EFFECTS OF DISORDER ON THE NON-ZERO TEMPERATURE MOTT TRANSITION

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Introduction

The physics of the metal-insulator transition continues to attract a lot of interest. Much on the interaction-driven transition has been understood using the Dynamical Mean Field Theory [1] (DMFT), which has been especially useful in describing the non-zero temperature behavior of the paramagnetic metal-insulator coexistence region. So far, most theoretical work has concentrated on clean systems, although several experiments indicate that effects of disorder are important in this coexistence regime. Measurements performed in NiSSe mixtures [2] and κ-organics [3] indicate that disorder pushes down the critical temperature end point of the coexistence region. We examined the evolution of the coexistence region as disorder was introduced from the perspective of the disordered Hubbard model, which was solved within the DMFT framework. [4]

Results and Discussion

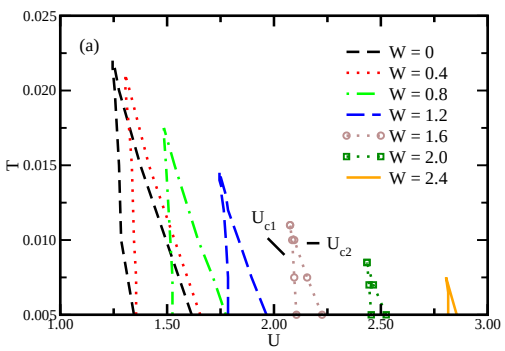

Fig. 1. (U,T) phase diagram for the Hubbard model and different disorder strengths.

Fig. 1 shows the phase diagram at non-zero temperature, for varying levels of disorder W. For each W, the first (from left) of the two lines, the so-called U_{c1}, indicates the stability boundary of the insulating solution. Conversely, the second of the two lines, identified as U_{c2}, represents the boundary of the metallic solution. The coexistence region is found between these two lines, i.e. for $U_{c1}<U<U_{c2}$. As W increases, the metal-insulator transition generally moves to larger U. Physically, this reflects the fact that disorder broadens the bands and smears the gap, making it harder for the Mott-Hubbard gap to open, so that a larger U is necessary for the transition. At the same time, the temperature-dependent coexistence region is found to shrink, persisting only below a critical end-point temperature $T_c(W)$.

In addition to the above results, the simple scaling properties displayed by the distribution of quasiparticle parameters in the metallic regime, at low temperatures, allowed us to characterize the approach to U_{c2}. As shown in [4], it retains a character qualitatively independent of the level of disorder, where the vanishing of quasiparticle weight signals the transmutation of itinerant electrons into localized magnetic moments.

Conclusions

Within the DMFT formulation, we showed that the region between the two spinodal lines U_{c1} and U_{c2} although reduced in size and extent cannot be completely eliminated no matter how large the disorder. This is valid only for weak enough disorder where Anderson localization effects can be ignored. By using a combination of numerical results and analytical arguments, we demonstrated that simple scaling behavior emerges, providing a complete description of the critical regime.

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