal convergence factor):

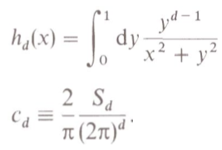


where W = 1/kFℓ. We find that the conductivity is zero in the thermodynamic limit, of course, except for in d > 2 dimensions, where a critically high disorder is needed. We’ll note that infinitesimal disorder localizes in d = 2 + ε dimensions. We find the same critical disorder in d > 2 as we did when calculating the diffusion ‘constant’.

We can back up from the thermodynamic limit, and work out results for finite sized metals. But there is some ‘trouble’ defining g, that he discusses to some degree. I’m not sure what it is exactly. But he seems to just replace k = 0 as the lower limit for the integrals in the self-consistent approach with k = 1/L, and also do some other machinations I didn’t really understand. Then we find, for the conductance, in terms of the previously defined localization lengths.



where,



and the localization lengths are (same as before in the Diffusion section):



Looking at g again, see how in the vicinity of the critical point, there is only *one* relevant length scale, ξ, on either side of the transition. On the conducting side it represents roughly 1/σ (see the WL section), and on the insulating side, it represents, well, the localization length. Observe that his results evince a critical exponent relation between the localization length and conductivity:



whereby



This is apparently a universal result. And seems to reinforce the idea that this theory is therefore valid in a certain dimension, perhaps d = 4 or something.

Markos says that self-consistent theory **doesn’t** give the correct exponents. That’s likely because it is a mean-field theory of some sort. In fact the Anderson model can be solved exactly on a Cayley tree, which seems to be equivalent to infinite dimension, and it gives the same exponents as SCT, reinforcing idea that this is results in some sort of MFT approximation. In 2008 Garcia-Garcia published a paper which modified the SCT (apparently it was able to treat D(q,ω), and not just D(ω)) and resulted in an improved estimate for ν, namely 1.5. But it also violated the Wegner scaling law, so…